**MITSUBISHI ELECTRIC**

# CNC
# MELDAS AC SERVO WITH INDEXING FUNCTION
# MR-J2-CT Series

## SPECIFICATIONS AND INSTRUCTION MANUAL

**MELDAS**

# Introduction

Thank you for selecting the Mitsubishi numerical control unit.

This instruction manual describes the handling and caution points for using this AC servo/spindle.

Incorrect handling may lead to unforeseen accidents, so always read this instruction manual thoroughly to ensure correct usage.

Make sure that this instruction manual is delivered to the end user.

Always store this manual in a safe place.

In order to confirm if all function specifications described in this manual are applicable, refer to the specifications for each CNC.

# Notes on Reading This Manual

(1) Since the description of this specification manual deals with NC in general, for the specifications of individual machine tools, refer to the manuals issued by the respective machine manufacturers.   The "restrictions" and "available functions" described in the manuals issued by the machine manufacturers have precedence to those in this manual.

(2) This manual describes as many special operations as possible, but it should be kept in mind that items not mentioned in this manual cannot be performed.

# Precautions for safety

Please read this manual and auxiliary documents before starting installation, operation, maintenance or inspection to ensure correct usage. Thoroughly understand the device, safety information and precautions before starting operation.

The safety precautions in this instruction manual are ranked as "WARNING" and "CAUTION".

| ⚠ **DANGER** | When there is a potential risk of fatal or serious injuries if handling is mistaken. |
|---|---|

| ⚠ **WARNING** | When a dangerous situation, or fatal or serious injuries may occur if handling is mistaken. |
|---|---|

| ⚠ **CAUTION** | When a dangerous situation may occur if handling is mistaken leading to medium or minor injuries, or physical damage. |
|---|---|

Note that some items described as ⚠ **CAUTION** may lead to major results depending on the situation.    In any case, important information that must be observed is described.

The signs indicating prohibited and mandatory matters are explained below.

| ⊘ | Indicates a prohibited matter. For example, "Fire Prohibited" is indicated as 🚭. |
|---|---|

| ● | Indicates a mandatory matter. For example, grounding is indicated as ⏚. |
|---|---|

After reading this specifications and instructions manual, store it where the user can access it easily for reference.

The numeric control unit is configured of the control unit, operation board, servo drive unit, spindle drive unit, power supply, servomotor and spindle motor, etc.

In this section "Precautions for safety", the following items are generically called the "motor".
- Servomotor
- Linear servomotor
- Spindle motor

In this section "Precautions for safety", the following items are generically called the "unit".
- Servo drive unit
- Spindle drive unit
- Power supply unit
- Scale interface unit
- Magnetic pole detection unit

| 💡 **POINT** | Important matters that should be understood for operation of this machine are indicated as a POINT in this manual. |
|---|---|

# ⚠ WARNING

## 1. Electric shock prevention

Do not open the front cover while the power is ON or during operation. Failure to observe this could lead to electric shocks.

Do not operate the unit with the front cover removed. The high voltage terminals and charged sections will be exposed, and can cause electric shocks.

Do not remove the front cover and connector even when the power is OFF unless carrying out wiring work or periodic inspections. The inside of the units is charged, and can cause electric shocks.

Since the high voltage is supplied to the main circuit connector while the power is ON or during operation, do not touch the main circuit connector with an adjustment screwdriver or the pen tip. Failure to observe this could lead to electric shocks.

Wait at least 15 minutes after turning the power OFF, confirm that the CHARGE lamp has gone out, and check the voltage between P and N terminals with a tester, etc., before starting wiring, maintenance or inspections. Failure to observe this could lead to electric shocks.

Ground the unit and motor following the standards set forth by each country.

Wiring, maintenance and inspection work must be done by a qualified technician.

Wire the servo drive unit and servomotor after installation. Failure to observe this could lead to electric shocks.

Do not touch the switches with wet hands. Failure to observe this could lead to electric shocks.

Do not damage, apply forcible stress, place heavy items on the cables or get them caught. Failure to observe this could lead to electric shocks.

## 2. Injury prevention

The linear servomotor uses a powerful magnet on the secondary side, and could adversely affect pacemakers, etc.

During installation and operation of the machine, do not place portable items that could malfunction or fail due to the influence of the linear servomotor's magnetic force.

Take special care not to pinch fingers, etc., when installing (and unpacking) the linear servomotor.

In the system where the optical communication with CNC is executed, do not see directly the light generated from CN1A/CN1B connector of drive unit or the end of cable. When the light gets into eye, you may feel something is wrong for eye.
(The light source of optical communication corresponds to class1 defined in JISC6802 or IEC60825-1.)

## ⚠ CAUTION

### 1. Fire prevention

Install the units, motors and regenerative resistor on non-combustible material. Direct installation on combustible material or near combustible materials could lead to fires.

Always install a circuit protector and contactor on the servo drive unit power input as explained in this manual. Refer to this manual and select the correct circuit protector and contactor. An incorrect selection could result in fire.

Shut off the power on the unit side if a fault occurs in the units. Fires could be caused if a large current continues to flow.

When using a regenerative resistor, provide a sequence that shuts off the power with the regenerative resistor's error signal. The regenerative resistor could abnormally overheat and cause a fire due to a fault in the regenerative transistor, etc.

The battery unit could heat up, ignite or rupture if submerged in water, or if the poles are incorrectly wired.

Cut off the main circuit power with the contactor when an alarm or emergency stop occurs.

### 2. Injury prevention

Do not apply a voltage other than that specified in this manual, on each terminal. Failure to observe this item could lead to ruptures or damage, etc.

Do not mistake the terminal connections. Failure to observe this item could lead to ruptures or damage, etc.

Do not mistake the polarity ($\oplus$, $\ominus$). Failure to observe this item could lead to ruptures or damage, etc.

Do not touch the radiation fin on unit back face, regenerative resistor or motor, etc., or place parts (cables, etc.) while the power is turned ON or immediately after turning the power OFF. These parts may reach high temperatures, and can cause burns or part damage.

Structure the cooling fan on the unit back face, etc., etc so that it cannot be touched after installation. Touching the cooling fan during operation could lead to injuries.

# ⚠ CAUTION

## 3. Various precautions

Observe the following precautions. Incorrect handling of the unit could lead to faults, injuries and electric shocks, etc.

### (1) Transportation and installation

⚠ Correctly transport the product according to its weight.

🛈 Use the motor's hanging bolts only when transporting the motor. Do not transport the machine when the motor is installed on the machine.
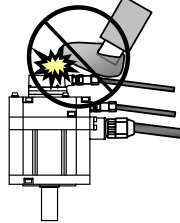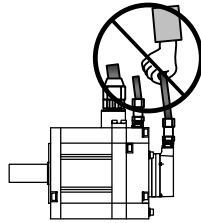
⚠ Do not stack the products above the tolerable number.

⚠ Follow this manual and install the unit or motor in a place where the weight can be borne.

⚠ Do not get on top of or place heavy objects on the unit.

⚠ Do not hold the cables, axis or detector when transporting the motor.

⚠ Do not hold the connected wires or cables when transporting the units.

⚠ Do not hold the front cover when transporting the unit. The unit could drop.

⚠ Always observe the installation directions of the units or motors.

⚠ Secure the specified distance between the units and control panel, or between the servo drive unit and other devices.

⚠ Do not install or run a unit or motor that is damaged or missing parts.

⚠ Do not block the intake or exhaust ports of the motor provided with a cooling fan.

⚠ Do not let foreign objects enter the units or motors. In particular, if conductive objects such as screws or metal chips, etc., or combustible materials such as oil enter, rupture or breakage could occur.

⚠ The units and motors are precision devices, so do not drop them or apply strong impacts to them.

# ⚠ CAUTION

⚠ Store and use the units under the following environment conditions.

| Environment | Unit | Motor |
|---|---|---|
| Ambient temperature | Operation: 0 to 55°C (with no freezing), Storage / Transportation: -15°C to 70°C (with no freezing) | Operation: 0 to 40°C (with no freezing), Storage: -15°C to 70°C [Note 2] (with no freezing) |
| Ambient humidity | Operation: 90%RH or less (with no dew condensation) Storage / Transportation: 90%RH or less (with no dew condensation) | Operation: 80%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation) |
| Atmosphere | Indoors (no direct sunlight) With no corrosive gas, inflammable gas, oil mist, dust or conductive fine particles | |
| Altitude | Operation/Storage: 1000 meters or less above sea level, Transportation: 13000 meters or less above sea level | Operation: 1000 meters or less above sea level, Storage: 10000 meters or less above sea level |
| Vibration/impact | According to each unit or motor specification | |

(Note 1) For details, confirm each unit or motor specifications in addition.
(Note 2) -15°C to 55°C for linear servomotor.

⚠ Securely fix the servomotor to the machine. Insufficient fixing could lead to the servomotor slipping off during operation.

⚠ Always install the servomotor with reduction gear in the designated direction. Failure to do so could lead to oil leaks.

⚠ Structure the rotary sections of the motor so that it can never be touched during operation. Install a cover, etc., on the shaft.

⚠ When installing a coupling to a servomotor shaft end, do not apply an impact by hammering, etc. The detector could be damaged.

⚠ Do not apply a load exceeding the tolerable load onto the servomotor shaft. The shaft could break.

⚠ Store the motor in the package box.

⚠ When inserting the shaft into the built-in IPM motor, do not heat the rotor higher than 130°C. The magnet could be demagnetized, and the specifications characteristics will not be ensured.

⚠ Always use a nonmagnetic tool (explosion-proof beryllium copper alloy safety tool: NGK Insulators, etc.) when installing the linear servomotor.

⚠ Always provide a mechanical stopper on the end of the linear servomotor's travel path.

❶ If the unit has been stored for a long time, always check the operation before starting actual operation. Please contact the Service Center, Service Station, Sales Office or delayer.

# ⚠ CAUTION

## (2) Wiring

⚠ Correctly and securely perform the wiring. Failure to do so could lead to abnormal operation of the motor.

⚠ Do not install a condensing capacitor, surge absorber or radio noise filter on the output side of the drive unit.

⚠ Correctly connect the output side of the drive unit (terminals U, V, W). Failure to do so could lead to abnormal operation of the motor.

⚠ When using a power regenerative power supply unit, always install an AC reactor for each power supply unit.

⚠ In the main circuit power supply side of the unit, always install an appropriate circuit protector or contactor for each unit. Circuit protector or contactor cannot be shared by several units.

⚠ Always connect the motor to the drive unit's output terminals (U, V, W).

⚠ Do not directly connect a commercial power supply to the servomotor. Failure to observe this could result in a fault.

⚠ When using an inductive load such as a relay, always connect a diode as a noise measure parallel to the load.

⚠ When using a capacitance load such as a lamp, always connect a protective resistor as a noise measure serial to the load.

⚠ Do not reverse the direction of a diode which connect to a DC relay for the control output signals such as contractor and motor brake output, etc. to suppress a surge. Connecting it backwards could cause the drive unit to malfunction so that signals are not output, and emergency stop and other safety circuits are inoperable.
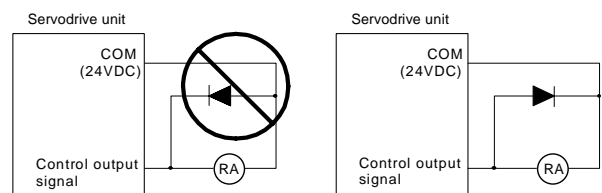


⚠ Do not connect/disconnect the cables connected between the units while the power is ON.

⚠ Securely tighten the cable connector fixing screw or fixing mechanism. An insecure fixing could cause the cable to fall off while the power is ON.

⚠ When using a shielded cable instructed in the instruction manual, always ground the cable with a cable clamp, etc.

⚠ Always separate the signals wires from the drive wire and power line.

⚠ Use wires and cables that have a wire diameter, heat resistance and flexibility that conforms to the system.

# ⚠ CAUTION

**(3) Trial operation and adjustment**

⚠ Check and adjust each program and parameter before starting operation. Failure to do so could lead to unforeseen operation of the machine.

⚠ Do not make remarkable adjustments and changes of parameter as the operation could become unstable.

⚠ The usable motor and unit combination is predetermined. Always check the models before starting trial operation.

⚠ If the axis is unbalanced due to gravity, etc., balance the axis using a counterbalance, etc.

⚠ The linear servomotor does not have a stopping device such as magnetic brakes. Install a stopping device on the machine side.

**(4) Usage methods**

❗ In abnormal state, install an external emergency stop circuit so that the operation can be stopped and power shut off immediately.

⚠ Turn the power OFF immediately if smoke, abnormal noise or odors are generated from the unit or motor.

🚫 Do not disassemble or repair this product.

⚠ Never make modifications.

⚠ When an alarm occurs, the machine will start suddenly if an alarm reset (RST) is carried out while an operation start signal (ST) is being input. Always confirm that the operation signal is OFF before carrying out an alarm reset. Failure to do so could lead to accidents or injuries.

⚠ Reduce magnetic damage by installing a noise filter. The electronic devices used near the unit could be affected by magnetic noise. Install a line noise filter, etc., if there is a risk of magnetic noise.

⚠ Use the unit, motor and regenerative resistor with the designated combination. Failure to do so could lead to fires or trouble.

🚫 The brake (magnetic brake) of the servomotor are for holding, and must not be used for normal braking.

⚠ There may be cases when holding is not possible due to the magnetic brake's life, the machine construction (when ball screw and servomotor are coupled via a timing belt, etc.) or the magnetic brake's failure. Install a stop device to ensure safety on the machine side.

⚠ After changing the programs/parameters or after maintenance and inspection, always test the operation before starting actual operation.

⚠ Do not enter the movable range of the machine during automatic operation. Never place body parts near or touch the spindle during rotation.

⚠ Follow the power supply specification conditions given in each specification for the power (input voltage, input frequency, tolerable sudden power failure time, etc.).

⚠ Set all bits to "0" if they are indicated as not used or empty in the explanation on the bits.

⚠ Do not use the dynamic brakes except during the emergency stop. Continued use of the dynamic brakes could result in brake damage.

⚠ If a circuit protector for the main circuit power supply is shared by several units, the circuit protector may not activate when a short-circuit fault occurs in a small capacity unit. This is dangerous, so never share the circuit protector.

# ⚠ CAUTION

**(5) Troubleshooting**

⚠ If a hazardous situation is predicted during power failure or product trouble, use a servomotor with magnetic brakes or install an external brake mechanism.
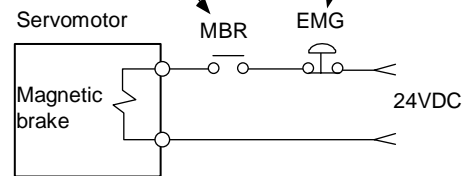
❗ Use a double circuit configuration that allows the operation circuit for the magnetic brakes to be operated even by the external emergency stop signal.

Shut off with the servomotor brake control output.

Shut off with NC brake control PLC output.

Servomotor　　MBR　　EMG

Magnetic brake　　24VDC

⚠ Always turn the input power OFF when an alarm occurs.

⚠ If an alarm occurs, remove the cause, and secure the safety before resetting the alarm.

⚠ Never go near the machine after restoring the power after a power failure, as the machine could start suddenly. (Design the machine so that personal safety can be ensured even if the machine starts suddenly.)

**(6) Maintenance, inspection and part replacement**

⚠ Always backup the programs and parameters before starting maintenance or inspections.

⚠ The capacity of the electrolytic capacitor will drop over time due to self-discharging, etc. To prevent secondary disasters due to failures, replacing this part every five years when used under a normal environment is recommended. Contact the Service Center, Service Station, Sales Office or delayer for repairs or part replacement.

⚠ Do not perform a megger test (insulation resistance measurement) during inspections.

❗ If the battery low warning is issued, back up the machining programs, tool data and parameters with an input/output unit, and then replace the battery.

⚠ Do not short circuit, charge, overheat, incinerate or disassemble the battery.

⚠ The heat radiating fin used in some units contains substitute Freon as the refrigerant. Take care not to damage the heat radiating fin during maintenance and replacement work.

**(7) Disposal**

⚠ Do not dispose of this type of unit as general industrial waste. Always contact the Service Center, Service Station, Sales Office or delayer for repairs or part replacement.

⚠ Do not disassemble the unit or motor.

⚠ Dispose of the battery according to local laws.

⚠ Always return the secondary side (magnet side) of the linear servomotor to the Service Center or Service Station.

⚠ When incinerating optical communication cable, hydrogen fluoride gas or hydrogen chloride gas which is corrosive and harmful may be generated. For disposal of optical communication cable, request for specialized industrial waste disposal services that has incineration facility for disposing hydrogen fluoride gas or hydrogen chloride gas.

## ⚠ CAUTION

**(8) Transportation**

⚠ The unit and motor are precision parts and must be handled carefully.

⚠ According to a United Nations Advisory, the battery unit and battery must be transported according to the rules set forth by the International Civil Aviation Organization (ICAO), International Air Transportation Association (IATA), International Maritime Organization (IMO), and United States Department of Transportation (DOT), etc.

**(9) General precautions**

The drawings given in this manual show the covers and safety partitions, etc., removed to provide a clearer explanation. Always return the covers or partitions to their respective places before starting operation, and always follow the instructions given in this manual.

# ○ Treatment of waste ○

The following two laws will apply when disposing of this product. Considerations must be made to each law. The following laws are in effect in Japan. Thus, when using this product overseas, the local laws will have a priority. If necessary, indicate or notify these laws to the final user of the product.

**1. Requirements for "Law for Promotion of Effective Utilization of Resources"**
(1) Recycle as much of this product as possible when finished with use.
(2) When recycling, often parts are sorted into steel scraps and electric parts, etc., and sold to scrap contractors. Mitsubishi recommends sorting the product and selling the members to appropriate contractors.

**2. Requirements for "Law for Treatment of Waste and Cleaning"**
(1) Mitsubishi recommends recycling and selling the product when no longer needed according to item (1) above. The user should make an effort to reduce waste in this manner.
(2) When disposing a product that cannot be resold, it shall be treated as a waste product.
(3) The treatment of industrial waste must be commissioned to a licensed industrial waste treatment contractor, and appropriate measures, including a manifest control, must be taken.
(4) Batteries correspond to "primary batteries", and must be disposed of according to local disposal laws.

# Compliance to European EC Directives

## 1. European EC Directives

The European EC Directives were issued to unify Standards within the EU Community and to smooth the distribution of products of which the safety is guaranteed. In the EU Community, the attachment of a CE mark (CE marking) to the product being sold is mandatory to indicate that the basic safety conditions of the Machine Directives (issued Jan. 1995), EMC Directives (issued Jan. 1996) and the Low-voltage Directives (issued Jan. 1997) are satisfied. The machines and devices in which the servo is assembled are a target for CE marking.
The servo is a component designed not to function as a single unit but to be used with a combination of machines and devices. Thus, it is not subject to the EMC Directives, and instead the machines and devices in which the servo is assembled are targeted.
This servo complies with the Standards related to the Low-voltage Directives in order to make CE marking of the assembled machines and devices easier. The EMC INSTALLATION GUIDELINES (IB (NA) 67303) which explain the servo drive unit installation method and control panel manufacturing method, etc., has been prepared to make compliance to the EMC Directives easier. Contact Mitsubishi or your dealer for more information.

## 2. Cautions of compliance

Use the standard servo drive unit and EN Standards compliance part (some standard models are compliant) for the servomotor. In addition to the items described in this specifications and instruction manual, observe the items described below.

**(1) Environment**
The servo drive unit must be used within an environment having a Pollution Class of 2 or more (Pollution Class 1 or 2) as stipulated in the IEC664. For this, install the servo amplifier in a control panel having a structure (IP54) into which water, oil, carbon and dust cannot enter.

**(2) Power supply**
① The servo drive unit must be used with the overvoltage category II conditions stipulated in IEC664. For this, prepare a reinforced insulated transformer that is IEC or EN Standards complying at the power input section.
② When supplying the control signal input/output power supply from an external source, use a 24 VDC power supply of which the input and output have been reinforced insulated.

**(3) Installation**
① To prevent electric shocks, always connect the servo drive unit protective earth (PE) terminal (terminal with ⏚ mark) to the protective earth (PE) on the control panel.
② When connecting the earthing wire to the protective earth (PE) terminal, do not tighten the wire terminals together. Always connect one wire to one terminal.



**(4) Wiring**
① Always use crimp terminals with insulation tubes so that the wires connected to the servo drive unit terminal block do not contact the neighboring terminals.
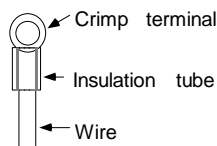
② Connect the HC-MF Series servomotor power lead to the servo drive unit using a fixed terminal block. Do not connect the wires directly. (EN standards compliance parts of the HA-FF motor have cannon plug specifications.)
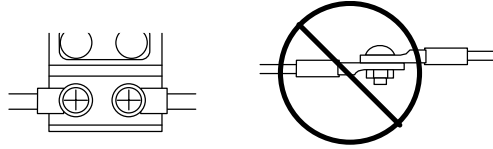


**(5) Peripheral devices**
  ① Use a circuit protector and magnetic contactor that comply with the EN/IEC Standards described in "Chapter 4 Options and Peripheral Devices".
  ② The wires sizes must follow the conditions below. When using other conditions, follow Table 5 of EN60204 and the Appendix C.

  - Ambient temperature: 40°C
  - Sheath: PVC (polyvinyl chloride)
  - Install on wall or open table tray

**(6) Servomotor**
A servomotor that complies with the EN Standards as a standard, and an EN Standards compatible servomotor are available.

| Motor series name | EN Standards compatible servomotor |
|---|---|
| HC-SF series | Complies as a standard |
| HC-RF series | |
| HA-FF series | HA-FF∗∗C-UE |
| HC-MF series | HC-MF∗∗-UE<br>HC-MF∗∗-S15 |

Refer to "Chapter 6 Setup and Operation" for the connectors and detector cables, and use the EN Standards compatible parts.

**(7) Miscellaneous**
The EMC test for a machine or device incorporating a servo drive unit must match the magnetism compatibility (immunity and emission) standards in the state that the working environment and electric device specifications are satisfied.
Refer to the EMC INSTALLATION GUIDELINES (IB (NA) 67303) for other EMC Directive measures related to the servo drive unit.

# Instruction Manual for Compliance with UL/c-UL Standard

(MDS-B-SVJ2, MDS-B-SPJ2 and MR-J2-CT Series)

The instructions of UL/c-UL listed products are described in this manual. The descriptions of this manual are conditions to meet the UL/c-UL standard for the UL/c-UL listed products. To obtain the best performance, be sure to read this manual carefully before use.

To ensure proper use, be sure to read specification manual carefully for each product before use.

## 1. Operation surrounding air ambient temperature

The recognized operation ambient temperatures of each unit are as shown in the table below. The recognized operation ambient temperatures are the same as an original product specification for all of the units.

| Classification | Unit name | operation ambient temperature |
|---|---|---|
| AC servo/ spindle system | Power supply unit | 0~55°C |
| | Servo drive unit | 0~55°C |
| | Spindle drive unit | 0~55°C |
| | Option unit | 0~55°C |
| | Battery unit | 0~55°C |
| | Servo motor, Spindle motor | 0~40°C |

## 2. Notes for AC servo/spindle system

### 2-1 General Precaution

It takes 10 minutes to discharge the bus capacitor. (The capacitor discharge time is one minute for MDS-B-SVJ2-01, 03, 04; two minutes for MDS-B-SVJ2-06 and three minutes for MDS-B-SVJ2-07, 10, 20.) When starting wiring or inspection, shut the power off and wait for more than 15 minutes to avoid a hazard of electrical shock.

### 2-2 Installation

MDS-B-SVJ2, MDS-B-SPJ2 and MR-J2-CT Series have been approved as the products which have been installed in the electrical enclosure.

The minimum enclosure size is based on 150 percent of each MDS-B-SVJ2, SPJ2 and MR-J2-CT Series combination. And also, design the enclosure so that the ambient temperature in the enclosure is 55°C (131°F) or less, refer to the specifications manual. (MDS-B-SVJ2: BNP-B3937, MDS-B-SPJ2: BNP-B2164, MR-J2-CT: BNP-B3944)

"The user must include the use of a 100 cfm fan spaced 4 in. above the drive."

### 2-3 Short-circuit ratings

Suitable for use in a circuit capable of delivering not more than 100 kA rms symmetrical amperes, 500 volts maximum.

## 2-4 Peripheral device

To comply with UL/c-UL Standard, use the peripheral devices which conform to the corresponding standard.

- Fuses

| Applicable drive unit | UL Fuse type | UL Voltage rating, Vac | UL Current rating, A |
|---|---|---|---|
| MDS-B-SVJ2-01 | K5 | 250 | 10 |
| MDS-B-SVJ2-03 | K5 | 250 | 10 |
| MDS-B-SVJ2-04 | K5 | 250 | 15 |
| MDS-B-SVJ2-06 | K5 | 250 | 20 |
| MDS-B-SVJ2-07 | K5 | 250 | 20 |
| MDS-B-SVJ2-10 | K5 | 250 | 25 |
| MDS-B-SVJ2-20 | K5 | 250 | 40 |
| MDS-B-SPJ2-02 | K5 | 250 | 10 |
| MDS-B-SPJ2-04 | K5 | 250 | 15 |
| MDS-B-SPJ2-075 | K5 | 250 | 20 |
| MDS-B-SPJ2-15 | K5 | 250 | 40 |
| MDS-B-SPJ2-22 | K5 | 250 | 40 |
| MDS-B-SPJ2-37 | K5 | 250 | 60 |
| MDS-B-SPJ2-55 | K5 | 250 | 90 |
| MDS-B-SPJ2-75 | K5 | 250 | 125 |
| MDS-B-SPJ2-110 | K5 | 250 | 175 |

| Applicable drive unit | UL Fuse type | UL Voltage rating, Vac | UL Current rating, A |
|---|---|---|---|
| MR-J2-10CT | K5 | 250 | 10 |
| MR-J2-20CT | K5 | 250 | 10 |
| MR-J2-40CT | K5 | 250 | 15 |
| MR-J2-60CT | K5 | 250 | 20 |
| MR-J2-70CT | K5 | 250 | 20 |
| MR-J2-100CT | K5 | 250 | 25 |
| MR-J2-200CT | K5 | 250 | 40 |
| MR-J2-350CT | K5 | 250 | 70 |

- Circuit Breaker for of spindle motor Fan
  Select the Circuit Breaker by doubling the spindle motor fan rated.
  A rush current that is approximately double the rated current will flow, when the fan is started

<Notice>

- For installation in United States, branch circuit protection must be provided, in accordance with the National Electrical Code and any applicable local codes.
- For installation in Canada, branch circuit protection must be provided, in accordance with the Canada Electrical Code and any applicable provincial codes.

## 2-5 Motor Over Load Protection

Servo drive unit MDS-B-SVJ2, MDS-B-SPJ2 and MR-J2-CT series have each solid state motor over load protection. (The motor full load current is the same as rated current.)

When adjusting the level of motor over load, set the parameter as follows.

### 2-5-1 MDS-B-SVJ2 Series

| Para- meter No. | Para- meter abbr. | Parameter name | Setting procedure | Standard setting value | Setting range |
|---|---|---|---|---|---|
| SV021 | OLT | Overload time constant | Set the time constant for overload detection. (Unit: 1 second.) | 60s | 1~300s |
| SV022 | OLL | Overload detection level | Set the overload current detection level with a percentage (%) of the stall rating. | 150% | 1~500 % |

### 2-5-2 MDS-B-SPJ2 Series

| Para- meter No. | Para- meter abbr. | Parameter name | Setting procedure | Standard setting value | Setting range |
|---|---|---|---|---|---|
| SP063 | OLT | Overload time constant | Set the time constant for overload detection. (Unit: 1 second.) | 60s | 0~1000 s |
| SP064 | OLL | Overload detection level | Set the overload current detection level with a percentage (%) of the rating. | 120% | 0~200 % |

### 2-5-3 MR-J2-CT Series

The overload current detection level is 150% of the rated current.

## 2-6 Flange of servo motor

Mount the servo motor on a flange which has the following size or produces an equivalent or higher heat dissipation effect:

| Flange size (mm) | Servo motor | | | | |
|---|---|---|---|---|---|
| | HC□ | HC-RF□ | HC-MF□ | HA-FF□ | HC-SF□ |
| 150x150x6 | – | – | under 100W | under 100W | – |
| 250x250x6 | – | – | 200W | 200, 300W | – |
| 250x250x12 | 0.5~1.5kW | 1.0~2.0kW | 400W | 400,600W | 0.5~1.5kW |
| 300x300x12 | – | – | 750W | – | – |
| 300x300x20 | 2.0kW | – | – | – | 2.0kW |

## 2-7 Field Wiring Reference Table for Input and Output

Use the UL-approved Round Crimping Terminals to wire the input and output terminals of MDS-B-SVJ2, MDS-B-SPJ2 and MR-J2-CT Series. Crimp the terminals with the crimping tool recommended by the terminal manufacturer.

Following described crimping terminals and tools type is example of Japan Solderless Terminal Mfg. Co., Ltd.

### 2-7-1 Servo Drive Unit (MDS-B-SVJ2 Series)

| Capacity [kW] | | 0.1   0.7 | 1.0 | 2.0 |
|---|---|---|---|---|
| Terminal Screw Size | D, C, P, N | Note 1 | M4 | M4 |
| | Screw torque [lb in/ N m] | 5.3/0.6 | 11/1.3 | 11/1.3 |
| | L11, L21 | Note 1 | M4 | M4 |
| | Screw torque [lb in/ N m] | 5.3/0.6 | 11/1.3 | 11/1.3 |
| | U, V, W,⏚ L1,L2,L3 | M4 | M4 | M4 |
| | Screw torque [lb in/ N m] | 11/1.3 | 11/1.3 | 11/1.3 |

Note1 Control circuit terminal block (MDS-B-SVJ2-01   07)

| Terminal | Wire size (AWG) | Terminal bar model | | Crimping tools type |
|---|---|---|---|---|
| | | Single-wire | Double-wire | |
| D, C, P L11, L21 | #14/75 | AI2.5-8BU AI2.5-8BU-1000 | AI-TWIN2x2.5-10BU AI-TWIN2x2.5-13BU | CRIMPFOX-UD6 |

Crimping terminals and tools type are example of Phoenix-contact

**L11, L21**

| Capacity [kW] | 1.0, 2.0 |
|---|---|
| Wire Size (AWG) /Temp rating Note 2 | #14/60 |
| | #14/75 |
| Crimping terminals type | V2-4 |
| Crimping tools type | YNT-1614 |

**D, C, P**

| Capacity [kW] | 1.0, 2.0 |
|---|---|
| Wire Size (AWG) /Temp rating Note 2 | #14/60 |
| | #14/75 |
| Crimping terminals type | R2-4 |
| Crimping tools type | YHT-2210 |

**L1, L2, L3**

| Capacity [kW] | 0.1   2.0 |
|---|---|
| Wire size (AWG) /Temp rating Note 2 | #14/60 |
| | #14/75 |
| Crimping terminals type | R2-4 |
| Crimping tools type | YHT-2210 |
| Earth wire size (AWG) | #14/60 |
| | #14/75 |

**U, V, W**

| Capacity [kW] | 0.1   2.0 |
|---|---|
| Wire size (AWG) /Temp rating Note 2 | #14/60 |
| | #14/75 |
| Crimping terminals type | R2-4 |
| Crimping tools type | YHT-2210 |
| Earth wire size (AWG) | #14/60 |
| | #14/75 |

Note 2   75°C : Grade heat-resistant polyvinyl chloride insulated wires (HIV)
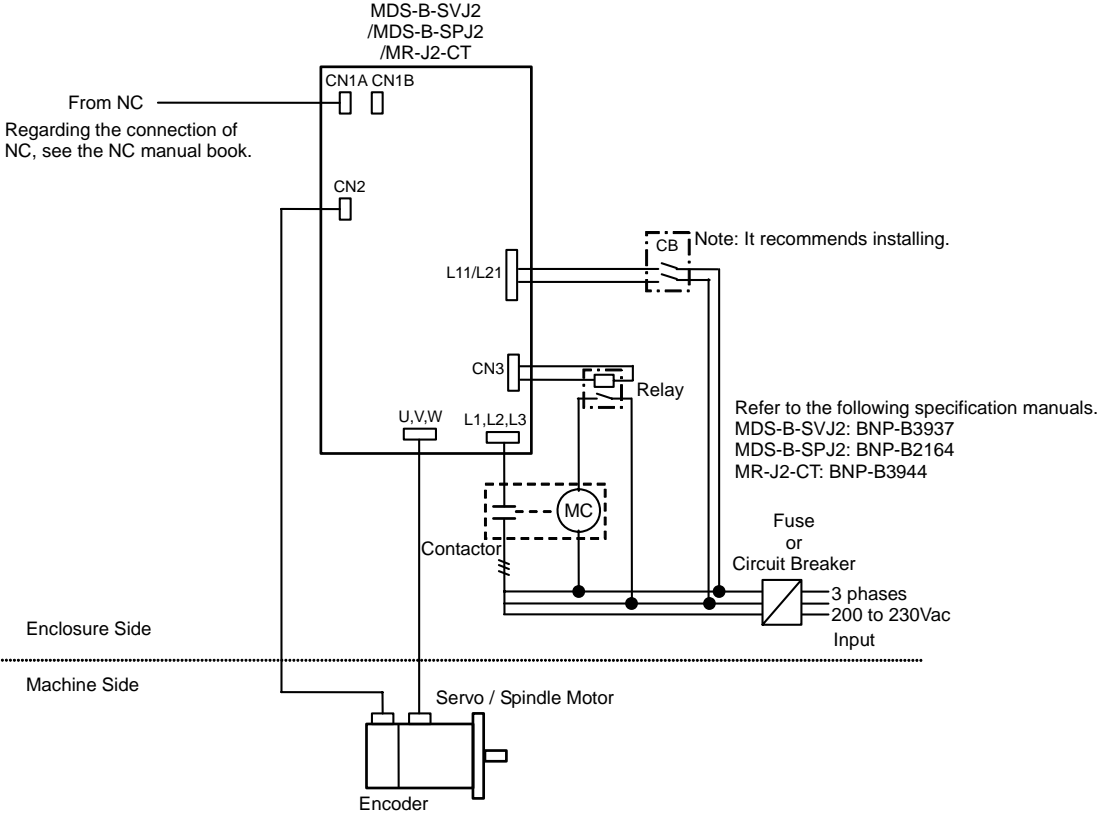Use copper wire only.
Above listed wire are for use in the electric cabinet on machine or equipment.

### 2-7-2 Spindle Drive Unit (MDS-B-SPJ2)

| Capacity [kW] | | 0.2   0.75 | 1.5   3.7 | 5.5   11.0 |
|---|---|---|---|---|
| Terminal screw size | D, C, P, N | Note1 | M4 | M4 |
| | Screw torque [lb in/ N m] | 5.3/0.6 | 10.4/1.2 | 10.4/1.2 |
| | L11, L21 | Note1 | M4 | M4 |
| | Screw torque [lb in/ N m] | 5.3/0.6 | 10.4/1.2 | 17.4/2.0 |
| | U, V, W,⏚ L1,L2,L3 | M4 | M4 | M4 |
| | Screw torque [lb in/ N m] | 10.4/1.2 | 10.4/1.2 | 10.4/1.2 |

Note1 Control circuit terminal block (MDS-B-SPJ2-02   075)

| Terminal | Wire size (AWG) | Terminal bar model | | Crimping tools type |
|---|---|---|---|---|
| | | Single-wire | Double-wire | |
| D, C, P L11, L21 | #14/75 | AI2.5-8BU AI2.5-8BU-1000 | AI-TWIN2x2.5-10BU AI-TWIN2x2.5-13BU | CRIMPFOX-UD6 |

Crimping terminals and tools type are example of Phoenix-contact.

**L11, L21**

| Capacity [kW] | 1.5   11.0 |
|---|---|
| Wire size (AWG) /Temp rating Note 2 | #14/60 |
| | #14/75 |
| Crimping terminals type | V2-4 |
| Crimping tools type | YNT-1614 |

**D, C, P**

| Capacity [kW] | 1.5 | 2.2   11.0 |
|---|---|---|
| Wire Size (AWG) /Temp rating Note 2 | #14/60 | #12/60 |
| | #14/75 | #14/75 |
| Crimping terminals type | R2-4 | 5.5-S4 |
| Crimping tools type | YHT-2210 | |

**L1, L2, L3**

| Capacity [kW] | 0.2   3.7 | 5.5 | 7.5 | 11.0 |
|---|---|---|---|---|
| Wire Size (AWG) /Temp rating Note 2 | #14/60 | #12/60 | #10/60 | #8/60 |
| | #14/75 | #12/75 | #10/75 | #8/75 |
| Crimping terminals type | R2-4 | 5.5-S4 | 5.5-S4 | TU8-4 |
| Crimping tools type | YHT-2210 | | | YHT-8S |
| Earth wire size (AWG) | #14/60 | #12/60 | #10/60 | #8/60 |
| | #14/75 | #12/75 | #10/75 | #8/75 |

**U, V, W**

| Capacity [kW] | 0.2   3.7 | 5.5 | 7.5 | 11.0 |
|---|---|---|---|---|
| Wire size (AWG) /Temp rating Note 2 | #14/60 | #12/60 | #10/60 | #8/60 |
| | #14/75 | #12/75 | #10/75 | #8/75 |
| Crimping terminals type | R2-4 | 5.5-S4 | 5.5-S4 | TU8-4 |
| Crimping tools type | YHT-2210 | | | YHT-8S |
| Earth wire size (AWG) | #14/60 | #12/60 | #10/60 | #8/60 |
| | #14/75 | #12/75 | #10/75 | #8/75 |

Note 2   75°C : Grade heat-resistant polyvinyl chloride insulated wires (HIV)
Use copper wire only.
Above listed wire are for use in the electric cabinet on machine or equipment.

### 2-7-3 Servo Drive Unit (MR-J2-CT Series)

| Capacity [kW] | | 0.1    1.0 | 2.0 | 3.5 |
|---|---|---|---|---|
| Terminal screw size | D, C, P, N | Note 1 | M4 | M4 |
| | Screw torque [lb in/ N m] | 5.3/0.6 | 11/1.3 | 11/1.3 |
| | L11, L21 | Note 1 | M4 | M4 |
| | Screw torque [lb in/ N m] | 5.3/0.6 | 11/1.3 | 11/1.3 |
| | U, V, W, ⏚ L1,L2,L3 | M4 | M4 | M4 |
| | Screw torque [lb in/ N m] | 11/1.3 | 11/1.3 | 11/1.3 |

Note1 Control circuit terminal block (MR-J2-10    100)

| Terminal | Wire size (AWG) | Terminal bar model | | Crimping tools type |
|---|---|---|---|---|
| | | Single-wire | Double-wire | |
| D, C, P L11, L21 | #14/75 | AI2.5-8BU AI2.5-8BU-1000 | AI-TWIN2x2.5-10BU AI-TWIN2x2.5-13BU | CRIMPFOX-UD6 |

Crimping terminals and tools type are example of Phoenix-contact

**L11, L21**

| Capacity [kW] | 2.0 , 3.5 |
|---|---|
| Wire size (AWG) /Temp rating Note 2 | #14/60 |
| | #14/75 |
| Crimping terminals type | V2-4 |
| Crimping tools type | YNT-1614 |

**D, C, P**

| Capacity [kW] | 2.0 , 3.5 |
|---|---|
| Wire size (AWG) /Temp rating Note 2 | #14/60 |
| | #14/75 |
| Crimping terminals type | R2-4 |
| Crimping tools type | YHT-2210 |

**L1, L2, L3**

| Capacity [kW] | 0.1    2.0 | 3.5 |
|---|---|---|
| Wire size (AWG) /Temp rating Note 2 | #14/60 | #10/60 |
| | #14/75 | #10/75 |
| Crimping terminals type | R2-4 | 5.5-S4 |
| Crimping tools type | YHT-2210 | |
| Earth wire size (AWG) | #14/60 | #12/60 |
| | #14/75 | #12/75 |

**U, V, W**

| Capacity [kW] | 0.1    2.0 | 3.5 |
|---|---|---|
| Wire size (AWG) /Temp rating Note 2 | #14/60 | #10/60 |
| | #14/75 | #10/75 |
| Crimping terminals type | R2-4 | 5.5-S4 |
| Crimping tools type | YHT-2210 | |
| Earth wire size (AWG) | #14/60 | #12/60 |
| | #14/75 | #12/75 |

Note 2    75°C : Grade heat-resistant polyvinyl chloride insulated wires (HIV)
Use copper wire only.
Above listed wire are for use in the electric cabinet on machine or equipment.

## 2-8 Spindle Drive / Motor Combinations

Following combinations are the Standard combinations

| Drive unit | Applicable spindle motor (kW) | |
|---|---|---|
| | SJ-P Series | SJ-PF Series |
| MDS-B-SPJ2-02 | 0.2 | |
| MDS-B-SPJ2-04 | 0.4 | |
| MDS-SPJ2-075 | 0.75 | 0.75 |
| MDS-B-SPJ2-15 | 1.5 | 1.5 |
| MDS-B-SPJ2-22 | 2.2 | 2.2 |
| MDS-B-SPJ2-37 | 3.7 | 3.7 |
| MDS-B-SPJ2-55 | | 5.5 |
| MDS-B-SPJ2-75 | | 5.5, 7.5 |
| MDS-B-SPJ2-110 | | 7.5, 11 |

# 3. AC Servo/Spindle System Connection

MDS-B-SVJ2
/MDS-B-SPJ2
/MR-J2-CT

CN1A CN1B

From NC

Regarding the connection of
NC, see the NC manual book.

CN2

CB  Note: It recommends installing.

L11/L21

CN3

Relay

Refer to the following specification manuals.
MDS-B-SVJ2: BNP-B3937
MDS-B-SPJ2: BNP-B2164
MR-J2-CT: BNP-B3944

U,V,W  L1,L2,L3

MC

Contactor

Fuse
or
Circuit Breaker

3 phases
200 to 230Vac
Input

Enclosure Side

Machine Side

Servo / Spindle Motor

Encoder

# Transportation restrictions for lithium batteries

## 1. Restriction for packing

The United Nations Dangerous Goods Regulations "Article 12" became effective from 2003. When transporting lithium batteries with means subject to the UN Regulations, such as by air transport, measures corresponding to the Regulations must be taken. The UN Regulations classify the batteries as dangerous goods (Class 9) or not dangerous goods according to the lithium content.
To ensure safety during transportation, lithium batteries (battery unit) directly exported from Mitsubishi are packaged in a dedicated container (UN package) for which safety has been confirmed. When the customer is transporting these products with means subject to the UN Regulations, such as air transport, the shipper must follow the details explained in the section "1-2 Handling by user".

### 1-1 Target products

The following Mitsubishi NC products use lithium batteries. The UN Regulations classify the batteries as dangerous goods (Class 9) or not dangerous goods according to the lithium content. If the batteries subjected to hazardous materials are incorporated in a device and shipped, a dedicated packaging (UN packaging) is not required. However, the item must be packed and shipped following the Packing Instruction 912 specified in the IATA DGR (Dangerous Goods Regulation) book.
Also, all lithium battery products incorporated in a machinery or device must be fixed securely in accordance with the Packing Instruction 900 and shipped with protection in a way as to prevent damage or short-circuits.

**(1) Products requiring dedicated packaging (Materials falling under Class 9)**

| Mitsubishi type (Type for arrangement) | Battery type | Lithium metal content | Application | Battery class | Outline dimension drawing |
|---|---|---|---|---|---|
| **MDS-A-BT-4** | ER6-B4-11 | 2.6g | For servo | Battery | For each outline dimension drawing of servo, refer to the section "4-2 Battery option". |
| **MDS-A-BT-6** | ER6-B6-11 | 3.9g | For servo | | |
| **MDS-A-BT-8** | ER6-B8-11 | 5.2g | For servo | | |
| **FCU6-BT4-D1** | Combination of ER6-B4D-11 and ER6 | 2.6g+0.65g | For NC/ servo | | |
| **CR23500SE-CJ5 (Note1)** | CR23500SE-CJ5 | 1.52g | For NC(M500) | Battery cell | |

**(2) Products not requiring dedicated packaging (Materials not falling under Class 9)**

| Mitsubishi type (Type for arrangement) | Battery type | Lithium metal content | Application | Battery class | Outline dimension drawing |
|---|---|---|---|---|---|
| **MDS-A-BT-2** | ER6-B2-12 | 1.3g | For servo | Battery | For each outline dimension drawing of servo, refer to the section "4-2 Battery option". |
| **FCU6-BTBOX series** | 2CR5 | 1.96g | For NC/ servo | | |
| **CR2032 (for built-in battery)** | CR2032 | 0.067g | For NC | Battery cell | |
| **CR2450 (for built-in battery)** | CR2450 | 0.173g | For NC | | |
| **ER6, ER6V series (for built-in battery)** | ER6, ER6V | 0.7g | For NC/servo | | |
| **A6BAT (MR-BAT)** | ER17330V | 0.48g | For servo | | |
| **Q6BAT** | Q6BAT | 0.49g | For NC | | |
| **MR-J3BAT** | ER6V | 0.65g | For servo | | |

**(Note 1)** When CR23500SE-CJ5 is incorporated in the unit, this battery is not subject to the regulation.
**(Note 2)** Dedicated packaging is required if the shipment exceeds 12 batteries/24 battery cells. Package the batteries so that this limit is not exceeded.
**(Note 3)** The battery units labeled as "FCUA-" instead of "MDS-A-" also use the same battery.
**(Note 4)** Always use the cell battery (A6BAT) in combination with the dedicated case (MDS-BTCASE). Maximum 8 (either 2, 4, 6 or 8) cell batteries (A6BAT) can be installed to the dedicated case (MDS-BTCASE).

**Example) Rating nameplate for battery units**

```
MITSUBISHI BATTERY UNIT

TYPE       MDS-A-BT-6        ◄──────── Mitsubishi type
OUTPUT DC 3.6 V
LITHIUM BATTERIES: ER6 x6   Class 9  ◄──── Safety class
(Battery Type: ER6-B6-11)   ◄──────── Battery manufacturer type
Mercury Content: Less than 1 ppm
Lithium Metal Content: 3.9 g  ◄─────── Lithium metal content

MITSUBISHI ELECTRIC CORPORATION   JAPAN
```

## 1-2 Handling by user

The following technical opinion is solely Mitsubishi's opinion. The shipper must confirm the latest IATA Dangerous Goods Regulations, IMDG Codes and laws and orders of the corresponding export country. These should be checked by the company commissioned for the actual transportation.

IATA : International Air Transport Association
IMDG Code : A uniform international code for the transport of dangerous goods by seas determined by IMO (International Maritime Organization).

### ■ When shipping isolated lithium battery products (Packing Instruction 903)

#### (1) Reshipping in Mitsubishi UN packaging

Mitsubishi packing applies the isolated battery's safety test and packaging specifications complying with the UN Regulations (Packing Instruction 903).
The user only needs to add the following details before shipping. (Consult with the shipping company for details.)

##### (a) Indication of container usage mark on exterior box (Label with following details recorded.)

- Proper shipping name (Lithium batteries)
- UN NO. (UN3090 for isolated battery, UN3091 for battery incorporated in a device or included)
- Shipper and consignee's address and name

```
                            Example of completing form
SHIPPER:                                      CONSIGNEE:
        Shipper information                            Consignee information



PROPER SHIPPING NAME   LITHIUM BATTERIES


UN NO.: UN3090        CLASS: 9        SUBSIDIARY RISK
PACKING GROUP: II     PACKING INST.: 903
```

##### (b) Preparation of shipping documents (Declaration of dangerous goods)

(Refer to "3. Example of hazardous goods declaration list" in this section.)

#### (2) When packaged by user

The user must follow UN Regulations when packing, preparing for shipping and preparing the indications, etc.

##### (a) Packing a lithium battery falling under Class 9

- Consult with The Ship Equipment Inspection Society of Japan for details on packaging.
- Prepare for shipping as explained in "(1) Reshipping in Mitsubishi UN packaging".

The Ship Equipment Inspection Society of Japan
Headquarters Telephone: 03-3261-6611 Fax: 03-3261-6979

##### (b) Packing a lithium battery not falling under Class 9

- Cells and batteries are separated so as to prevent short circuits and are stored in a strong outer packaging.   (12 or less batteries, 24 or less cells.)
- Prepare for the certificates or test results showing compliance to battery safety test.
  The safety test results have been obtained from the battery manufacturer. (Consult with Mitsubishi when the safety test results are required.)
- Prepare for shipping as explained in "(1) Reshipping in Mitsubishi UN packaging".

■ **When shipping lithium batteries upon incorporating in a machinery or device (Packing Instruction 900)**
Pack and prepare for shipping the item in accordance with the Packing Instruction 900 specified in the IATA DGR (Dangerous Goods Regulation) book. (Securely fix the batteries that comply with the UN Manual of Tests and Criteria to a machinery or device, and protect in a way as to prevent damage or short-circuit.)
Note that all the lithium batteries provided by Mitsubishi have cleared the UN recommended safety test; fixing the battery units or cable wirings securely to the machinery or device will be the user's responsibility.
Check with your shipping company for details on packing and transportation.


■ **When shipping a device with lithium batteries incorporated (Packing Instruction 912)**
A device incorporating lithium batteries does not require a dedicated packaging (UN packaging). However, the item must be packed, prepared for shipping and labeled following the Packing Instruction 912 specified in the IATA DGR (Dangerous Goods Regulation) book.
Check with your shipping company for details on packing and transportation.

The outline of the Packing Instruction 912 is as follows:
- All the items in the packing instructions for shipping the isolated lithium battery products (Packing Instruction 903) must be satisfied, except for the items related to container, short-circuit, and fixation.
- A device incorporating lithium batteries has to be stored in a strong water-proofed outer packaging.
- To prevent an accidental movement during shipment, securely store the item in an outer packaging.
- Lithium content per device should be not more than 12g for cell and 500g for battery.
- Lithium battery mass per device should be not more than 5kg.


## 1-3 Reference

Refer to the following materials for details on the regulations and responses.

Guidelines regarding transportation of lithium batteries and lithium ion batteries (Edition 2)
•••••Battery Association of Japan

## 2. Issuing domestic law of the United State for primary lithium battery transportation

Federal Aviation Administration (FAA) and Research and Special Programs Administration (RSPA) announced an additional regulation (interim final rule) for the primary lithium batteries transportation restrictions item in "Federal Register" on Dec.15 2004. This regulation became effective from Dec.29, 2004.

This law is a domestic law of the United States, however if also applies to the domestic flight and international flight departing from or arriving in the United States. Therefore, when transporting lithium batteries to the United State, or within the United State, the shipper must take measures required to transport lithium batteries.

Refer to the Federal Register and the code of Federal Regulation ("2-4 Reference") for details.

### 2-1 Outline of regulation

(1) Transporting primary lithium battery by passenger aircraft is forbidden.
- Excluding primary lithium battery for personal use in a carry-on or checked luggage (Lithium metal content should be not more than 5g for cell and 25g for battery. For details on the lithium metal content, refer to "1-1 Target products".)

(2) When transporting primary lithium battery by cargo aircraft, indicate that transportation by passenger aircraft is forbidden on the exterior box.

### 2-2 Target products

All NC products for which the lithium batteries are used are subject to the regulation.
(Refer to the table "1-1 Target products".)

### 2-3 Handling by user

The "2-1 Outline of regulation" described above is solely Mitsubishi's opinion. The shipper must confirm orders of "2-4 Reference" described below for transportation method corresponding the regulation. Actually, these should be checked by the company commissioned for the actual lithium buttery transportation.

**(1) Indication of exterior box**

When transporting primary lithium battery by cargo aircraft, indicate that transportation by passenger aircraft is forbidden on the exterior box.

**Display example**

| |
|---|
| PRIMARY LITHIUM BATTERIES |
| FORBIDDEN FOR TRANSPORT ABOARD PASSENGER AIRCRAFT. |

- The character color must be displayed with contrast. (black characters against white background, black characters against yellow background, etc.)
- The height (size) of characters to be displayed is prescribed depending on the packaging mass.
  When the total mass is over 30kg: at least 12mm
  When the total mass is less than 30kg: at least 6mm

### 2-4 Reference

(1) Federal Register (Docket No. RSPA-2004-19884 (HM-224E) ) PDF format
http://www.regulations.gov/fredpdfs/05-11765.pdf
(2) 49CFR (Code of Federal Regulation, Title49) (173.185 Lithium batteries and cells.)
http://www.access.gpo.gov/nara/cfr/waisidx_00/49cfr173_00.html
(3) DOT regulation body (Department of Transportation)
http://hazmat.dot.gov/regs/rules/final/69fr/docs/69fr-75207.pdf

## 3. Example of hazardous goods declaration list

This section describes a general example of the hazardous goods declaration list.    For details, please inquire each transportation company.
This will be applied only to the batteries described in "1. Restriction for Packing".

### (1)  Outline of hazard

| | |
|---|---|
| **Principal hazard and effect** | Not found. |
| **Specific hazard** | As the chemical substance is stored in a sealed metal container, the battery itself is not hazardous.    But when the internal lithium metal attaches to human skin, it causes a chemical skin burn.    As a reaction of lithium with water, it may ignite or forms flammable hydrogen gas. |
| **Environmental effect** | Not found. |
| **Possible state of emergency** | Damages or short-circuits may occur due to external mechanical or electrical pressures. |

### (2)  First-aid measure

| | |
|---|---|
| **Inhalation** | If a person inhales the vapor of the substance due to the battery damage, move the person immediately to fresh air.    If the person feels sick, consult a doctor immediately. |
| **Skin contact** | If the content of the battery attaches to human skin, wash off immediately with water and soap.    If skin irritation persists, consult a doctor. |
| **Eye contact** | In case of contact with eyes due to the battery damage, rinse immediately with a plenty of water for at least 15 minutes and then consult a doctor. |
| **Ingestion** | If swallowed, consult a doctor immediately. |

### (3)  Fire-fighting measure

| | |
|---|---|
| **Appropriate fire-extinguisher** | Dry sand, dry chemical, graphite powder or carbon dioxide gas |
| **Special fire-fighting measure** | Keep the battery away from the fireplace to prevent fire spreading. |
| **Protectors against fire** | Fire-protection gloves, eye/face protector (face mask), body/skin protective cloth |

### (4)  Measure for leakage

| | |
|---|---|
| **Environmental precaution** | Dispose of them immediately because strong odors are produced when left for a long time. |
| **How to remove** | Get them absorbed into dry sand and then collect the sand in an empty container. |

### (5)  Handling and storage

| | | |
|---|---|---|
| **Handling** | **Cautions for safety handling** | Do not peel the external tube or damage it.<br>Do not dispose of the battery in fire or expose it to heat.<br>Do not immerse the battery in water or get it wet.<br>Do not throw the battery.<br>Do not disassemble, modify or transform the battery.<br>Do not short-circuit the battery. |
| **Storage** | **Appropriate storage condition** | Avoid direct sunlight, high temperature and high humidity.<br>(Recommended temp. range: +5 to +35 °C, humidity: 70%RH or less) |
| | **Material to avoid** | Flammable or conductive material (Metal: may cause a short-circuit) |

### (6)  Physical/chemical properties

| | | |
|---|---|---|
| **Appear-ance** | **Physical form** | Solid |
| | **Shape** | Cylinder type |
| | **Smell** | Odorless |
| | **pH** | Not applicable (insoluble) |
| | **Boiling point/Boiling range, Melting point, Decomposition temperature, Flash point** | No information |

## (7) Stability and reactivity

| Stability | Stable under normal handling condition. |
|---|---|
| Condition to avoid | Do not mix multiple batteries with their terminals uninsulated.    This may cause a short-circuit, resulting in heating, bursting or ignition. |
| Hazardous decomposition products | Irritative or toxic gas is emitted in the case of fire. |

## (8) Toxicological information

As the chemical substance is stored in a sealed metal container, the battery has no harmfulness.
Just for reference, the table below describes the main substance of the battery.

**(Lithium metal)**

| Acute toxicity | No information |
|---|---|
| Local effect | Corrosive action in case of skin contact |

## (9) Ecological information

| Mobility, Persistence/Decomposability, Bio-accumulation potential, Ecological toxicity | Not found. |
|---|---|

## (10) Caution for disposal

Dispose of the battery following local laws or regulations.
Pack the battery properly to prevent a short-circuit and avoid contact with water.

# Compliance with Restrictions in China

## 1. Compliance with China CCC certification system
### 1-1 Outline of China CCC certification system

The Safety Certification enforced in China included the "CCIB Certification (certification system based on the "Law of the People's Republic of China on Import and Export Commodity Inspection" and "Regulations on Implementation of the Import Commodities Subject to the Safety and Quality Licensing System" enforced by the State Administration of Import and Export Commodity Inspection (SACI) on import/export commodities, and the "CCEE Certification" (certification system based on "Product Quality Certification Management Ordinance" set forth by the China Commission for Conformity Certification of Electrical Equipment (CCEE) on commodities distributed through China. CCIB Certification and CCEE Certification were merged when China joined WTO (November 2001), and were replaced by the "China Compulsory Product Certification" (hereinafter, CCC Certification) monitored by the State General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ) of the People's Republic of China.

The CCC Certification system was partially enforced from May 2002, and was fully enforced from May 2003. Target commodities which do not have CCC Certification cannot be imported to China or sold in China. (Indication of the CCIB or CCEE mark has been eliminated from May 1, 2003.)

    CCIB : China Commodity Inspection Bureau
    CCEE: China Commission for Conformity Certification of Electrical Equipment
    CCC  : China Compulsory Certification

### 1-2 First catalogue of products subject to compulsory product certification

The First Catalogue of Products subject to Compulsory Product Certification, covering 132 items (19 categories) based on the CCIB products (104 items), CCEE products (107 items) and CEMC products (Compulsory EMC Certification products) was designated on December 3, 2001.

| Class | Product catalogue | |
|---|---|---|
| 1 | Electric Wires and Cables (5 items) | |
| 2 | Switches, Installation protective and connection devices (6 items) | |
| 3 | Low-voltage Electrical Apparatus (9 items) | Compulsory Certification Regulations |
| | Circuit-breakers (including RCCB, RCBO, MCB) | |
| | Low-voltage switchers (disconnectors, switch-disconnectors, and fuse-combination devices. | |
| | Other protective equipment for circuits (Current limiting devices, circuits protective devices, over current protective devices, thermal protectors, over load relays, low-voltage electromechanical contactors and motor starters) | |
| | Relays (36V < Voltage ≤ 1000V) | CNCA -01C -011: 2001 (Switch and Control Equipment) CNCA -01C -012: 2001 (Installation Protective Equipment) |
| | Other switches (Switches for appliances, vacuum switches, pressure switches, proximity switches, foot switches, thermal sensitive switches, hydraulic switches, push-button switches, position limit switches, micro-gap switches, temperature sensitive switches, travel switches, change-over switches, auto-change-over switches, knife switches) | |
| | Other devices (contactors, motor starters, indicator lights, auxiliary contact assemblies, master controllers, A.C. Semiconductor motor controllers and starters) | |
| | Earth leakage protectors | |
| | Fuses | |
| | Low-voltage switchgear | CNCA-01C-010:2001 (Low-voltage switchgear) |
| 4 (Note) | Small power motors (1 item) | CNCA-01C-013:2001 (Small power motors) |

| Class | Product catalogue | |
|---|---|---|
| 5 | Electric tools | (16 items) |
| 6 | Welding machines | (15 items) |
| 7 | Household and similar electrical appliances | (18 items) |
| 8 | Audio and video equipment | (16 items) |
| 9 | Information technology equipment | (12 items) |
| 10 | Lighting apparatus | (2 items) |
| 11 | Telecommunication terminal equipment | (9 items) |
| 12 | Motor vehicles and Safety Parts | (4 items) |
| 13 | Tyres | (4 items) |
| 14 | Safety Glasses | (3 items) |
| 15 | Agricultural Machinery | (1 item) |
| 16 | Latex Products | (1 item) |
| 17 | Medical Devices | (7 items) |
| 18 | Fire Fighting Equipment | (3 items) |
| 19 | Detectors for Intruder Alarm Systems | (1 item) |

**(Note)** When the servomotor or the spindle motor of which output is 1.1kW or less (at 1500 r/min) is used, NC could have been considered as a small power motor. However, CQC (China Quality Certification Center) judged it is not.

## 1-3 Precautions for shipping products

As indicated in 1-2, NC products are not included in the First Catalogue of Products subject to Compulsory Product Certification. However, the Customs Officer in China may judge that the product is subject to CCC Certification just based on the HS Code.[Note 2]
NC cannot be imported if its HS code is used for the product subject to CCC Certification. <u>Thus, the importer must apply for a "Certification of Exemption" with CNCA.</u>[Note 3] Refer to 1-4 Application for Exemption for details on applying for an exemption.

**(Note 1)** The First Catalogue of Products subject to Compulsory Product Certification (Target HS Codes) can be confirmed at http://www.cqc.com.cn/Center/html/60gonggao.htm.
**(Note 2)** HS Code: Internationally unified code (up to 6 digits) assigned to each product and used for customs.
**(Note 3)** CNCA: Certification and Accreditation Administration of People's Republic of China (Management and monitoring of certification duties)

## 1-4 Application for exemption

Following "Announcement 8" issued by the Certification and Accreditation Administration of the People's Republic of China (CNCA) in May 2002, a range of products for which application for CCC Certification is not required or which are exempt from CCC marking has been approved for special circumstances in production, export and management activities.

An application must be submitted together with materials which prove that the corresponding product complies with the exemption conditions. Upon approval, a "Certification of Exemption" shall be issued.

### <Range of products for which application is exempt>

| | |
|---|---|
| Range of products not requiring application | (a) Items brought into China for the personal use by the foreign embassies, consulates, business agencies and visitors (Excluding products purchased from Service Company for Exporters)<br>(b) Products presented on a government-to-government basis, presents<br>(c) Exhibition products (products not for sale)<br>(d) Special purpose products (e.g., for military use)<br>Products not requiring application for CCC Certification are not required to be CCC marked or certified. |
| Range of products for which application is exempted | (e) Products imported or manufactured for research and development and testing purposes<br>(f) Products shipped into China for integration into other equipment destined for 100% re-export to a destination outside of China<br>(g) Products for 100% export according to a foreign trade contract (Excluding when selling partially in China or re-importing into China for sales)<br>(h) Components used for the evaluation of an imported product line<br>(i) The products imported or manufactured for the service (service and repairs) to the end-user. Or the spare parts for the service (service and repairs) of discontinued products.<br>(j) Products imported or manufactured for research and development, testing or measurements<br>(k) Other special situations |

The following documents must be prepared to apply for an exemption of the "Import Commodity Safety and Quality License" and "CCC Certification".

(1) Formal Application
   (a) Relevant introduction and description of the company.
   (b) The characteristics of the products to be exempted.
   (c) The reason for exemption and its evidence (ex. customs handbook).
   (d) The name, trademark, quantity, model and specification of the products to be exempted. (Attach a detail listing of these items for a large quantity of products. When importing materials for processing and repair equipments, submit a list of the importing materials for each month and repair equipments.)
   (e) Guarantee for the safety of the products; self-declaration to be responsible for the safety during the manufacturing and use.
   (f) To be responsible for the authenticity and legitimacy of the submitted documents. Commitment to assist CNCA to investigate on the authenticity of the documents (When CNCA finds it necessary to investigate on the authenticity of the documents.)

(2) Business license of the company (Copy)
(3) Product compliance declaration
   Indicate which standard's requirements the products comply with or submit a test report (Copy is acceptable. The report can be prepared in a manufacturer's laboratory either at home or overseas.)
(4) Import license (Only if an import license is needed for this product. Copy is acceptable.)
(5) Quota certificate (Only if a quota certificate is needed for this product. Copy is acceptable.)
(6) Commercial contract (Copy is acceptable.)
(7) If one of item (4), (5) or (6) cannot be provided, alternative documents, such as bill of lading, the invoice, and other evidential documents must be submitted.

## 1-5 Mitsubishi NC product subject to/not subject to CCC certification

The state whether or not Mitsubishi NC products are subject to the CCC Certification is indicated below, based on the "First Catalogue of Products subject to Compulsory Product Certification" issued by the State General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ) of the People's Republic of China and the Certification and Accreditation Administration of the People's Republic of China (CNCA) on July 1, 2002.

| Model | China HS Code (Note 1) | Judgment on whether or not subject to CCC Certification |
|---|---|---|
| Power supply unit<br>Servo/spindle drive unit | 85044090<br>85371010 | Not subject to CCC Certification |
| Servo/spindle | 85015100<br>85015200 | Not subject to CCC Certification |
| NC | – | Not subject to CCC Certification |
| Display unit | – | Not subject to CCC Certification |

**(Note 1)** The China HS Code is determined by the customs officer when importing to China. The above HS Codes are set based on the HS Codes used normally when exporting from Japan.

**(Note 2)** Reference IEC Standards are used as the actual IEC Standards may not match the GB Standards in part depending on the model.

Whether or not the NC products are subject to CCC Certification was judged based on the following five items.

(a) Announcement 33 (Issued by AQSIQ and CNCA in December 2001)
(b) HS Codes for the products subject to CCC Certification (Export Customs Codes)
   \* HS Codes are supplementary materials used to determine the applicable range. The applicable range may not be determined only by these HS Codes.
(c) GB Standards (This is based on the IEC Conformity, so check the IEC. Note that some parts are deviated.)
(d) Enforcement regulations, and products specified in applicable range of applicable standards within
(e) "Products Excluded from Compulsory Certification Catalogue" (Issued by CNCA, November 2003)


**Reference**
- Outline of China's New Certification System (CCC Mark for Electric Products), Japan Electrical Manufacturers' Association
- Outline of China's New Certification System (CCC Mark for Electric Products) and Electric Control Equipment, Nippon Electric Control Equipment Industries Association

## 2. Response to the China environment restrictions

### 2-1 Outline of the law on the pollution prevention and control for electronic information products

Ministry of Information Industry (information industry ministry) issued this law on Feb.28, 2006 **(Note)** (effective from Mar.1, 2007.) in order to protect the environment and the health of the people with restricting and reducing the environmental pollution caused by the electronic information product wastes. The restrictions are applied to containing lead (Pb), hydrargyrum (Hg), cadmium (Cd), hexavalent chromium (Cr (VI)), polybrominated biphenyl (PBB) and polybrominated diphenyl ether (PBDE) in two stages.

**(Note)** For the details, refer to the following.
   http://www.mii.gov.cn/art/2006/03/02/art_524_7343.html

**(1) First stage: Requirement of indicating contained substance**

The producer and importer of the electronic information product are required to indicate the hazardous substance. The concrete categories of the products belonging in the following eleven main categories are described as subjected product list (electronic information product category note).

- Radar device   • Communication device   • Radio/TV device industry product
- Computer product   • Consumer-electronics device   • Electronic measuring apparatus
- Electronics industry dedicated device   • Electronic parts   • Electronics device
- Electronics application product   • Electronics dedicated material

**(2) Second stage: Suppressing the amount of contained substances and compulsory CCC Certification**

The product listed in the "Electronic information product pollution priority control list" cannot be sold in China unless it conforms to the Compulsory Product Certification System (CCC Certification) and its cadmium usage is suppressed to 0.01w% and other substances usage less than 0.1w%. Note that the timing when this is effective is unmentioned.

### 2-2 Response to the drive product for Mitsubishi NC

The drive product for NC has no items falling under the subjected product list (electronic information product category note). However, for use with the drive product included in the subjected product or for treating the product properly, information based on the law on the pollution prevention and control for electronic information products" are described in the section "2-3" for reference.

### 2-3 Indication based on "Pollution suppression marking request for electronic information product"

**(1) Electronic information product pollution suppression marking**

This marking indicates the environmental protection expiration date applied to the electronic information products sold in China according to the law on the pollution prevention and control for electronic information products issued on Feb.28, 2006. As long as you keep safety for this product and follow the precautions for use, there are no serious effects on the environment pollution, human body or property within its term reckoned from the manufacturing date.

Note: This symbol mark is for China only.

**(Note)** Equate the environmental protection expiration date of consumables, such as enclosed battery and cooling fan, with the product life. When disposing the product after using it properly, obey each local laws and restrictions for collecting and recycling of the electronic information product.

**(2) The names of contained six hazardous substances and the parts containing them**

The names of six substances contained in this product and the parts containing them are shown below.

| Parts name | Toxic/hazardous substance or element | | | | | |
|---|---|---|---|---|---|---|
| | Lead (Pb) | Hydrargyrum (Hg) | Cadmium (Cd) | Hexavalent chromium (Cr(VI)) | (PBB) | (PBDE) |
| Drive unit | × | ○ | ○ | ○ | ○ | ○ |
| Servo motor/spindle motor | × | ○ | ○ | ○ | ○ | ○ |
| Dedicated options (cable/connector) | × | ○ | ○ | × | ○ | ○ |
| Dedicated Options (detector/AC reactor) | × | ○ | ○ | × | ○ | ○ |
| Dedicated Options (battery) | × | ○ | ○ | ○ | ○ | ○ |

○: This mark means that toxic/hazardous substance content in all homogeneous materials of corresponding parts does not exceed the standard specified in the standard of SJ/T11363-2006.

×: This mark means that toxic/hazardous substance content in the homogeneous materials of corresponding parts exceeds the standard specified in the standard of SJ/T11363-2006.

# CONTENTS

# Chapter 1　Preface

## 1-1  Inspection at purchase

Open the package, and read the rating nameplate to confirm that the servo drive unit and servomotor are as ordered.

### 1-1-1  Package contents
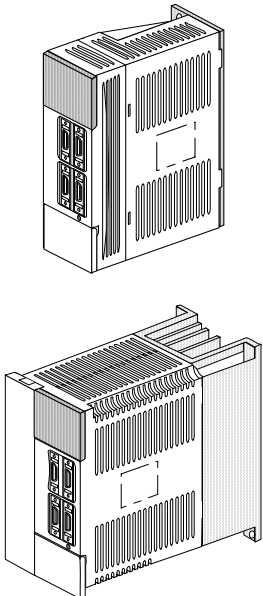
①Servo drive unit
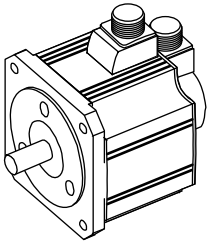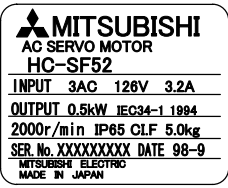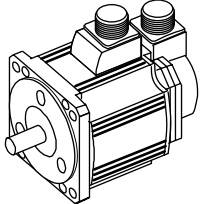
| Packaged parts | Qty. |
|---|---|
| Servo drive unit | 1 |
| Control power connector ⌈Excluding MR-J2-200CT⌉ ⌊and MR-J2-350CT⌋ | 1 |
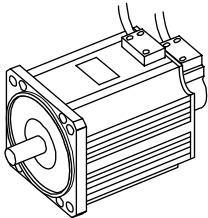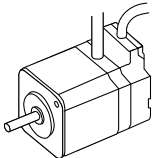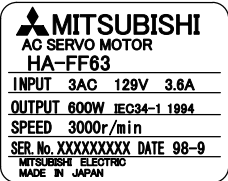
②Servomotor

| Packaged parts | Qty. |
|---|---|
| Servomotor | 1 |

### 1-1-2  Explanation of types

| | Appearance | Rating nameplate and type configuration |
|---|---|---|
| Servo drive unit |  | Type — Rated input — Rated output — Current status — Serial No. → MITSUBISHI  SERVO DRIVE UNIT / TYPE  MR-J2-20CT / POWER 0.2kW / INPUT 1.5A 3PH 200-230V 50/60Hz / 0.3A 1PH 200-230V 50/60Hz / OUTPUT 1.5A 3PH 170V 0-360Hz / MANUAL# BNP-B3944 / S/W BND517W000C5 H/W VER. M / SERIAL# XXXXXXXXXXX DATE 00/01 / MITSUBISHI ELECTRIC CORPORATION JAPAN  **MR - J2 - ▢ CT**  Mitsubishi AC servo MR-J2 series  Capacity class symbol |

| Symbol | Corresponding motor | | | | |
|---|---|---|---|---|---|
| | HC-SF (2000r/min) | HC-SF (3000r/min) | HC-RF (3000r/min) | HA-FF (3000r/min) | HC-MF (3000r/min) |
| 10 | – | – | – | 053, 13 | 053, 13 |
| 20 | – | – | – | 23 | 23 |
| 40 | – | – | – | 33, 43 | 43 |
| 60 | 52 | 53 | – | 63 | – |
| 70 | – | – | – | – | 73 |
| 100 | 102 | 103 | – | – | – |
| 200 | 152, 202 | 153, 203 | 103, 153 | – | – |
| 300 | 352 | 353 | 203 | – | – |

**(Note)** As a standard, the MR-J2-CT servo drive unit complies with the EN Standards and UL Standards.

| | Appearance | Rating nameplate and type configuration |
|---|---|---|
| Servomotor | HC-SF Series<br>• Medium inertia<br>• Auxiliary axis, for general industrial machines<br><br>HC-RF Series<br>• Low inertia<br>• Auxiliary axis, for general industrial machines | (see detail below) |

Type ⟶ **MITSUBISHI**
AC SERVO MOTOR
HC-SF52
Rated output ⟶ INPUT 3AC 126V 3.2A
Rated speed ⟶ OUTPUT 0.5kW IEC34-1 1994
2000r/min IP65 Cl.F 5.0kg
Serial No., ⟶ SER. No. XXXXXXXXX DATE 98-9
MITSUBISHI ELECTRIC
MADE IN JAPAN

**HC–SF** [②] [③] [④]

④ Shaft end shape

| Symbol | Shaft end shape |
|---|---|
| None | Straight |
| T | Taper |
| K | Keyway |

The taper axis specifications are compatible only with the SF52 to 152, 53 to 153 and RF103 to 203. The key is not provided with the keyway axis specifications.

③ Magnetic brake

| Symbol | Magnetic brake |
|---|---|
| None | None |
| B | With magnetic brake |

② Rated output and rated speed

| HC-SF Series | | | | HC-RF Series | |
|---|---|---|---|---|---|
| Rating 2000r/min | | Rating 3000r/min | | Rating 3000r/min | |
| Symbol | Rating output | Symbol | Rating output | Symbol | Rating output |
| 52 | 0.5kW | 53 | 0.5kW | 103 | 1.0kW |
| 102 | 1.0kW | 103 | 1.0kW | 153 | 0.5kW |
| 152 | 1.5kW | 153 | 1.5kW | 203 | 2.0kW |
| 202 | 2.0kW | 203 | 2.0kW | | |
| 352 | 3.5kW | 353 | 3.5kW | | |

① Motor series

| Symbol | Motor series |
|---|---|
| HC-SF | Medium inertia, medium capacity |
| HC-RF | Low inertia, medium capacity |

**(Note)** As a standard, the HC-SF, HC-RF motor complies with the EN Standards and UL Standards.

| | Appearance | Rating nameplate and type configuration |
|---|---|---|
| Servomotor | **HA-FF Series**<br>• Compact low inertia<br>• Auxiliary axis, for general industrial machines<br><br>**HC-MF Series**<br>• Ultra-compact low inertia<br>• Auxiliary axis, for general industrial machines | (see below) |

**HA-FF Series / HC-MF Series — Rating nameplate and type configuration**

MITSUBISHI
AC SERVO MOTOR
HA-FF63
INPUT　3AC　129V　3.6A
OUTPUT　600W　IEC34-1 1994
SPEED　3000r/min
SER. No. XXXXXXXXX　DATE 98-9
MITSUBISHI ELECTRIC
MADE IN JAPAN

Type
Rated output
Detector
Serial No.

HA–FF ② ③ ④ ⑤ ⑥

⑥ Standards and environment compliance

| Symbol | Standards and environment compliance |
|---|---|
| None | None (IP44 specification) |
| −UE | EN Standards + UL Standards (only the HA-FF follows IP54 specification) |
| −S15 | EN Standards + UL Standards + IP65 specification (Set for HC-MF13,23,43 and 73) |

⑤ Shaft end shape

| Symbol | HA-FF | | HC-MF | |
|---|---|---|---|---|
| | 053•13 | 23~63 | 053•13 | 23~73 |
| None | Straight | Keyway (with key) | Straight | Straight |
| K | × | × | × | Keyway (with key) |
| D | D cut | × | D cut | × |

④ Magnetic brake

| Symbol | Magnetic brake |
|---|---|
| None | None |
| B | With magnetic brake |

③ Power input

| Symbol | Power input |
|---|---|
| None | Lead |
| C | Cannon connector |

Always attach "C" to the HA-FF-UE. There is no "C" for other series servomotors.

② Rated output and rated speed

| HA-FF Series | | HC-MF Series | |
|---|---|---|---|
| Rating 3000r/min | | Rating 3000r/min | |
| Symbol | Rating output | Symbol | Rating output |
| 053 | 0.05kW | 053 | 0.05kW |
| 13 | 0.1kW | 13 | 0.1kW |
| 23 | 0.2kW | 23 | 0.2kW |
| 33 | 0.3kW | 43 | 0.4kW |
| 43 | 0.4kW | 73 | 0.75kW |
| 63 | 0.6kW | | |

① Motor series

| Symbol | Motor series |
|---|---|
| HA-FF | Low inertia, small capacity |
| HC-MF | Ultra-low inertia, small capacity |

## 1-2   Explanation of each part

### 1-2-1   Explanation of each servo drive unit part

**Absolute position detection battery**
**Absolute position detection battery holder**

**Absolute position detection battery connector**

**Display section :** The operation status and alarms are displayed.

**Axis No. setting rotary switch**

**Installation screw hole**

**Display setting section cover**
  **CN1A**
    NC bus connector
  **CN1B**
    NC bus connector
 **CN2**
   For motor end detector connection connector
**CN3**
  Digital input/output, personal computer
  connection, D/A output connector

**Charge lamp**
  This indicates that a high voltage is applied
  in the drive unit (main circuit capacitor).
  When this lamp is lit, do not touch the
  terminal block or connect/disconnect the
  cables and connectors.

**Terminal block cover**

**Grounding terminal**
Connect the grounding wire

MR-J2-10CT
  〜
MR-J2-100CT

MR-J2-200CT
  〜
MR-J2-350CT

| L1 | L2 | L3 |
| U | V | W |

| L11 | L21 | D | P | C | N |
| L1 | L2 | L3 | U | V | W |

**Main circuit terminal block**
  Connect the main circuit power supply and motor power supply
  wire.  (In the 200CT and 350CT, this includes the control power
  supply and regeneration option.)

MR-J2-10CT
  〜
MR-J2-60CT

MR-J2-70CT
  〜
MR-J2-100CT

D
C
P
L21
L11

D
C
P
L21
L11
N

**Control power supply connector**
  Connect the control power supply and regenerative
  option.

### 1-2-2   Explanation of each servomotor part

**HC-SF, HC-RF Series**

Detector connector          Power connector

Detector

Motor shaft

**HA-FF, HC-MF Series**

Detector cable          Power cable

Detector

Motor shaft
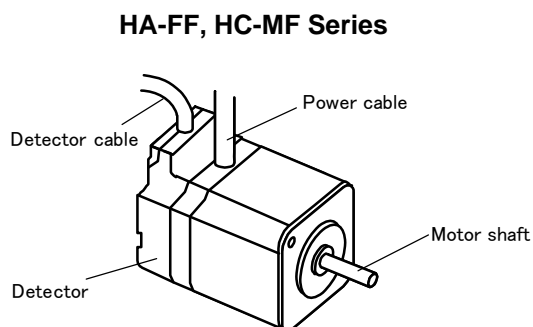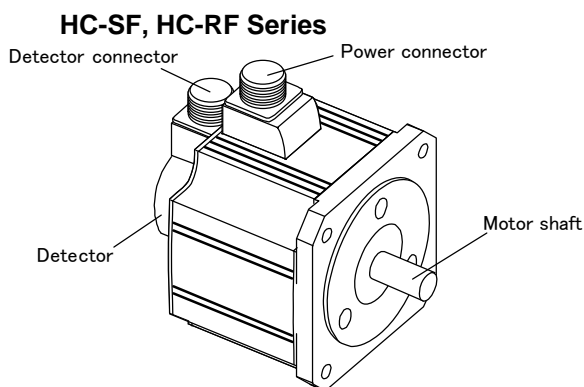
## 1-3    Basic configuration

The MR-J2-CT is a Mitsubishi NC auxiliary axis servo drive unit with an indexing function for the rotation axis built in.
The MR-J2-CT is used with a high-speed serial bus connection to the Mitsubishi NC. The run command to the MR-J2-CT is issued from the PLC built into the NC.

### 1-3-1    Examples of MR-J2-10CT to MR-J2-100CT basic configurations

3-phase AC
power supply
200V to 230V
50/60Hz
L1, L2, L3

Circuit protector

Mitsubishi NC

SH21 cable

To next
drive unit

Terminator
A-TM

**MR-J2-10CT**

**MR-J2-100CT**

SH21
cable

Commercial personal
computer and
Windows
95/98/2000/XP

Setup
software

&

Emergency stop

Near-point

Brake control signal    BRK

Contactor control
signal                          MC

Analog output 2ch

Relay terminal
block for
maintenance

Contactor
Cutoff the main circuit
power supply when an
emergency stop occurs.

Grounding

Main circuit
power
supply

L1    L2    L3

Main circuit
output

U    V    W

Control power supply

Detector cable

External regenerative
resistor (option)

When using
the external
regenerative
resistor,
disconnect this
connection.

D    C    P    L21  L11  N

N is for 70CT, and 100CT only

AC servomotor

## 1-3-2   Examples of MR-J2-200CT and MR-J2-350CT basic configurations

3-phase AC
power supply
200V to 230V
50/60Hz
L1, L2, L3

Circuit protector

Commercial personal
computer and
Windows
95/98/2000/XP

Setup
software

&

Emergency stop

Near-point

Brake control signal — (BRK)

Contactor control
signal — (MC)

Analog output 2ch

Relay terminal
block for
maintenance

Mitsubishi NC

SH21 cable

To next
drive unit

Terminator
A-TM

**MR-J2-200CT
MR-J2-350CT**

SH21
cable

Grounding

Contactor
Cutoff the main circuit
power supply when an
emergency stop occurs.

When using the external
regenerative resistor,
disconnect this connection.

Control power supply

External regenerative
resistor (option)

Detector cable

L11 L21 D P C N

L1 L2 L3 U V W

Main circuit power supply

AC servomotor

## 1-4  Combinations of servo drive unit and servomotor capacities

Top line : Rated output, Middle line : Rated speed, Bottom line : Max. torque

| | | MR-J2-10 CT | MR-J2-20 CT | MR-J2-40 CT | MR-J2-60 CT | MR-J2-70 CT | MR-J2-10 0CT | MR-J2-20 0CT | MR-J2-35 0CT |
|---|---|---|---|---|---|---|---|---|---|
| Medium capacity Medium inertia (IP65) | HC-SF52 | | | | 500W 2000 r/mim 7.16N·m | | | | |
| | HC-SF102 | | | | | | 1000W 2000 r/mim 14.4N·m | | |
| | HC-SF152 | | | | | | | 1500W 2000 r/mim 21.6N·m | |
| | HC-SF202 | | | | | | | 2000W 2000 r/mim 28.5N·m | |
| | HC-SF352 | | | | | | | | 3500W 2000 r/mim 50.1N·m |
| | HC-SF53 | | | | 500W 3000 r/mim 4.77N·m | | | | |
| | HC-SF103 | | | | | | 1000W 3000 r/mim 9.55N·m | | |
| | HC-SF153 | | | | | | | 1500W 3000 r/mim 14.3N·m | |
| | HC-SF203 | | | | | | | 2000W 3000 r/mim 19.1N·m | |
| | HC-SF353 | | | | | | | | 3500W 3000 r/mim 33.4N·m |
| Medium capacity Low inertia (IP65) **(Note 2)** | HC-RF103 | | | | | | | 1000W 3000 r/mim 7.95N·m | |
| | HC-RF153 | | | | | | | 1500W 3000 r/mim 11.9N·m | |
| | HC-RF203 | | | | | | | | 2000W 3000 r/mim 15.9N·m |
| Small capacity Low inertia (IP54) (IP44) | HA-FF053 | 50W 3000 r/mim 0.48N·m | | | | | | | |
| | HA-FF13 | 100W 3000 r/mim 0.95N·m | | | | | | | |
| | HA-FF23 | | 200W 3000 r/mim 1.9N·m | | | | | | |
| | HA-FF33 | | | 300W 3000 r/mim 2.9N·m | | | | | |
| | HA-FF43 | | | 400W 3000 r/mim 3.8N·m | | | | | |
| | HA-FF63 | | | | 600W 3000 r/mim 5.7N·m | | | | |
| Small capacity Ultra-low inertia (IP44) | HA-MF053 | 50W 3000 r/mim 0.48N·m | | | | | | | |
| | HA-MF13 | 100W 3000 r/mim 0.95N·m | | | | | | | |
| | HC-MF23 | | 200W 3000 r/mim 1.9N·m | | | | | | |
| | HC-MF43 | | | 400W 3000 r/mim 3.8N·m | | | | | |
| | HC-MF73 | | | | | 750W 3000 r/mim 7.2N·m | | | |

**(Note 1)** Blank boxes in the table indicate that a combination is not possible.
**(Note 2)** Take care to the HC-RF motor and drive unit capacity combination.

## 1-5 Outline of built-in function

### 1-5-1 Axis control function

| | | |
|---|---|---|
| No. of control axes | : | 1 axis |
| Command and setting unit | : | 0.001° |
| Positioning resolution | : | Follows No. of detector pulses and gear ratio. |

**<Example>**

When using an HC-SF motor (No. of detector pulses: 16384 pulses/rev) motor and a gear ratio of 1:10, the positioning resolution will be: (Refer to Chapter 13)

Positioning resolution =

$$\text{Detector resolution} \times 2 = \frac{360° \times 2}{16384 \times 10} = 0.0044°$$

| | | |
|---|---|---|
| Servo OFF function | : | The power to the motor can be randomly cut off (motor free run) using commands. |
| Follow up function | : | The axis movement is monitored even during servo OFF or emergency stop, and the machine position counter is updated. |
| Torque limit function | : | The motor's output torque can be limited. Four random limit values can be set, and one selected with a command. |

### 1-5-2 Servo control function

| | | |
|---|---|---|
| Control method | : | The real-time automatic tuning function with model adaptive control is incorporated. The servo's characteristic gain does not need to be adjusted. |
| Vibration suppressing function | : | The vibration caused by machine resonance can be suppressed with a notch filter and jitter compensation. |

### 1-5-3 Feed function

| | | |
|---|---|---|
| Feedrate designation | : | Four per-minute feeds can be set with a °/min unit (rotation axis) or mm/min (linear axis), and one selected with a command. The feedrate command range is 1 to 100000. |
| Acceleration/deceleration method | : | The inclined constant acceleration/deceleration is automatically controlled. The linear acceleration/deceleration or soft acceleration/deceleration can be selected. |
| Acceleration/deceleration pattern designation | : | Four acceleration/deceleration patterns can be set, and method one selected with a command. |
| Short-cut control | : | When using the rotation axis, the rotation direction with least movement distance is automatically judged and the axis is rotated. The rotation direction can be designated with a command. |

### 1-5-4 Coordinate system setting function

| | | |
|---|---|---|
| Coordinate system | : | Corresponds to the rotation axis coordinates (0° to 360°) and the linear coordinates. |
| Coordinate system shift function | : | The machine coordinates can be shifted. |

## 1-5-5 Command method

Station method (for rotation axis) : A point (station) obtained by equally dividing the rotation axis can be selected with a command, and positioned to. The max. No. of divisions is 360.

&lt;When eight stations are set (8 divisions)&gt;
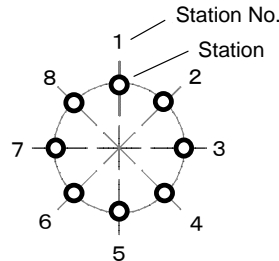


Station method (for linear axis) : The equal division points (stations) are determined by the valid stroke length and No. of stations. The Max. No. of stations is 360.

&lt;When five stations are set&gt;
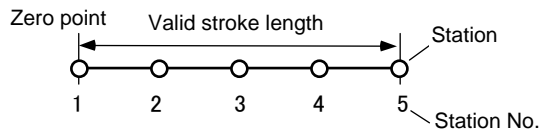


- The zero point is station 1, and the final end of the valid stroke is station 5.
- When using a linear axis, the No. of equal divisions is "No. of stations -1".

Uneven station method : When the positioning positions (stations) are not at an equal pitch, up to eight coordinate points can be randomly set to determine the station coordinates. This can be used for either the rotation axis or linear axis.

Random coordinate designation method : Random coordinates (absolute coordinates using zero point as reference) can be transferred from the PLC and used for positioning.

## 1-5-6 Operation function

The following seven operation modes can be used. The operation mode is changed with commands from the PLC.

Automatic mode : This mode carries out positioning to the designated station No. with the start signal. If the start signal turns OFF before the positioning is finished, the axis will be positioned to the nearest station position.
Positioning to random coordinates is also possible.

Manual mode : This mode rotates at a set speed in the designated direction while the start signal is ON.
If the start signal turns OFF, the axis will be positioned to the nearest station position.

JOG mode : This mode rotates at a set speed in the designated direction while the start signal is ON.

Incremental feed mode : This feed mode moves only the designated movement amount at each start.

Manual handle mode : This mode moves the axis with the pulse command (manual handle signal) transferred from the NC.

Reference point return mode : This mode positions to the reference point. The dog switch method, or the method to position to the reference point registered in the memory can be used.

Stopper positioning mode : This mode positions by pressing against the machine end, etc. The approach amount, pressing amount, pressing speed, and pressing torque limit amount can be set.

### 1-5-7   Absolute position detection function

The detector monitors the machine movement even when the power is turned OFF. After turning the power ON, automatic operation can be started immediately without returning to the reference point (zero point).

### 1-5-8   Machine compensation function

Electronic gears : By setting the gear ratio and ball screw pitch (for linear axis), the commanded position and speed will be automatically converted to the motor's rotation angle and speed. All settings can be made with the machine end movement amount and speed without considering the weight of one detector pulse.

Backlash compensation : The positioning error caused by backlash of the gear or ball screw, etc., can be compensated.

### 1-5-9   Protective functions

Emergency stop function : A hot line can be established with the NC allowing the external emergency stop signal to be directly input. During an emergency stop, the axis can be stopped with the dynamic brakes built in the drive unit, or by decelerating to a stop.

Excessive error monitor function : The max. tolerable amount of the axis tracking delay (droop) can be monitored during feed. If a droop exceeding the tolerable value occurs, the servomotor will emergency stop.

Interlock : Movement of the axis in a specific direction can be prohibited.

Edit lock : Rewriting of the parameters can be prohibited.

### 1-5-10   Operation auxiliary function

PSW : Eight sets of position switches using software processing are mounted. Using these, the axis movement state can be monitored even without mechanical switches.

### 1-5-11   Diagnosis function

Self diagnosis : The various alarms are displayed on the main unit's 7-segment LED display, and output to the NC and personal computer.

Servo monitor : The operation state (speed, current, etc.) is output to the NC and personal computer. The personal computer requires dedicated setup software.

Signal monitor : The commands sent to the personal computer from the PLC and the status output signal to the PLC can be monitored. The personal computer requires dedicated setup software.

Test operation : Commands from the personal computer can be fed and operated. The personal computer requires dedicated setup software.

Analog monitor : The operation state (speed, current, etc.) to the drive unit CN3 connector are analog output. Two channels can be used simultaneously.

Alarm history : The past six alarms can be recorded and output to the NC or personal computer.

# Chapter 2   Wiring and Connection

**DANGER**

1. Wiring work must be done by a qualified technician.
2. Wait at least 10 minutes after turning the power OFF and check the voltage with a tester, etc., before starting wiring. Failure to observe this could lead to electric shocks.
3. Securely ground the servo drive unit and servomotor with Class 3 grounding or higher.
4. Wire the servo drive unit and servomotor after installation. Failure to observe this could lead to electric shocks.
5. Do not damage, apply forcible stress, place heavy items or engage the cable. Failure to observe this could lead to electric shocks.
6. Always insulate the connection of the power terminal. Failure to observe this could lead to electric shocks.

**CAUTION**

1. Correctly and securely perform the wiring. Failure to do so could lead to runaway of the servomotor.
2. Do not mistake the terminal connections.
   Failure to observe this item could lead to ruptures or damage, etc.
3. Do not mistake the polarity ( + , − ). Failure to observe this item could lead to ruptures or damage, etc.
4. Do not mistake the direction of the diodes for the surge absorption installed on the DC relay for the motor brake and contactor (magnetic contact) control. The signal might not be output when a failure occurs.

Servo drive unit

COM
(24VDC)

Control output signal                    RA
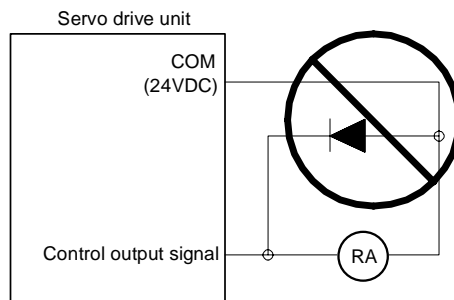
5. Electronic devices used near the servo drive unit may receive magnetic obstruction. Reduce the effect of magnetic obstacles by installing a noise filter, etc.
6. Do not install a phase advancing capacitor, surge absorber or radio noise filter on the power supply wire (U, V, W) of the servomotor.
7. Do not modify this unit.
8. The CN1A, CN1B, CN2 and CN3 connectors on the front of the drive unit have the same shape. If the connectors are connected incorrectly, faults could occur. Make sure that the connection is correct.
9. When grounding the motor, connect to the protective grounding terminal on the servo drive unit, and ground from the other protective grounding terminal. (Use one-point grounding)
   Do not separately ground the connected motor and servo drive unit as noise could be generated.
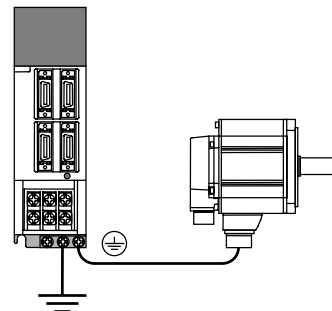
## 2-1   System connection diagram

Configure a sequence that shuts off the MC when an emergency stop occurs. The converter unit output or CN3 connector output (MC) of the MR-J2-CT can be used.

Always disconnect the connection between P and D when connecting the external regenerative option. The servo drive unit could be damaged.

Mount the optional battery (MR-BAT) in the drive unit when using the absolute position detection. Connect the MDS-A-BT-□ to the final axis.

Connect the SH21 cable from the NC to the CN1A connector

Always insert the terminator connector (A-TM) into CN1B for the final axis)

**Notes)**

1. The total length of the SH21 cable must be within 30 m.
2. The motor side connections following the 2nd axis have been omitted.
3. This is a motor with magnetic brakes. The power connected to the magnetic brake does not have a polarity.
4. The connection method will differ according to the motor.
5. When using as an absolute position detector, connect MR-BAT or MDS-A-BT-□ instead of the terminator connector.
6. Do not mistake the diode direction. If connected in reverse, the drive unit will fail and the signal will not be output.

## 2-2   Servo drive unit main circuit terminal block, control circuit terminal block

⚠ **CAUTION**   Do not apply a voltage other than that specified in Instruction Manual on each terminal. Failure to observe this item could lead to ruptures or damage, etc.

### 2-2-1   Main circuit terminal block, control circuit terminal block signal layout

The signal layout of each terminal block is as shown below.

| | Servo drive unit / Terminal | MR-J2-10CT<br>MR-J2-20CT<br>MR-J2-40CT<br>MR-J2-60CT | MR-J2-70CT<br>MR-J2-100CT | MR-J2-200CT<br>MR-J2-350CT |
|---|---|---|---|---|
| | Terminal position | Front | Bottom | |
| Terminal signal ① | Main circuit terminal block (TE1) | L1  L2  L3<br>U  V  W<br>Terminal screw : M4 × 0.7   Tightening torque: 1.24 N·m | | L1  L2  L3  U  V  W<br>Terminal screw : M4 × 0.7<br>Tightening torque : 1.24 N·m |
| ② | Control circuit terminal block (TE2) | Front / Rear<br>D<br>C<br>P<br>L21<br>L11 | Front / Rear<br>D<br>C<br>P<br>L21<br>L11<br>N | L11  L21  D  P  C  N<br>Terminal screw : M4 × 0.7<br>Tightening torque : 1.24 N·m |
| ③ | Protective grounding terminal block (PE) | MR-J2-10CT to 20CT<br>MR-J2-40CT to 60CT<br>Terminal screw : M4 × 0.7<br>Tightening torque : 1.24 N·m | Terminal screw : M4 × 0.7<br>Tightening torque : 1.24 N·m | Terminal screw : M4 × 0.7<br>Tightening torque : 1.24 N·m |

### 2-2-2   Names and application of main circuit terminal block and control circuit terminal block signals

The following table shows the details for each terminal block signal.

| Name | Signal name | Description |
|---|---|---|
| L1·L2·L3 | Main circuit power supply | Main circuit power supply input terminal <br> Connect a 3-phase 200 to 230VAC, 50/60Hz power supply. |
| L11·L12 | Control circuit power supply | Control circuit power supply input terminal <br> Connect a single-phase 200 to 230VAC, 50/60Hz power supply. <br> Connect the same power supply phase for L11 and L1, and L21 and L2. |
| P·C·D | Regenerative option | Regenerative option connection terminal. P to D is wired at shipment. <br> When using the regenerative option, disconnect the wire between P and D and wire the regenerative option between P and C. |
| (N) | Main circuit reference potential | This is not used normally. <br> (This is the reference potential for the main circuit DC voltage.) |
| U·V·W | Servomotor output | Servomotor power supply output terminal <br> The servomotor power supply terminal (U, V, W) is connected. |
| ⏚ | Protective grounding (PE) | Grounding terminal <br> The servomotor grounding terminal is connected and grounded. |

◇ **DANGER**   Never connect anything to the main circuit reference voltage (N). <br> Failure to observe this could lead to electric shock or servo drive unit damage.

⚠ **CAUTION**   When using a standard built-in regenerative resistor, connect it between the P and D terminals. (Shipment state.) <br> When using an external option regenerative resistor, disconnect the wiring between the P and D terminals, and connect between P and C. Standard built-in regenerative resistors cannot be used in combination with an external option regenerative resistor.

### 2-2-3   How to use the control circuit terminal block (MR-J2-10CT to 100CT)

#### (1)   For connector of the spring lock type

• Treatment of wire end

(a) Single strand
Peel the wire sheath, and use the wire.

Sheeth   Core

Approx. 10mm
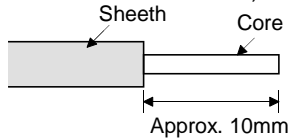
(b) Stranded wire
1) When the wire is inserted directly
Peel the wire sheath, and then twist the core wires. Take care to prevent short circuits with the neighboring poles due to the fine strands of the core wires. Solder plating onto the core wire section could cause a contact defect and must be avoided.

2) When the twisted wires are put together using a bar terminal
Use the bar terminal shown below.

| Wire size | | Bar terminal type | | Crimping tool | Manufacturer |
|---|---|---|---|---|---|
| [mm²] | AWG | For one wire | For two wires | | |
| 1.25/1.5 | 16 | AI1.5-10BK | AI-TWIN2 × 1.5-10BK | CRIMPFOX ZA 3 | Phoenix contact |
| 2/2.5 | 14 | AI2.5-10BU | | | |

Cut the wire running out of bar terminal to less than 0.5 mm

Less than 0.5mm
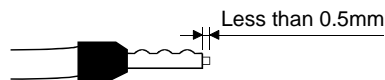
When using a bar terminal for two wires, insert the wires in the direction where the insulation sleeve does not interfere with next pole, and pressure them.

Pressure

Pressure
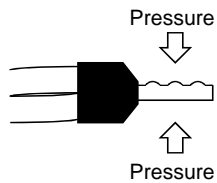
• Connection method

(a) When the wire is inserted directly
Insert the wire to the end pressing the button with a small flat-blade screwdriver or the like.

Button

Small flat blade
screwdriver or the like

Twisted wire

When removing the short-circuit bar
from across P-D, press the buttons of
P and D alternately pulling the
short-circuit bar. For the installation,
insert the bar straight to the end.
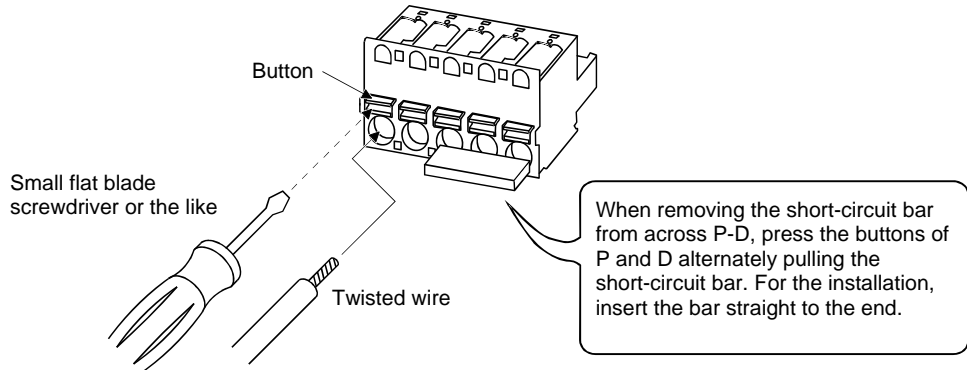
(b) When the twisted wires are put together using a bar terminal
Insert a bar terminal with the odd-shaped side of the pressured terminal on the button side.

Bar terminal for one wire
or
single strand

Bar terminal for two wires
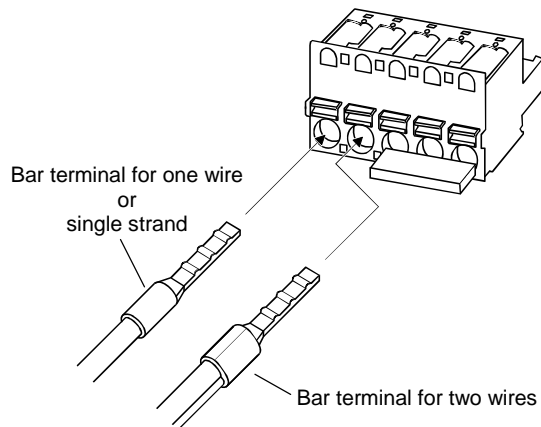
When two wires are inserted into one opening, a bar terminal for two wires is required.

**(2)  For connector of the screw lock type**

• Treatment of wire end

(a) Single strand
Peel the wire sheath, and use the wire.



Sheeth   Core

Approx. 10mm
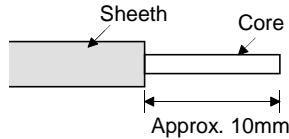
(b) Stranded wire
Peel the wire sheath, and then twist the core wires. Take care to prevent short circuits with the neighboring poles due to the fine strands of the core wires. Solder plating onto the core wire section could cause a contact defect and must be avoided.
Use a bar terminal and bundle the strands.

| Wire size | | Bar terminal type | | Crimping tool | Manufacturer |
|---|---|---|---|---|---|
| [mm²] | AWG | For one wire | For two wires | | |
| 1.25/1.5 | 16 | AI1.5-10BK | AI-TWIN2 × 1.5-10BK | CRIMPFOX ZA 3 or CRIMPFOX UD 6 | Phoenix contact |
| 2/2.5 | 14 | AI2.5-10BU | | | |

• Connection method
Insert the core wire section of the wire into the opening, and tighten with a flat-blade screwdriver so that the wire does not come out. (Tightening torque: 0.5 to 0.6 N•m) When inserting the wire into the opening, make sure that the terminal screw is sufficiently loose. When using a wire that is 1.5 mm² or less, two wires can be inserted into one opening.



Flat-blade screwdriver
( • Tip: 0.4 to 0.6mm )
( • Total width: 2.5～3.5mm )

Loosen  Tighten

Wire

Opening

Control circuit terminal block
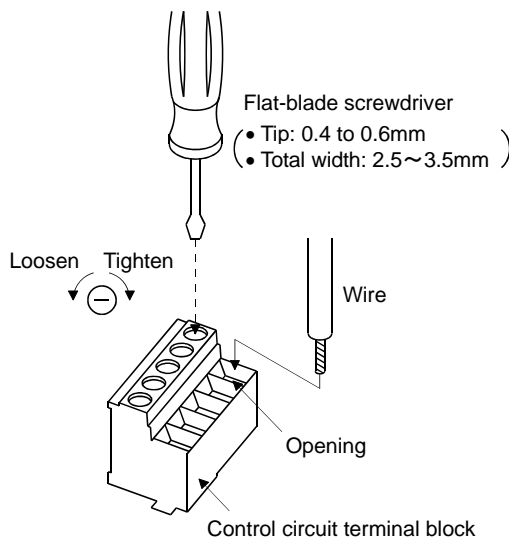
Use of a flat-blade torque screwdriver is recommended to manage the screw tightening torque. The following table indicates the recommended products of the torque screwdriver for tightening torque management and the flat-blade bit for torque screwdriver. When managing torque with a Phillips bit, please consult us.

| Product | Model | Manufacturer / Representative |
|---|---|---|
| Torque screwdriver | N6L   TDK | Nakamura Seisakusho |
| Bit for torque screwdriver | B-30, flat-blade, H3.5 X 73L | Shiro Sangyo |

## 2-3   NC and servo drive unit connection

The NC bus cables are connected from the NC to each servo drive unit so that they run in a straight line from the NC to the terminator connector (battery unit). The NC bus is dedicated for the MR-J2-CT Series, so other servo drive units, etc., cannot be connected to the same NC bus. Up to seven axes can be connected per system. (Note that the number of connected axes is limited by the NC. The following drawing shows an example with three axes connected.)

**< Connection >**

CN1A　:　CN1B connector of NC side drive unit or NC output
CN1B　:　CN1A connector of terminator connector side drive unit or terminator connector (battery unit)



Connected to the NC
MR-J2-CT dedicated output

Refer to the instruction manual of each NC for details.

MR-J2-CT 1st axis

MR-J2-CT 2nd axis

MR-J2-CT 3rd axis (final axis)

CN1A　　CN1B　　CN1A　　CN1B　　CN1A　　CN1B

SH21 cable

Connect to the battery unit with a terminator connector or SH21 cable.

Max. length of 30m from the NC to the terminator connector.
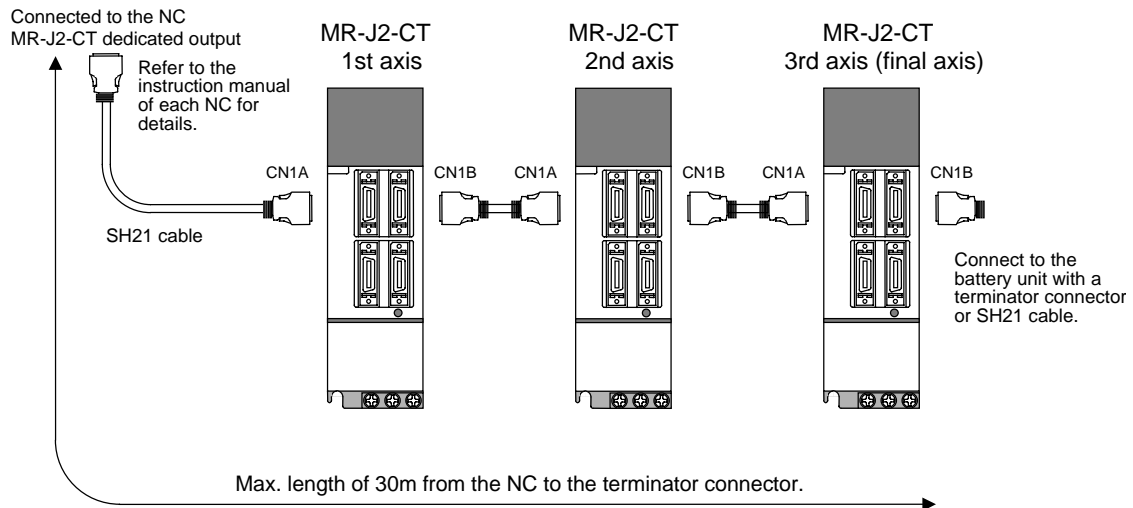
| ⚠ **CAUTION** | Arrange the NC and servo drive units so that the NC bus cable length from the NC to the terminator connector (battery unit) is 30m or less. |
|---|---|

| 💡 **POINT** | Axis Nos. are determined by the rotary switch for setting the axis No. (Refer to section "6-1-1 Setting the rotary switches".) The axis No. has no relation to the order for connecting to the NC. |
|---|---|

## 2-4   Motor and detector connection
### 2-4-1   Connection of HC-SF52, HC-SF53, HC-SF102, HC-SF103

Detector connector
MS3102A20-29P

| Pin | Signal |
|-----|--------|
| A | |
| B | |
| C | MR |
| D | MRR |
| E | |
| F | BAT |
| G | LG |
| H | |
| J | |
| K | |
| L | |
| M | |
| N | SD |
| P | |
| R | LG |
| S | P5 (+5V) |
| T | |

Option cable : MR-JHSCBL□M-H
(Refer to Chapter 4 for details on the cable treatment)

Max. 50m

MR-J2-60CT
MR-J2-100CT

Detector connector  :  CN2

Pin No.

No.1   No.11

No.10   No.20

| Pin | Signal | Pin | Signal |
|-----|--------|-----|--------|
| 1 | LG | 11 | LG |
| 2 | LG | 12 | LG |
| 3 | | 13 | |
| 4 | | 14 | |
| 5 | | 15 | |
| 6 | | 16 | |
| 7 | MR | 17 | MRR |
| 8 | | 18 | P5 (+5V) |
| 9 | BAT | 19 | P5 (+5V) |
| 10 | | 20 | P5 (+5V) |

U  V  W

Power wire and grounding wire
(Refer to Chapter 4 for details on selecting the wire.)
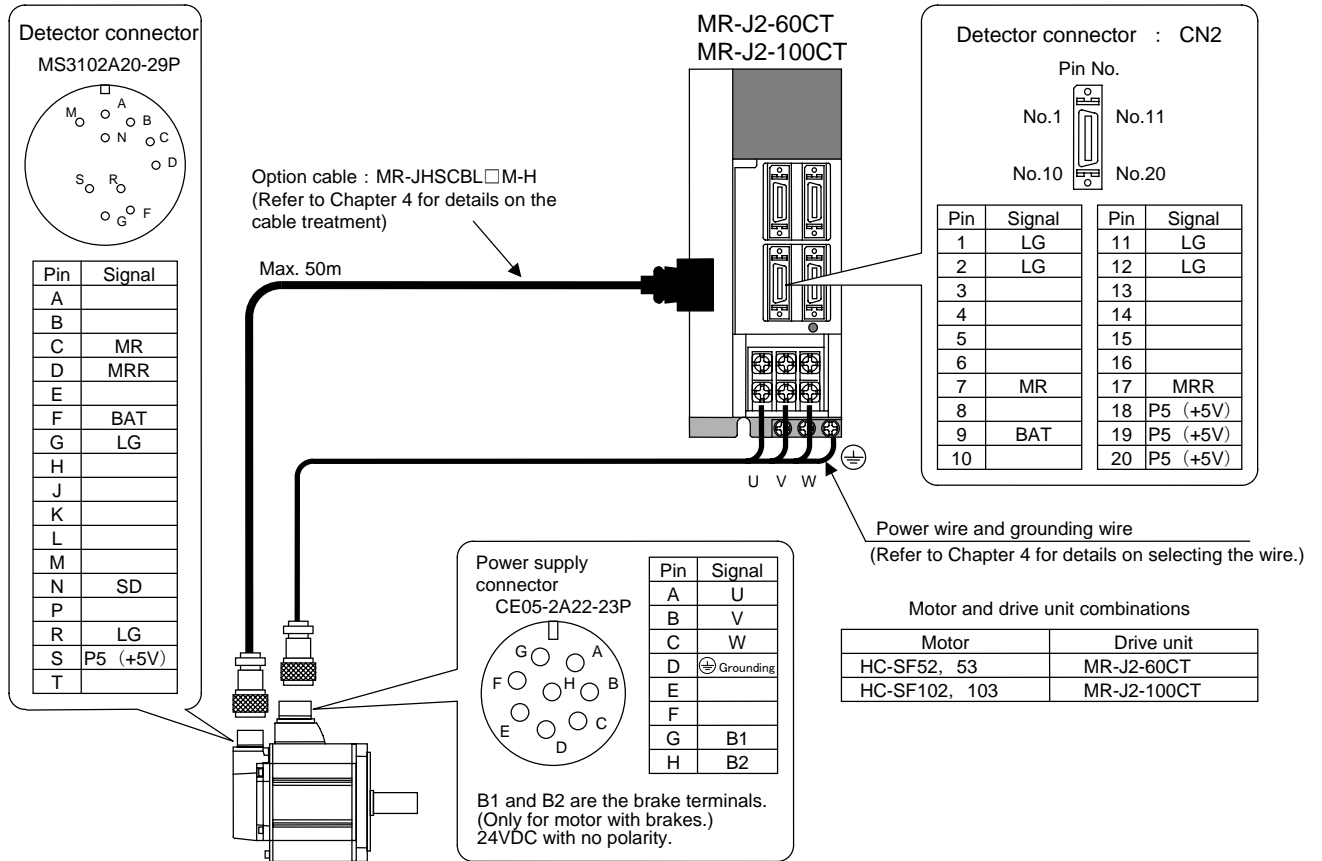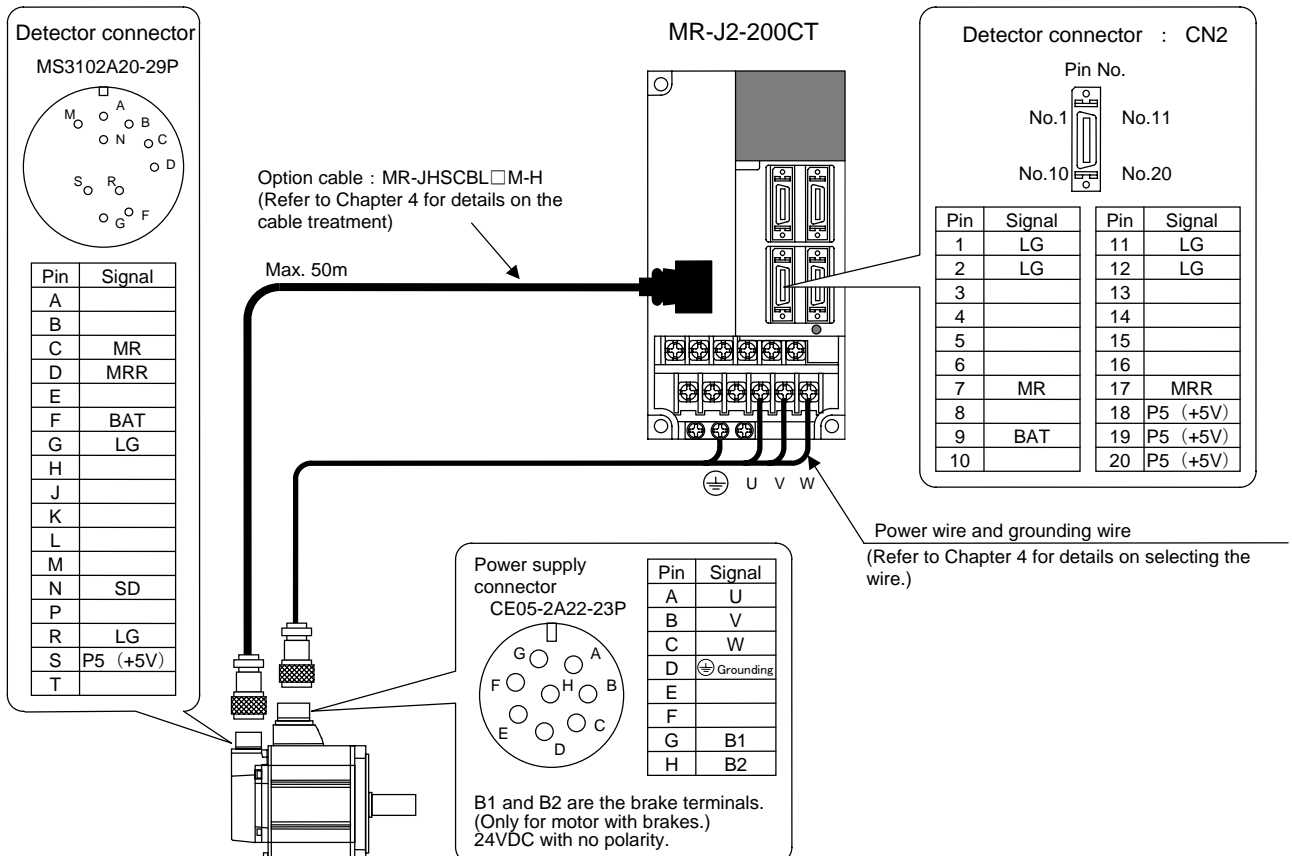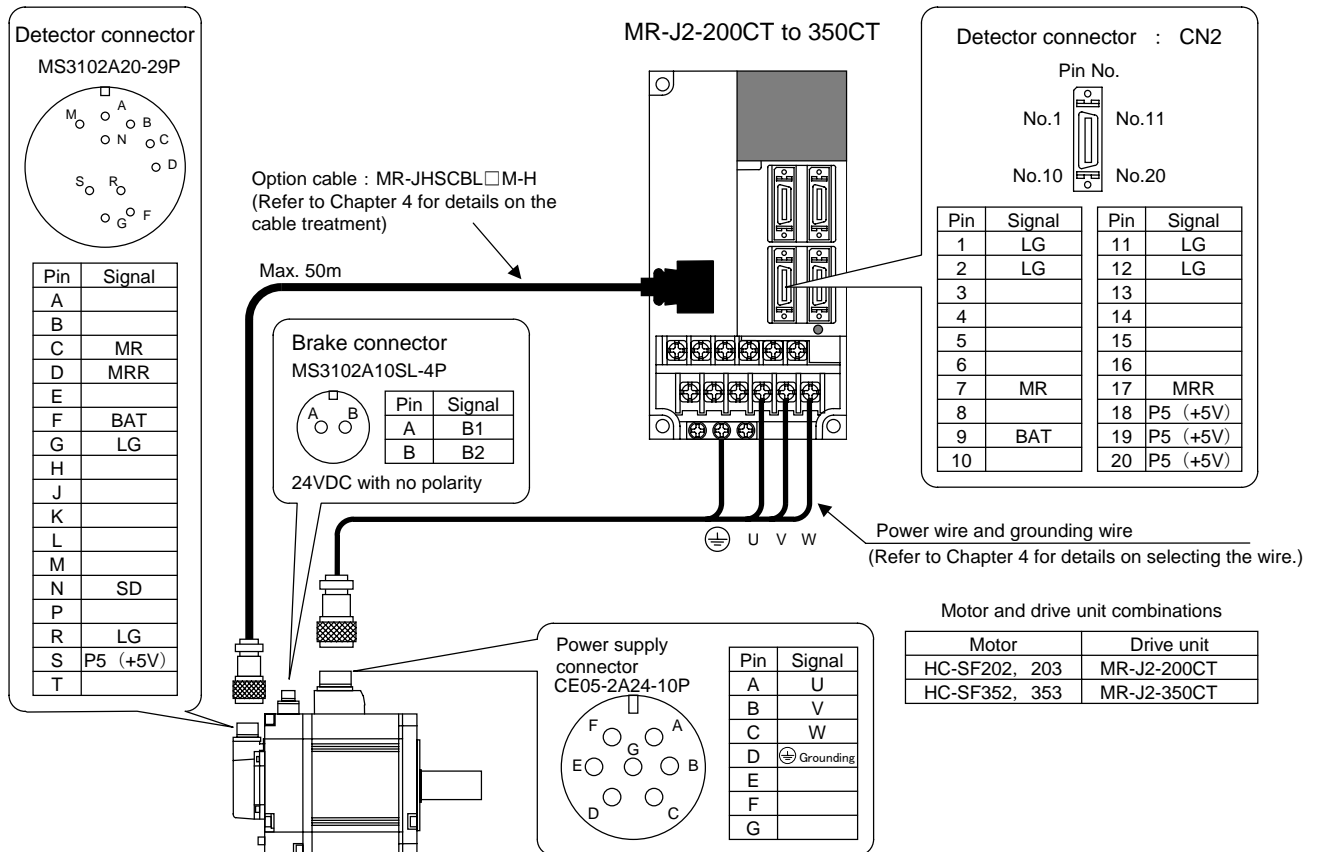
Motor and drive unit combinations

| Motor | Drive unit |
|-------|-----------|
| HC-SF52,  53 | MR-J2-60CT |
| HC-SF102,  103 | MR-J2-100CT |

Power supply connector
CE05-2A22-23P

| Pin | Signal |
|-----|--------|
| A | U |
| B | V |
| C | W |
| D | Grounding |
| E | |
| F | |
| G | B1 |
| H | B2 |

B1 and B2 are the brake terminals.
(Only for motor with brakes.)
24VDC with no polarity.

### 2-4-2   Connection of HC-SF152, HC-SF153

Detector connector
MS3102A20-29P

| Pin | Signal |
|-----|--------|
| A | |
| B | |
| C | MR |
| D | MRR |
| E | |
| F | BAT |
| G | LG |
| H | |
| J | |
| K | |
| L | |
| M | |
| N | SD |
| P | |
| R | LG |
| S | P5 (+5V) |
| T | |

Option cable : MR-JHSCBL□M-H
(Refer to Chapter 4 for details on the cable treatment)

Max. 50m

MR-J2-200CT

Detector connector  :  CN2

Pin No.

No.1   No.11

No.10   No.20

| Pin | Signal | Pin | Signal |
|-----|--------|-----|--------|
| 1 | LG | 11 | LG |
| 2 | LG | 12 | LG |
| 3 | | 13 | |
| 4 | | 14 | |
| 5 | | 15 | |
| 6 | | 16 | |
| 7 | MR | 17 | MRR |
| 8 | | 18 | P5 (+5V) |
| 9 | BAT | 19 | P5 (+5V) |
| 10 | | 20 | P5 (+5V) |

U  V  W

Power wire and grounding wire
(Refer to Chapter 4 for details on selecting the wire.)

Power supply connector
CE05-2A22-23P

| Pin | Signal |
|-----|--------|
| A | U |
| B | V |
| C | W |
| D | Grounding |
| E | |
| F | |
| G | B1 |
| H | B2 |

B1 and B2 are the brake terminals.
(Only for motor with brakes.)
24VDC with no polarity.

## 2-4-3   Connection of HC-SF202, HC-SF203, HC-SF352, HC-SF353

Detector connector
MS3102A20-29P

| Pin | Signal |
|-----|--------|
| A | |
| B | |
| C | MR |
| D | MRR |
| E | |
| F | BAT |
| G | LG |
| H | |
| J | |
| K | |
| L | |
| M | |
| N | SD |
| P | |
| R | LG |
| S | P5 (+5V) |
| T | |

Option cable : MR-JHSCBL□M-H
(Refer to Chapter 4 for details on the cable treatment)

Max. 50m

Brake connector
MS3102A10SL-4P

| Pin | Signal |
|-----|--------|
| A | B1 |
| B | B2 |

24VDC with no polarity

Power supply connector
CE05-2A24-10P

| Pin | Signal |
|-----|--------|
| A | U |
| B | V |
| C | W |
| D | Grounding |
| E | |
| F | |
| G | |

MR-J2-200CT to 350CT

Detector connector : CN2

Pin No.
No.1   No.11
No.10   No.20

| Pin | Signal | Pin | Signal |
|-----|--------|-----|--------|
| 1 | LG | 11 | LG |
| 2 | LG | 12 | LG |
| 3 | | 13 | |
| 4 | | 14 | |
| 5 | | 15 | |
| 6 | | 16 | |
| 7 | MR | 17 | MRR |
| 8 | | 18 | P5 (+5V) |
| 9 | BAT | 19 | P5 (+5V) |
| 10 | | 20 | P5 (+5V) |

U V W

Power wire and grounding wire
(Refer to Chapter 4 for details on selecting the wire.)

Motor and drive unit combinations

| Motor | Drive unit |
|-------|-----------|
| HC-SF202, 203 | MR-J2-200CT |
| HC-SF352, 353 | MR-J2-350CT |

## 2-4-4   Connection of HC-RF103, HC-RF153, HC-RF203

Detector connector
MS3102A20-29P

| Pin | Signal |
|-----|--------|
| A | |
| B | |
| C | MR |
| D | MRR |
| E | |
| F | BAT |
| G | LG |
| H | |
| J | |
| K | |
| L | |
| M | |
| N | SD |
| P | |
| R | LG |
| S | P5 (+5V) |
| T | |

Option cable : MR-JHSCBL□M-H
(Refer to Chapter 4 for details on the cable treatment)

Max. 50m

Power supply connector
CE05-2A22-23P

| Pin | Signal |
|-----|--------|
| A | U |
| B | V |
| C | W |
| D | Grounding |
| E | |
| F | |
| G | B1 |
| H | B2 |

B1 and B2 are the brake terminals.
(Only for motor with brakes.)
24VDC with no polarity.

MR-J2-200CT to 350CT

Detector connector : CN2

Pin No.
No.1   No.11
No.10   No.20

| Pin | Signal | Pin | Signal |
|-----|--------|-----|--------|
| 1 | LG | 11 | LG |
| 2 | LG | 12 | LG |
| 3 | | 13 | |
| 4 | | 14 | |
| 5 | | 15 | |
| 6 | | 16 | |
| 7 | MR | 17 | MRR |
| 8 | | 18 | P5 (+5V) |
| 9 | BAT | 19 | P5 (+5V) |
| 10 | | 20 | P5 (+5V) |

U V W

Power wire and grounding wire
(Refer to Chapter 4 for details on selecting the wire.)

Motor and drive unit combinations

| Motor | Drive unit |
|-------|-----------|
| HC-RF103, 153 | MR-J2-200CT |
| HC-RF203 | MR-J2-350CT |

## 2-4-5   Connection of HA-FF Series

MR-J2-10CT to 60CT

Detector connector
172161-9

| Pin | Signal |
|-----|--------|
| 1 | MR |
| 2 | MRR |
| 3 | BAT |
| 4 | MD |
| 5 | MDR |
| 6 | CONT |
| 7 | P5（+5V） |
| 8 | LG |
| 9 | LG |

Option cable : MR-JHSCBL□M-H
(Refer to Chapter 4 for details on the cable treatment)

Max. 50m

Power supply lead
VCTF3-1.25² 0.5m
With round crimp terminal with end insulator 1.25-4
Red:U phase, White:V phase, Black : W phase

Detector cable   0.3m
With connector
172169-9 (AMP)

Grounding terminal
M3 screw

Brake lead
VCTF2-0.5² 0.5m
With round crimp terminal with end insulator 1.25-2
24VDC with no polarity.

Power wire and grounding wire
(Refer to Chapter 4 for details on selecting the wire.)

Detector connector ： CN2

Pin No.

No.1    No.11

No.10    No.20

| Pin | Signal | Pin | Signal |
|-----|--------|-----|--------|
| 1 | LG | 11 | LG |
| 2 | LG | 12 | LG |
| 3 |  | 13 |  |
| 4 |  | 14 |  |
| 5 |  | 15 |  |
| 6 |  | 16 |  |
| 7 | MR | 17 | MRR |
| 8 |  | 18 | P5（+5V） |
| 9 | BAT | 19 | P5（+5V） |
| 10 |  | 20 | P5（+5V） |

U V W

Motor and drive unit combinations

| Motor | Drive unit |
|-------|-----------|
| HA-FF053, 13 | MR-J2-10CT |
| HA-FF23 | MR-J2-20CT |
| HA-FF33, 43 | MR-J2-40CT |
| HA-FF63 | MR-J2-60CT |

## 2-4-6   Connection of HA-FF□C-UE Series

MR-J2-10CT ~ 60CT

Detector connector
MS3102A20-29P

| Pin | Signal |
|-----|--------|
| A |  |
| B |  |
| C | MR |
| D | MRR |
| E |  |
| F | BAT |
| G | LG |
| H |  |
| J |  |
| K |  |
| L |  |
| M |  |
| N | SD |
| P |  |
| R | LG |
| S | P5（+5V） |
| T |  |

Option cable : MR-JHSCBL□M-H
(Refer to Chapter 4 for details on the cable treatment)

Max. 50m

Power supply connector
CE05-2A14S-2PD-B（D17）

| Pin | Signal |
|-----|--------|
| A | U |
| B | V |
| C | W |
| D | Grounding |

Brake connector
MS3102A10SL-4P

| Pin | Signal |
|-----|--------|
| A | B1 |
| B | B2 |

24VDC with no polarity

Power wire and grounding wire
(Refer to Chapter 4 for details on selecting the wire.)

Detector connector ： CN2

Pin No.

No.1    No.11

No.10    No.20

| Pin | Signal | Pin | Signal |
|-----|--------|-----|--------|
| 1 | LG | 11 | LG |
| 2 | LG | 12 | LG |
| 3 |  | 13 |  |
| 4 |  | 14 |  |
| 5 |  | 15 |  |
| 6 |  | 16 |  |
| 7 | MR | 17 | MRR |
| 8 |  | 18 | P5（+5V） |
| 9 | BAT | 19 | P5（+5V） |
| 10 |  | 20 | P5（+5V） |

U V W

Motor and drive unit combinations

| Motor | Drive unit |
|-------|-----------|
| HA-FF053C-UE, 13C-UE | MR-J2-10CT |
| HA-FF23C-UE | MR-J2-20CT |
| HA-FF33C-UE, 43C-UE | MR-J2-40CT |
| HA-FF63C-UE | MR-J2-60CT |

## 2-4-7   Connection of HC-MF(-UE) Series



Detector connector
172161-9

| Pin | Signal |
|-----|--------|
| 1 | MR |
| 2 | MRR |
| 3 | BAT |
| 4 | MD |
| 5 | MDR |
| 6 | CONT |
| 7 | P5 (+5V) |
| 8 | LG |
| 9 | LG |

Detector cable   0.3m
With connector
172169-9 (AMP)

Option cable : MR-JHSCBL□M-H
(Refer to Chapter 4 for details on the cable treatment)

Max. 50m

Brake lead
2-0.3² 0.3m
With round crimp terminal with end insulator 1.25-2
Blue: B1, B2 24VDC with no polarity

Power supply lead
4-AWG19   0.3m
With round crimp terminal with end insulator 1.25-4
Red : U phase, White :V phase, Black : W phase
Yellow/Green : Grounding

MR-J2-10CT to 40CT
MR-J2-70CT

Power wire and grounding wire
(Refer to Chapter 4 for details on selecting the wire.)

Detector connector : CN2

Pin No.

No.1   No.11
No.10   No.20

| Pin | Signal | Pin | Signal |
|-----|--------|-----|--------|
| 1 | LG | 11 | LG |
| 2 | LG | 12 | LG |
| 3 | | 13 | |
| 4 | | 14 | |
| 5 | | 15 | |
| 6 | | 16 | |
| 7 | MR | 17 | MRR |
| 8 | | 18 | P5 (+5V) |
| 9 | BAT | 19 | P5 (+5V) |
| 10 | | 20 | P5 (+5V) |

Motor and drive unit combinations

| Motor | Drive unit |
|-------|-----------|
| HC-MF053 (-UE) , 13 (-UE) | MR-J2-10CT |
| HC-MF23 (-UE) | MR-J2-20CT |
| HC-MF43 (-UE) | MR-J2-40CT |
| HC-MF73 (-UE) | MR-J2-60CT |

## 2-4-8   Connection of HC-MF□-S15 Series



Detector connector
RM15WTP-10P

| Pin | Signal |
|-----|--------|
| 1 | MR |
| 2 | MRR |
| 3 | BAT |
| 4 | MD |
| 5 | MDR |
| 6 | CONT |
| 7 | P5 (+5V) |
| 8 | LG |
| 9 | SD |
| 10 | |

Detector cable   0.5m
With connector
RM15WTP-10P
(Hirose)

Option cable : MR-RMCBL□M
(Refer to Chapter 4 for details on the cable treatment)

Max. 50m

Brake lead   0.5m
With connector RM15WTP-4P
(Hirose)

Power supply connector
RM15WTP-4P

| Pin | Signal |
|-----|--------|
| 1 | U |
| 2 | V |
| 3 | W |
| 4 | Grounding |

MR-J2-10CT to 40CT
MR-J2-70CT

Power wire and grounding wire
(Refer to Chapter 4 for details on selecting the wire.)

Detector connector : CN2

Pin No.

No.1   No.11
No.10   No.20

| Pin | Signal | Pin | Signal |
|-----|--------|-----|--------|
| 1 | LG | 11 | LG |
| 2 | LG | 12 | LG |
| 3 | | 13 | |
| 4 | | 14 | |
| 5 | | 15 | |
| 6 | MD | 16 | MDR |
| 7 | MR | 17 | MRR |
| 8 | | 18 | P5 (+5V) |
| 9 | BAT | 19 | P5 (+5V) |
| 10 | | 20 | P5 (+5V) |

Motor and drive unit combinations

| Motor | Drive unit |
|-------|-----------|
| HC-MF13-S15 | MR-J2-10CT |
| HC-MF23-S15 | MR-J2-20CT |
| HC-MF43-S15 | MR-J2-40CT |
| HC-MF73-S15 | MR-J2-70CT |

## 2-5   Connection of power supply

<table>
<tr>
<td rowspan="2">⚠ **CAUTION**</td>
<td>
1. Make sure that the power supply voltage is within the specified range of the servo drive unit. Failure to observe this could lead to damage or faults.
2. For safety purposes, always install a circuit protector, and make sure that the circuit is cut off when an error occurs or during inspections. Refer to Chapter 4 and select the circuit protector.
3. The wire size will differ according to the drive unit capacity. Refer to Chapter 4 and select the size.
4. For safety purposes, always install a contactor (magnetic contactor) on the main circuit power supply input. Large rush currents will flow when the power is turned ON. Refer to Chapter 4 and select the correct contactor.
5. When the MR-J2-CT emergency stop sequence is separated from other drive units using a parameter setting, always install a contactor dedicated for that axis.
</td>
</tr>
</table>

### 2-5-1   Example of connection when controlling the contactor with the MR-J2-CT

Drive the contactor via the relay from the contactor control output of the (MC) CN3 connector. There are also some types of contactors that can be directly driven with 24VDC.



2 - 14
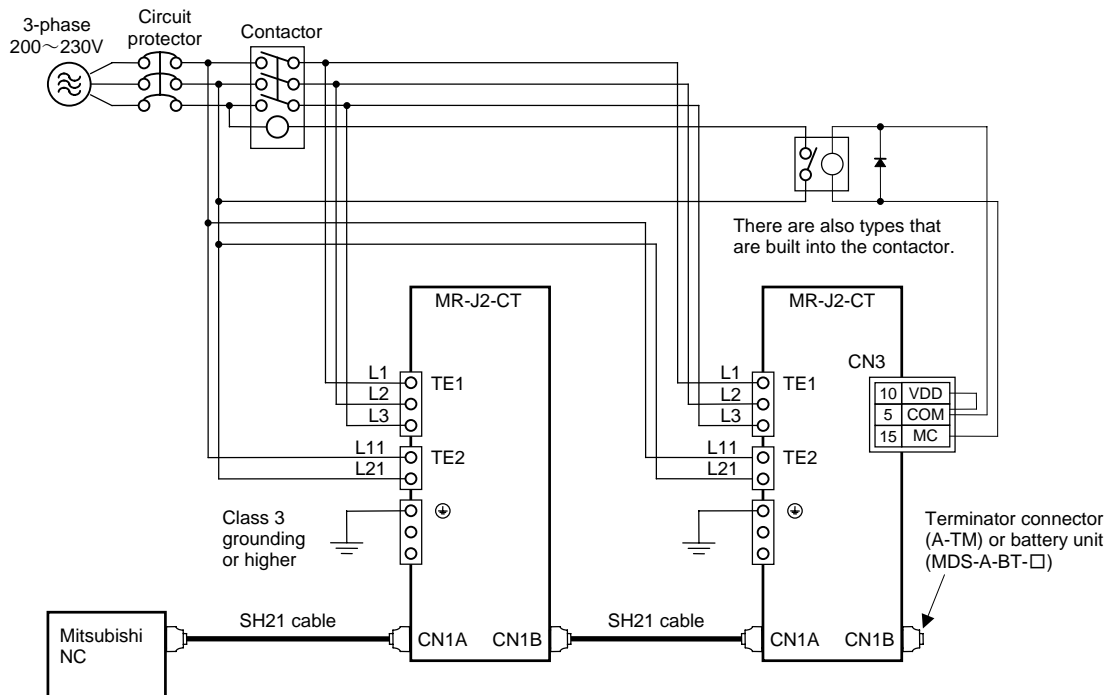
### 2-5-2    Example of connection when using converter unit

If there is a converter unit in the system, the contactor control can be shared using the contactor control output (MC1) of the converter. Note that this is only possible when the emergency stop sequence is shared with the NC feed axis servo drive unit, etc.

#### (1)    When sharing a converter and power supply
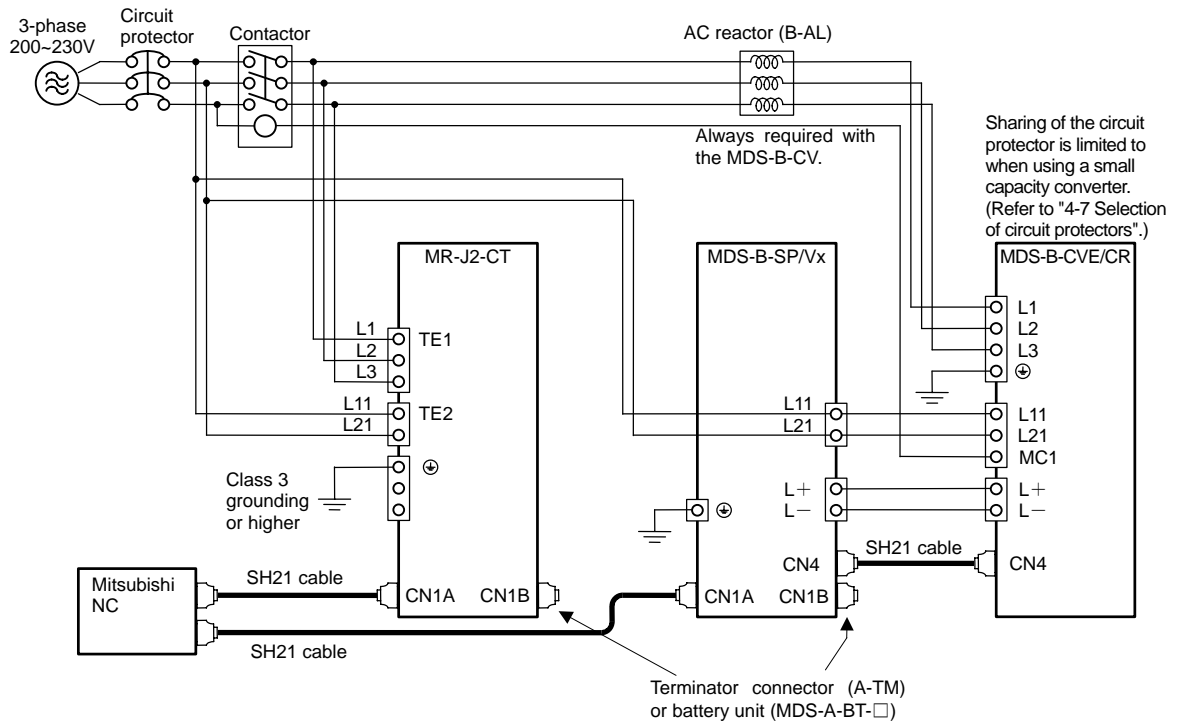


| | |
|---|---|
| ⚠ **CAUTION** | 1. The MDS-B-CV is a power supply regenerative type converter; an AC reactor is required in the power supply line.<br>Connect the MR-J2-CT main circuit power supply on the power supply side of the AC reactor.<br>2. A circuit protector and contactor cannot be shared when the rated current of the circuit protector exceeds 60A.<br>3. If the emergency stop sequence differs from the converter side (when the PLC emergency stop or external emergency stop is used, or when the bus line emergency stop is invalidated), use the MR-J2-CT independent power configuration (refer to section 2-5-1). |

**(2)  When not sharing a converter and power supply**
If the rated current exceeds 60A by the selection of the circuit protector when the converter and power supply are shared, install the circuit protectors and contactors separate from the converter unit .
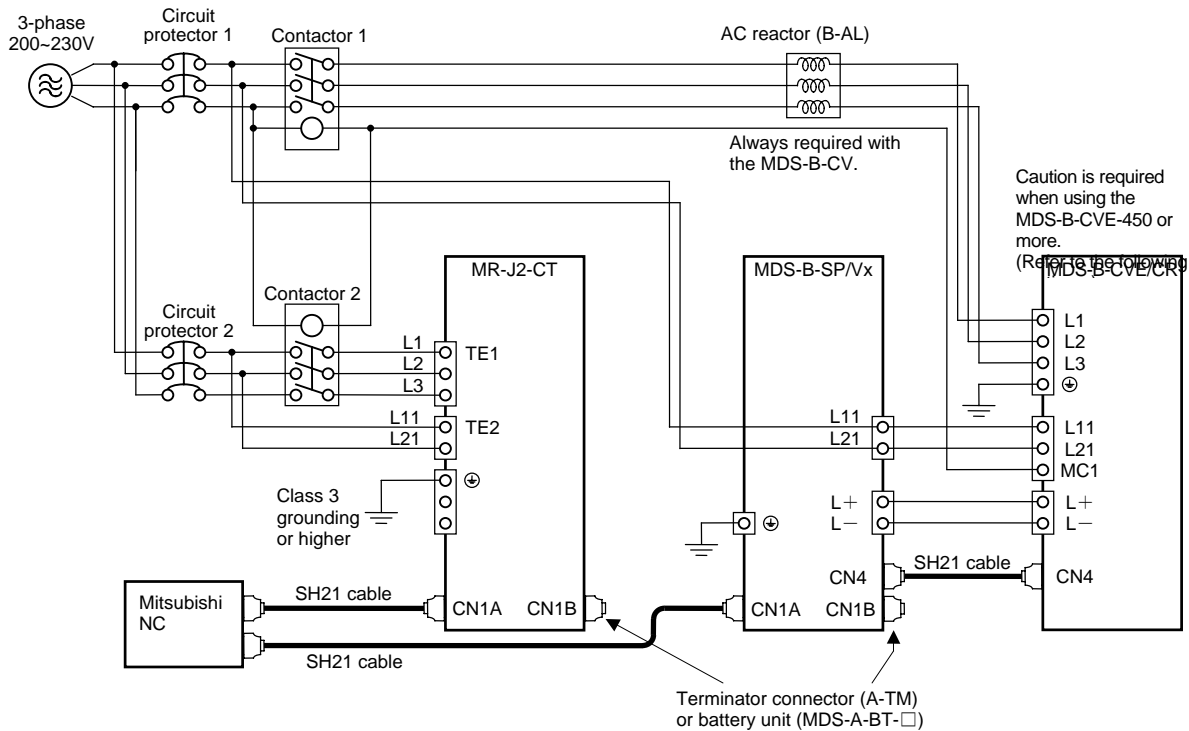


---

| | Install independent circuit protectors and contactors as the MR-J2-CT main circuit power supply if the total current capacity exceeds 60A when the converter and power supply are shared. |
|---|---|
| ◇ **DANGER** | Circuit protectors may not operate for short-circuits in small capacity drive units if they are shared with a large capacity unit, and this could cause fires. For the MR-J2-CT, use an NF60 type or lower capacity breaker.<br>(Refer to section "4-7 Selection of circuit protectors".) |

| | If the converter capacity is more than MDS-B-CVE-450, the MR-J2-CT contactor drive cannot be shared with the converter. Refer to "2-5-1 Example of connection when controlling the contactor with the MR-J2-CT", and control contactor 2 from the MR-J2-CT. |
|---|---|
| ⚠ **CAUTION** | |

## 2-6   Connection of regenerative resistor

### 2-6-1   Standard built-in regenerative resistor

The built-in regenerative resistor is connected by short-circuiting between the P and D terminals of the control circuit terminal block (TE2). (Shipment state). Confirm that a short bar has been connected between the P and D terminals.
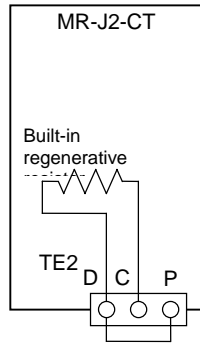


**(Note)**   The terminal block TE2 is on the top front of the drive unit in the MR-J2-200CT and -350CT.

Confirm that a short bar has been connected between the P and D terminals

### 2-6-2   External option regenerative resistor

Disconnect the short bar connected between the P and D terminals, and connect the option regeneration resistor between the P and C terminals. The servo drive unit has an internal regenerative resistor electronic thermal (software process), and when overheating of the regenerative resistor is detected, an over-regeneration (alarm 30) is detected. The thermal protector terminals (G3, G4) are used when double-protecting against overheating of the regenerative resistor. When double-protecting, construct a sequence in which an emergency stop occurs if a current stops flowing between G3 and G4.
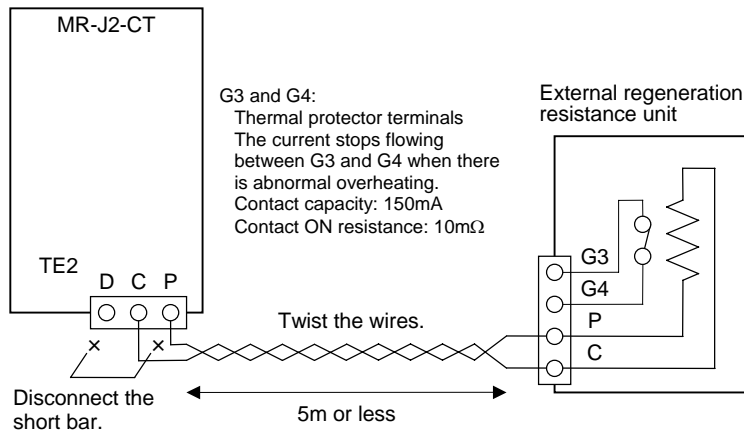


| ⚠ **DANGER** | 1. Be careful when selecting the installation location. Choose a location where foreign matter (cutting chips, cutting oil, etc.) does not adhere to the external regenerative resistor unit terminal. A short-circuit between the P and C terminals could lead to servo drive unit damage.<br>2. The regenerative resistor generates heat of approximately 100 degrees (or higher, depending on the installation conditions). Give sufficient consideration to heat dissipation and installation position.<br>  • Use flame resisting wire.<br>  • Make sure the wires do not contact the regenerative resistor unit. |
|---|---|

| ⚠ **CAUTION** | Always use twisted pair cable to connect to the servo drive unit, and keep the length of the wiring to 5m or less. |
|---|---|

## 2-7   Connection of digital input/output (DIO) signals

### 2-7-1   Types and functions of digital input/output (DIO) signals

The digital input/output (DIO) signals are assigned to the connector CN3, and have the following functions.



Connector for DIO : CN3

| Pin | Signal | Pin | Signal |
|-----|--------|-----|--------|
| 1 | LG | 11 | LG |
| 2 | RxD | 12 | TxD |
| 3 | SG | 13 | MBR |
| 4 | MO1 | 14 | MO2 |
| 5 | COM | 15 | MC |
| 6 | | 16 | |
| 7 | | 17 | |
| 8 | | 18 | |
| 9 | | 19 | DOG |
| 10 | VDD | 20 | EMGX |

SH21 cable

Relay terminal : MR-J2CN3TM
(Option)

To personal computer etc.

Each model I/F
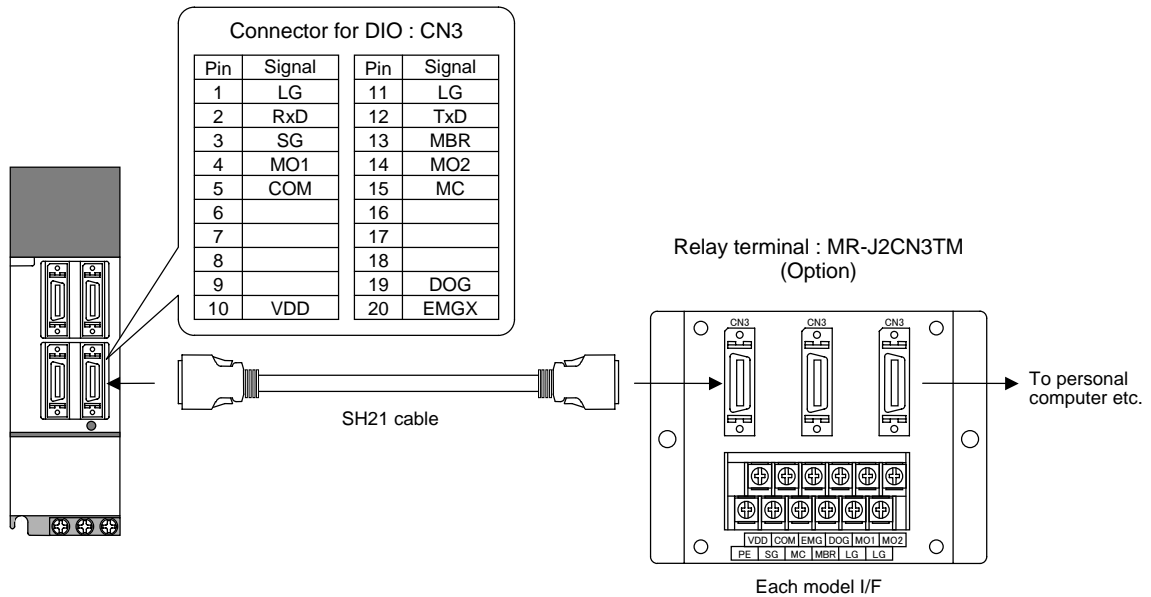
| Signal name | Abbrev. | Connector pin No. | Function and application | I/O class |
|-------------|---------|-------------------|-------------------------|-----------|
| Magnetic brake control | MBR | CN3-13 | This is the motor magnetic brake control output signal.<br>The brakes are released by the SERVO ON signal (motor power ON), and operated by the SERVO OFF (motor power OFF) signal. | DO |
| Contactor control | MC | CN3-15 | Contactor control output signal.<br>The contactor is turned ON by the READY ON signal, and turned OFF by the READY OFF signal. | DO |
| Near-point dog | DOG | CN3-19 | This inputs a near-point signal when executing dog-type zero point return. | DI |
| Emergency stop | EMGX | CN3-20 | This is the external emergency stop signal input. | DI |

**POINT**

1. The MBR and MC pin Nos. are set to the default parameter settings. The output pin No. can be changed with the MBR and MC signals by parameter setting. (Refer to the table below.)
2. The external emergency stop input (EMGX) is invalid when the parameters are set to their default values. Set parameter #103.bit0 to "0" to use this function.

| No. | Abbrev. | Parameter name | Description |
|-----|---------|----------------|-------------|
| #102 | ∗Cont2 | Control parameter 2 | HEX setting parameter. Set bits without a description to their default values. |

| bit | F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-----|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Default value | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |

| bit | Meaning when "0" is set. | Meaning when "1" is set. |
|-----|--------------------------|--------------------------|
| 1 | Error not corrected at servo OFF | Error corrected at servo OFF |
| 2 | Linear axis | Rotation axis |
| 3 | Station assignment direction CW | Station assignment direction CCW |
| 4 | Uniform indexing | Non-uniform indexing |
| 5 | DO channel standard assignment | DO channel reverse assignment |
| 6 | 2-wire detector communication | 4-wire detector communication |
| 7 | Incremental detection | Absolute position detection |

### 2-7-2   Wiring of digital input/output (DIO) signals

Either an internal or external power supply can be used, but they cannot be used together in the same drive unit.

**(1)   Motor brake control signal (MBR) output circuit**

The motor brake power supply is controlled via a relay. When using an inductive load, install a diode. (Tolerable current: 40mA or less, rush current: 100mA or less)
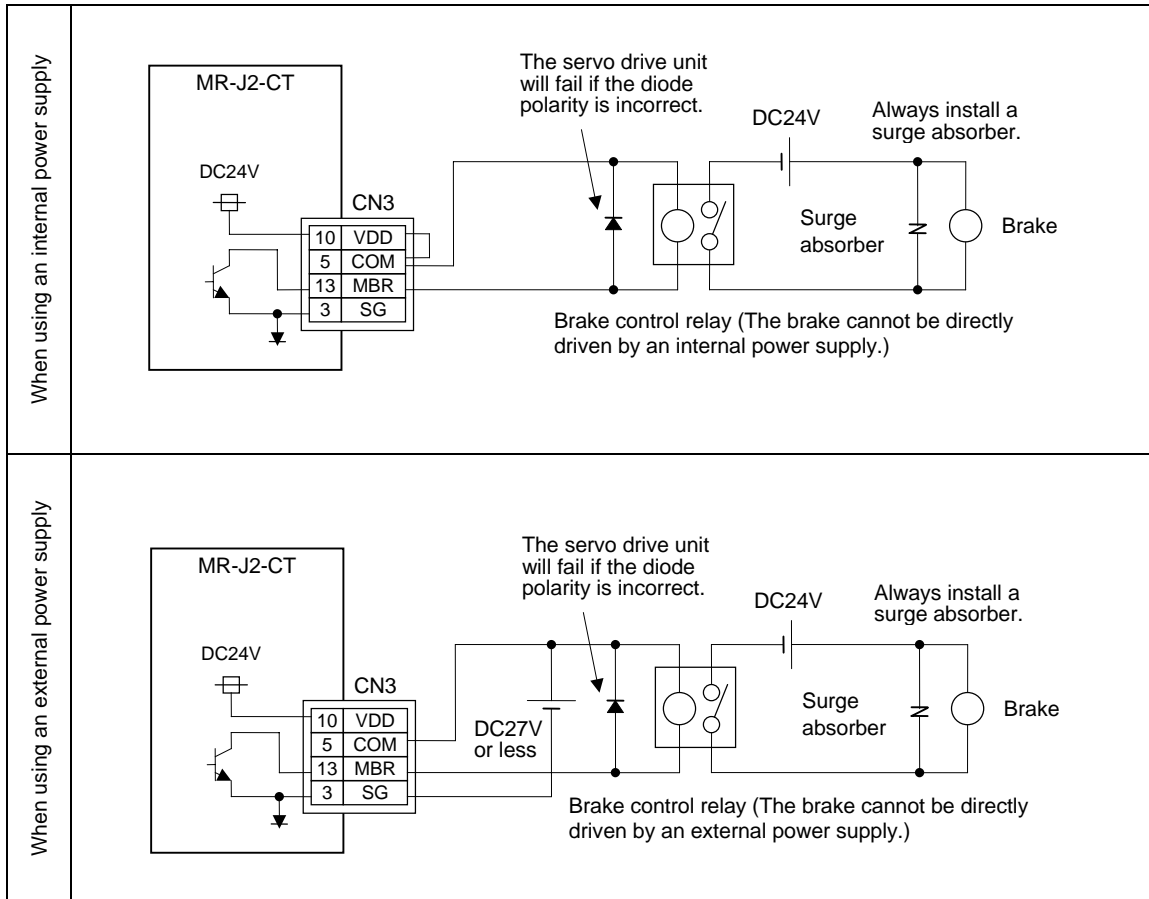




| 💡 **POINT** | When using an internal power supply, the power supply can be directly connected to VDD if only the digital output (MC, MBR) is being used. When using the digital input (DOG, EMGX), always connect between VDD and COM. |
| --- | --- |

| ⚠ **CAUTION** | 1. Always install a surge absorber near the motor's brake terminal to eliminate noise and protect the contacts. <br> 2. The magnetic brakes cannot be directly driven with the output signal from the servo drive unit. Always install a relay. <br> 3. The magnetic brakes cannot be driven by the servo drive unit's VDD (24VDC). Always install a separate power supply. |
| --- | --- |

**<Brake sequence>**

The Sequence related to the motor brake output signal is explained in this section.
Pay careful attention because its operation differs depending on the situations when an emergency stop was input, servo OFF command was input, or an alarm occurred.

### (a) When Emergency stop occurred at motor stop

| Emergency stop | Emergency stop released / Emergency stop | |
| Motor brake output(MBR) | Brake contact output | invalid / valid |
| Magnetic brake actual operation | Magnetic brake | invalid / valid |
| Servo ready | Ready | ON / OFF |

Magnetic brake delay time

Vertical axis drop prevention time
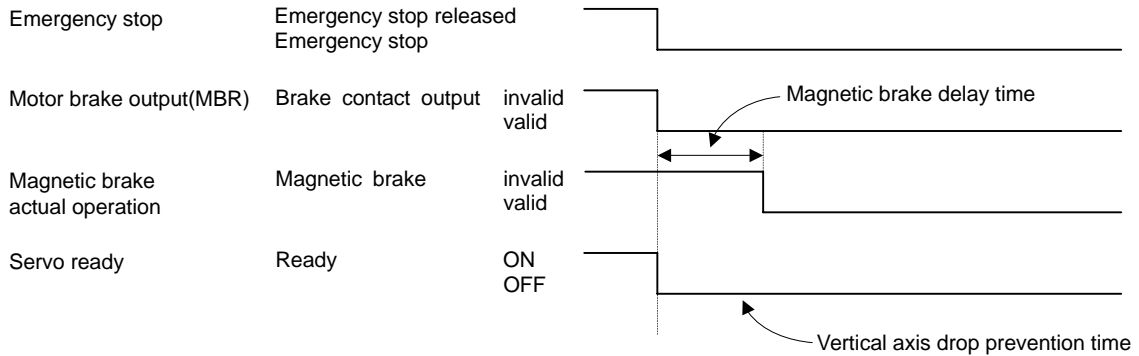
### (b) When servo OFF command is input at motor stop

| Servo ON/OFF command | Servo | invalid / valid |
| Motor brake output(MBR) | Brake contact output | invalid / valid |
| Magnetic brake actual operation | Magnetic brake | invalid / valid |
| Servo ready | Ready | ON / OFF |

Magnetic brake delay time

Vertical axis drop prevention time (#013)
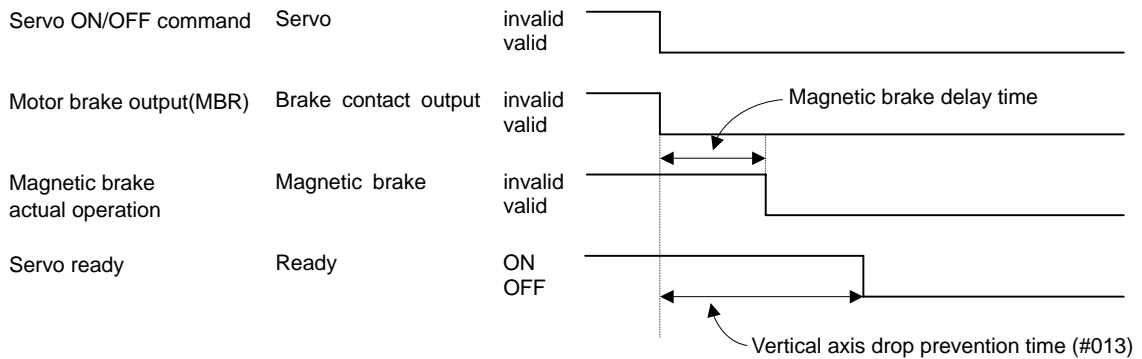
### (c) When emergency stop occurred when an alarm on which axes can decelerate to stop occurred.

| Emergency stop or alarm occurrence | Emergency stop released and no alarm. / Emergency stop or alarm occurred. | |
| Motor rotation speed | | |
| Motor brake output(MBR) | Brake contact output | invalid / valid |
| Magnetic brake actual operation | Magnetic brake | invalid / valid |
| Servo ready | Ready | ON / OFF |

Magnetic brake delay time
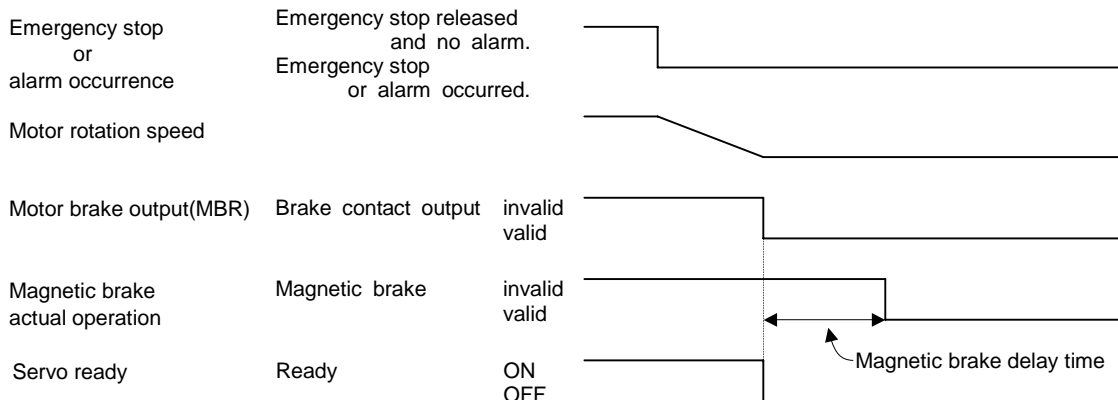
**(d) When servo OFF command is input while motor rotation.**

| | | |
|---|---|---|
| Servo command | Servo | ON / OFF |
| Movement command | | |
| Motor rotation speed | | |
| In-position | | |
| Motor brake output(MBR) | Brake contact output | invalid / valid |
| Magnetic brake actual operation | Magnetic brake | invalid / valid |
| Servo ready | Ready | ON / OFF |

Magnetic brake delay time

Vertical axis drop prevention time (#013)
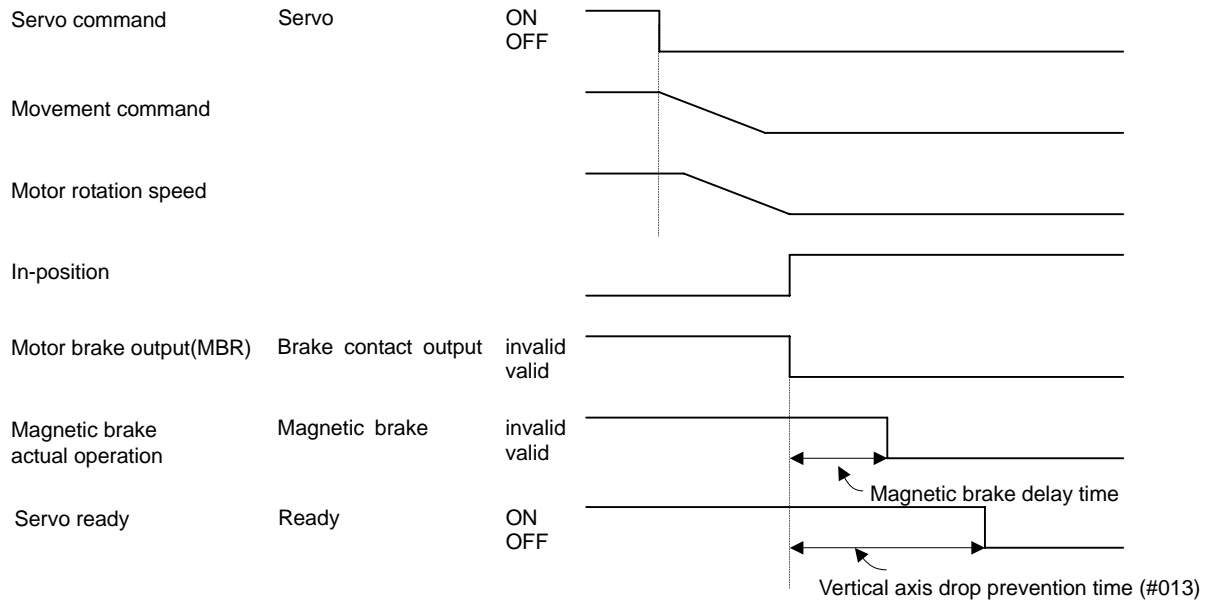
**(e) When an alarm on which the axes cannot decelerate to stop occurred.**

| | | |
|---|---|---|
| Alarm | Alarm: | not occurred / occurred |
| Motor rotation speed | | |
| Motor brake output(MBR) | Brake contact output | invalid / valid |
| Magnetic brake actual operation | Magnetic brake | invalid / valid |
| Servo ready | Ready | ON / OFF |

Dynamic brake

Dynamic brake + Magnetic brake

2 - 21
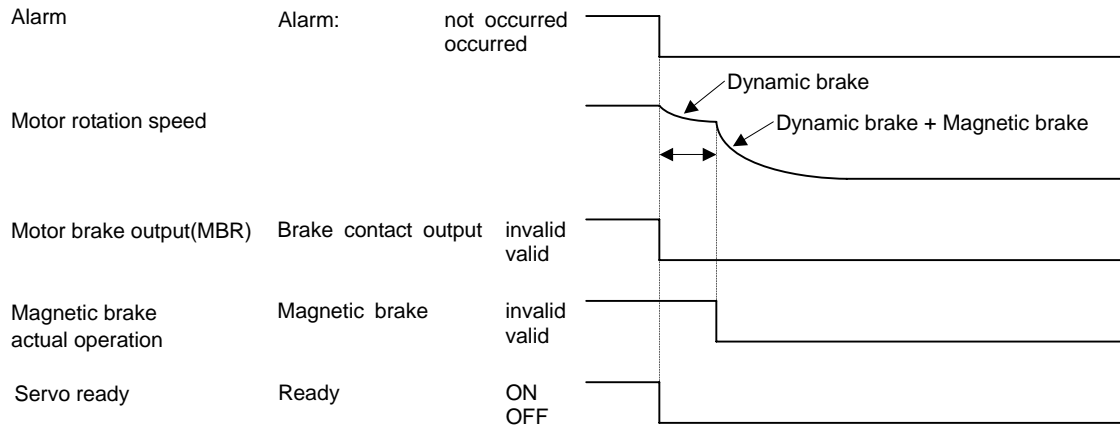
**(2)  Contactor control signal (MC) output circuit**

A relay or photocoupler can be driven with this circuit. When using an inductive load, install a diode. (Tolerable current: 40mA or less, rush current: 100mA or less)
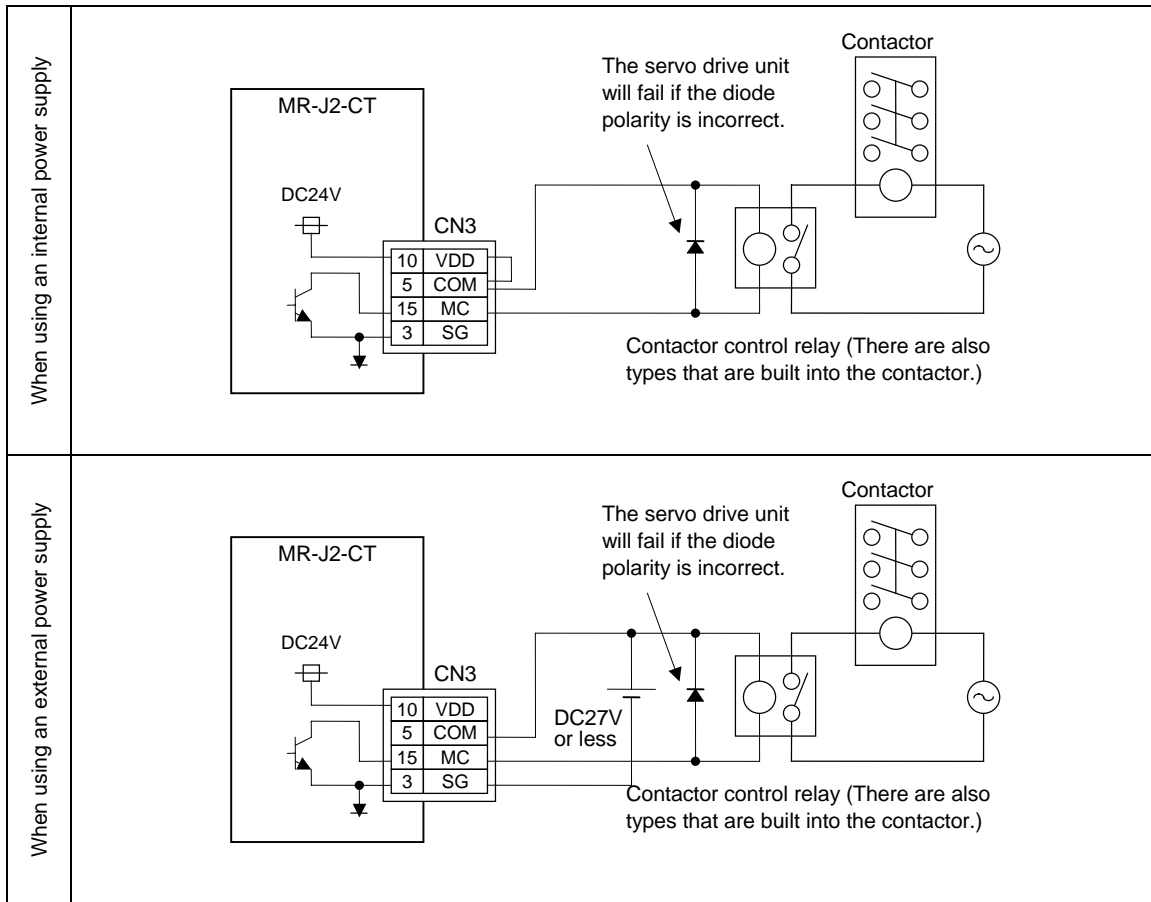


> **POINT**
>
> When using an internal power supply, the power supply can be directly connected to VDD if only the digital output (MC, MBR) is being used. When using the digital input (DOG, EMGX), always connect between VDD and COM.

**(3) Near point dog signal (DOG) input circuit**
Issue a signal using a relay or open-collector transistor.

When using an internal power supply

MR-J2-CT

DC24V

CN3

| 10 | VDD |
| 5 | COM |
| 19 | DOG |
| 3 | SG |

4.7k

Current direction approximately 5mA

When using a transistor:
$V_{CES} \leqq 1.0V$
$I_{CEO} \leqq 100 \mu A$

Near-point dog

Near-point dog canceled by closing.

When using an external power supply

MR-J2-CT

DC24V

CN3

DC27V or less

| 10 | VDD |
| 5 | COM |
| 19 | DOG |
| 3 | SG |

4.7k

Current direction

When using a transistor:
$V_{CES} \leqq 1.0V$
$I_{CEO} \leqq 100 \mu A$

Near-point dog

Near-point dog canceled by closing.
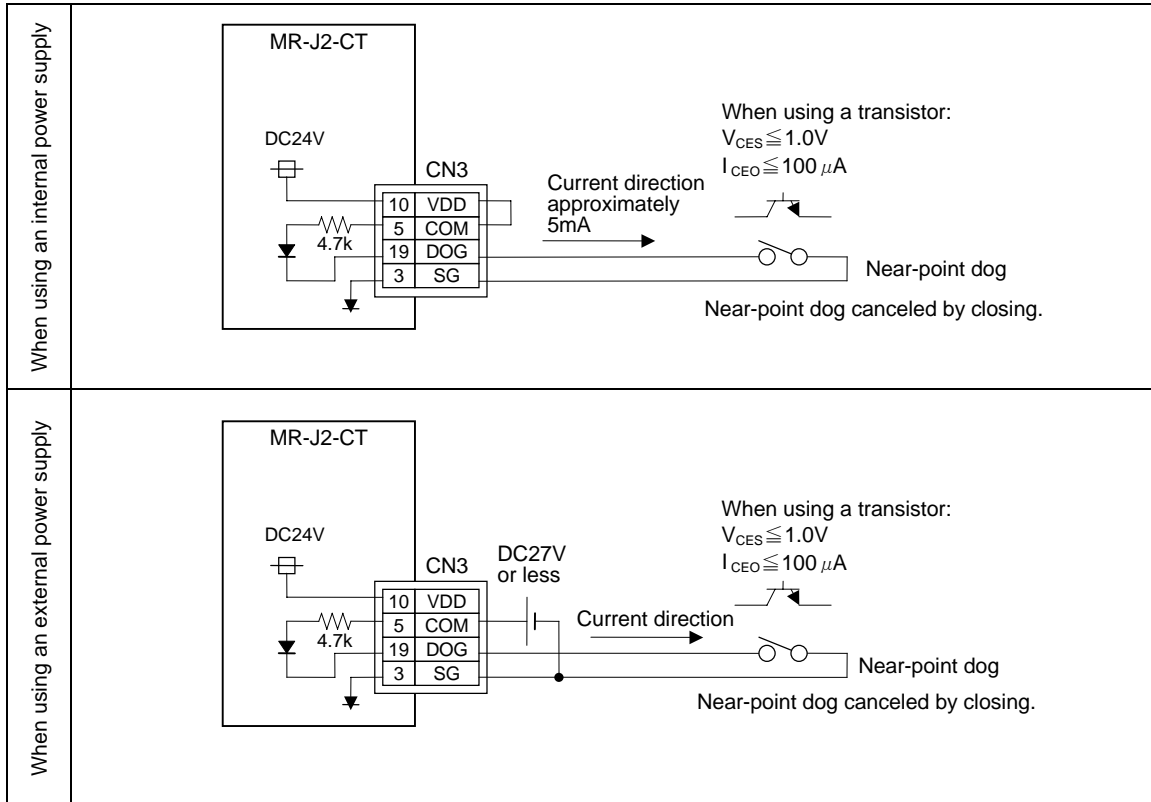
**(4) External emergency stop signal (EMGX) input circuit**
Issue a signal using a relay or open-collector transistor.

When using an internal power supply

MR-J2-CT

DC24V

CN3

| 10 | VDD |
| 5 | COM |
| 20 | EMGX |
| 3 | SG |

4.7k

Current direction approximately 5mA

When using a transistor:
$V_{CES} \leqq 1.0V$
$I_{CEO} \leqq 100 \mu A$

External emergency stop

Emergency stop canceled by closing.

When using an external power supply

MR-J2-CT

DC24V

CN3

DC27V or less

| 10 | VDD |
| 5 | COM |
| 20 | EMGX |
| 3 | SG |

4.7k

Current direction

When using a transistor:
$V_{CES} \leqq 1.0V$
$I_{CEO} \leqq 100 \mu A$

External emergency stop

Emergency stop canceled by closing.

## 2-8   Connection with personal computer

RS-232-C is used for connection with the commercial personal computer. The connector is CN3.



Commercial personal computer
+ Windows 95/98/2000/XP

Optional cable
MR-CPCATCBL (for DOS/V)

Setup software

CN3

SH21 cable

Relay terminal block
MR-J2-CN3TM (option)

# Chapter 3  Installation

⚠ **CAUTION**

1. Install the unit on noncombustible material. Direct installation on combustible material or near combustible materials could lead to fires.
2. Follow this Instruction Manual and install the unit in a place where the weight can be borne.
3. Do not get on top of or place heavy objects on the unit.
   Failure to observe this could lead to injuries.
4. Always use the unit within the designated environment conditions.
5. Do not let conductive objects such as screws or metal chips, etc., or combustible materials such as oil enter the servo drive unit or servomotor.
6. Do not block the servo drive unit intake and outtake ports. Doing so could lead to failure.
7. The servo drive unit and servomotor are precision devices, so do not drop them or apply strong impacts to them.
8. Do not install or run a servo drive unit or servomotor that is damaged or missing parts.
9. When storing for a long time, please contact your dealer.

## 3-1   Installation of the servo drive unit

⚠ **CAUTION**

1. Always observe the installation directions. Failure to observe this could lead to faults.
2. Secure the specified distance between the servo drive unit and control panel, or between the servo drive unit and other devices. Failure to observe this could lead to faults.

### 3-1-1   Environmental conditions

| Environment | Conditions |
|---|---|
| Ambient temperature | 0°C to +55°C      (with no freezing) |
| Ambient humidity | 90% RH or less (with no dew condensation) |
| Storage temperature | −20°C to +65°C (with no freezing) |
| Storage humidity | 90% RH or less (with no dew condensation) |
| Atmosphere | Indoors (Where unit is not subject to direct sunlight) |
| | With no corrosive gas, combustible gas, oil mist or dust |
| Altitude | 1000m or less above sea level |
| Vibration | 5.9m/s$^2$ (0.6G) or less |

## 3-1-2   Installation direction and clearance

Install the servo drive unit so that the front side is visible. Refer to the following drawings for the heat dissipation and wiring of each unit, and secure sufficient space for ventilation.

**Front  view**                    **Side  view**
(Top)

100mm or more    10mm or more

70mm or more

10mm or more    40mm or more    10mm or more

(Bottom)
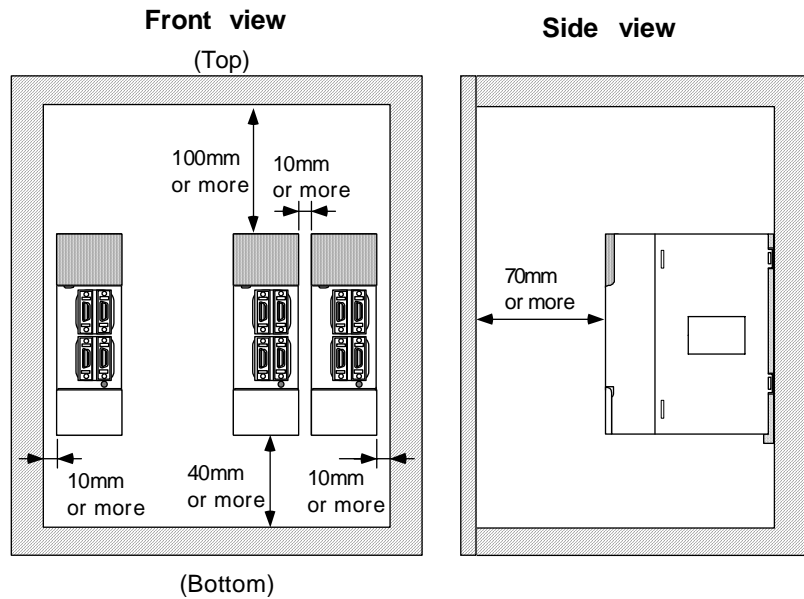
| ⚠ **CAUTION** | The ambient temperature condition for the servo drive unit is 55°C or less. Because heat can easily accumulate in the upper portion of the drive unit, give sufficient consideration to heat dissipation when designing the power distribution panel. If required, install a fan in the power distribution panel to agitate the heat in the upper portion of the drive unit. |
|---|---|

## 3-1-3   Prevention of entering of foreign matter

Treat the cabinet with the following items.
- Make sure that the cable inlet is dust and oil proof by using packing, etc.
- Make sure that the external air does not enter inside by using head radiating holes, etc.
- Close all clearances.
- Securely install door packing.
- If there is a rear cover, always apply packing.
- Oil will tend to accumulate on the top. Take special measures such as oil-proofing the top so that oil does not enter the cabinet from the screw holds.
- After installing each unit, avoid machining in the periphery. If cutting chips, etc., stick onto the electronic parts, trouble may occur.
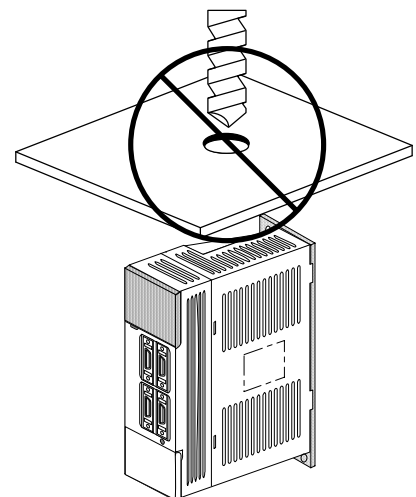
## 3-2   Installation of servomotor

| | |
|---|---|
| ⚠ **CAUTION** | 1. Do not hold the cables, axis or detector when transporting the servomotor. Failure to observe this could lead to faults or injuries.<br>2. Securely fix the servomotor to the machine. Insufficient fixing could lead to the servomotor deviating during operation. Failure to observe this could lead to injuries.<br>3. When coupling to a servomotor shaft end, do not apply an impact by hammering, etc. The detector could be damaged.<br>4. Never touch the rotary sections of the servomotor during operations. Install a cover, etc., on the shaft.<br>5. Do not apply a load exceeding the tolerable load onto the servomotor shaft. The shaft could break.<br>6. Do not connect or disconnect any of the connectors while the power is ON. |

### 3-2-1   Environmental conditions

| Environment | Conditions | |
|---|---|---|
| Ambient temperature | 0°C to +40°C       (with no freezing) | |
| Ambient humidity | 80% RH or less (with no dew condensation) | |
| Storage temperature | −15°C to +70°C (with no freezing) | |
| Storage humidity | 90% RH or less (with no dew condensation) | |
| Atmosphere | • Indoors (Where unit is not subject to direct sunlight)<br>• With no corrosive gas or combustible gas, mist or dust | |
| Altitude | 1000m or less above sea level | |
| Vibration | HC-SF (1.5kW) or less<br>HC-RF | X: 9.8 m/s$^2$ (1G)<br>Y: 24.5m/s$^2$ (2.5G) or less |
| | HC-SF (2.0kW) or less | X: 19.6 m/s$^2$ (2G)<br>Y: 49 m/s$^2$ (5G) or less |
| | HA-FF, HC-MF | X: 19.6 m/s$^2$ (2G)<br>Y: 19.6 m/s$^2$ (2G) or less |

The vibration conditions are as shown below.
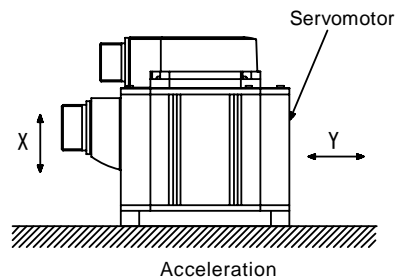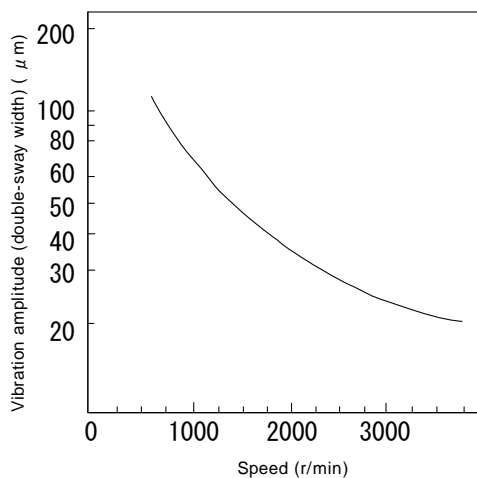
### 3-2-2   Cautions for mounting load (prevention of impact on shaft)

① When using the servomotor with key way, use the screw hole at the end of the shaft to mount the pulley onto the shaft. To install, first place the double-end stud into the shaft screw holes, contact the coupling end surface against the washer, and press in as if tightening with a nut. When the shaft does not have a key way, use a frictional coupling, etc.

② When removing the pulley, use a pulley remover, and make sure not to apply an impact on the shaft.

③ Install a protective cover on the rotary sections such as the pulley installed on the shaft to ensure safety.

④ The direction of the detector installation on the servomotor cannot be changed.
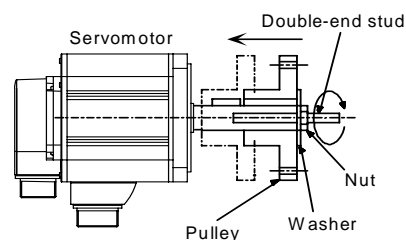
| ⚠ **CAUTION** | Never hammer the end of the shaft during assembly. |
| --- | --- |
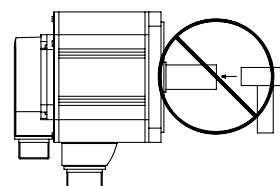
### 3-2-3   Installation direction

There are no restrictions on the installation direction. Installation in any direction is possible, but as a standard the servomotor is installed so that the motor power supply wire and detector cable cannon plugs (lead-in wires) face downward. Installation in the standard direction is effective against dripping. Measure against oil and water must be taken when not installing in the standard direction. Refer to section "3-2-5 Oil and waterproofing measures" and take appropriate measures.
The brake plates may make a sliding sound when a servomotor with magnetic brake is installed with the shaft facing upward, but this is not a fault.
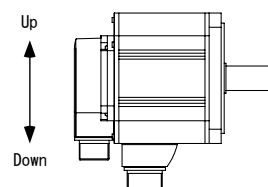
**Standard installation direction**

### 3-2-4   Tolerable load of axis

There are limits to the load that can be applied to the motor shaft. When mounting the motor on a machine, make sure the loads applied in the radial direction and thrust direction are less than the tolerable values shown in the table below. These loads can cause motor output torque, so this point should be carefully considered when designing the machine.
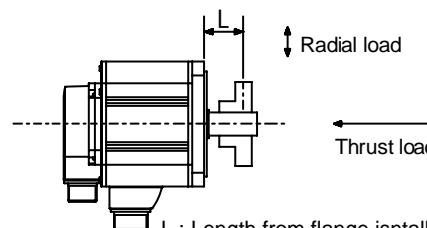
L : Length from flange isntallation surface to center of load weight [mm]

| Servomotor | Tolerable radial load | Tolerable thrust load |
| --- | --- | --- |
| HC-SF52T, 53T, 102T, 103T, 152T, 153T (taper shaft) | 392N (L=58) | 490N |
| HC-SF52, 53, 102, 103, 152, 153 (straight shaft) | 980N (L=55) | 490N |
| HC-SF202, 203, 352, 353 | 2058N (L=79) | 980N |
| HC-RF103T, 153T, 203T (taper shaft) | 392N (L=58) | 196N |
| HC-RF103, 153, 203 (straight shaft) | 686N (L=45) | 196N |
| HA-FF053 | 108N (L=30) | 98N |
| HA-FF13 | 118N (L=30) | 98N |
| HA-FF23, 33 | 176N (L=30) | 147N |
| HA-FF43, 63 | 323N (L=40) | 284N |
| HC-MF053, 13, 23 | 88N (L=25) | 59N |
| HC-MF43 | 245N (L=30) | 98N |
| HC-MF73 | 392N (L=40) | 147N |

| ⚠ **CAUTION** | 1. Use a flexible coupling when connecting with a ball screw, etc., and keep the shaft center deviation to below the tolerable radial load of the shaft. |
|---|---|
| | 2. When directly installing the gears on the motor shaft, the radial load increases as the diameter of the gear decreases. This should be carefully considered when designing the machine. |
| | 3. When directly installing the pulley on the motor shaft, carefully consider so that the radial load (double the tension) generated from the timing belt tension is less than the values shown in the table above. |
| | 4. In machines where thrust loads such as a worm gear are applied, carefully consider providing separate bearings, etc., on the machine side so that loads exceeding the tolerable thrust loads are not applied to the motor. |
| | 5. Do not use a rigid coupling as an excessive bending load will be applied on the shaft and could cause the shaft to break. |

### 3-2-5  Oil and waterproofing measures

① A form based on IEC standards (IP types) is displayed as the   servomotor protective form (Refer to "12-2-1 List of Specifications."). However, these standards are short-term performance specifications. They do not guarantee continuous environmental protection characteristics. Measures such as   covers, etc., must be provided if there is any possibility that oil or water will fall on the motor, or the motor will be constantly wet and permeated by water. Note that IP-type motors are not indicated as corrosion-resistant.

Oil or water
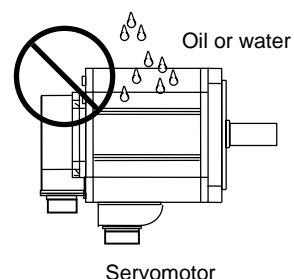
Servomotor

② When a gear box is installed on the servomotor, make sure that the oil level height from the center of the shaft is higher than the values given below. Open a breathing hole on the gear box so that the inner pressure does not rise. An oil seal is provided only on the HA-FF∗∗C-UE and HC-MF∗∗-S15 of the HA-FF and HC-MF Series.

| Servomotor | Oil level (mm) |
|---|---|
| HC-SF52, 102, 152<br>HC-SF53, 103, 153 | 20 |
| HC-SF202, 203, 352, 353 | 25 |
| HC-RF103, 153, 203 | 20 |
| HA-FF053C-UE, 13C-UE | 8 |
| HA-FF23C-UE, 33C-UE | 12 |
| HA-FF43C-UE, 63C-UE | 14 |
| HC-MF13-S15 | 10 |
| HC-MF23-S15, 43-S15 | 15 |
| HC-MF73-S15 | 20 |

Gear

Servomotor

Oil level

Lip

V-ring
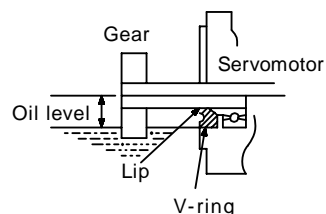
| ⚠ **CAUTION** | 1. The servomotors, including those having IP65 specifications, do not have a completely waterproof (oil-proof) structure. Do not allow oil or water to constantly contact the motor, enter the motor, or accumulate on the motor. Oil can also enter the motor through cutting chip accumulation, so be careful of this also. |
|---|---|
| | 2. When the motor is installed facing upwards, take measures on the machine side so that gear oil, etc., does not flow onto the motor shaft. |
| | 3. The HC-MF Series and standard HA-FF Series servomotors do not have an oil seal. Provide a seal on the gear box side so that lubricating oil, etc., does not enter the servomotor. |
| | 4. Do not remove the detector from the motor. (The detector installation screw is treated for sealing.) |

③  When installing the servomotor horizontally, set the
power cable and detector cable to face downward.
When installing vertically or on an inclination, provide a
cable trap.

Cable trap
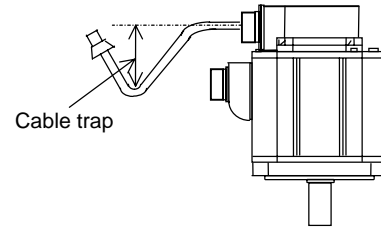
④  Do not use the unit with the cable submerged in oil or water.
(Refer to right drawing.)

Cover

Servomotor

Oil/water accumulation
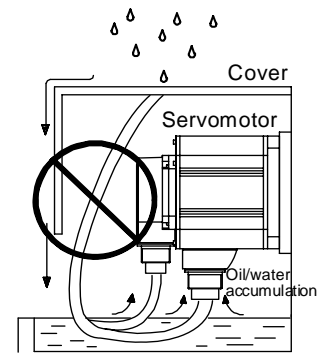
**<Fault>  Capillary tube**
           **phenomenon**

⑤  Make sure that oil and water do not flow along the cable
into the motor or detector. (Refer to right drawing.)

Cover
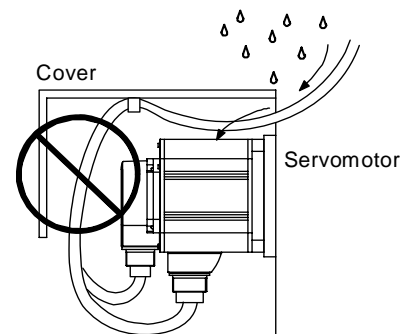
Servomotor

**<Fault> Breathing action**

⑥  When installing on the top of the shaft end, make
sure that oil from the gear box, etc., does not enter
the servomotor. The servomotor does not have a
waterproof structure.

Gear

Lubricating oil

Servomotor

3 - 7
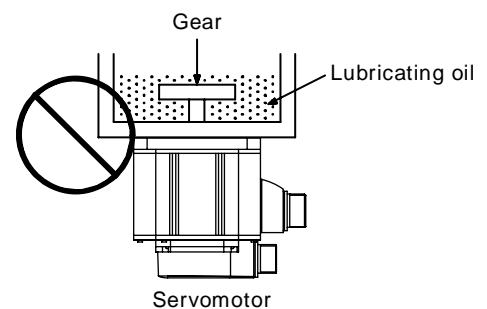
### 3-2-6   Cable stress

① Sufficiently consider the cable clamping method so that bending stress and the stress from the cable's own weight is not applied on the cable connection.

② In applications where the servomotor moves, make sure that excessive stress is not applied on the cable.
   If the detector cable and servomotor wiring are stored in a cable bear and the servomotor moves, make sure that the cable bending section is within the range of the optional detector cable.
   Fix the detector cable and power cable enclosed with the servomotor.

③ Make sure that the cable sheaths will not be cut by sharp cutting chips, worn by contacting the machine corners, or stepped on by workers or vehicles.

④ The bending life of the detector cable is as shown below. Regard this with a slight allowance. If the servomotor is installed on a machine that moves, make the bending radius as large as possible.
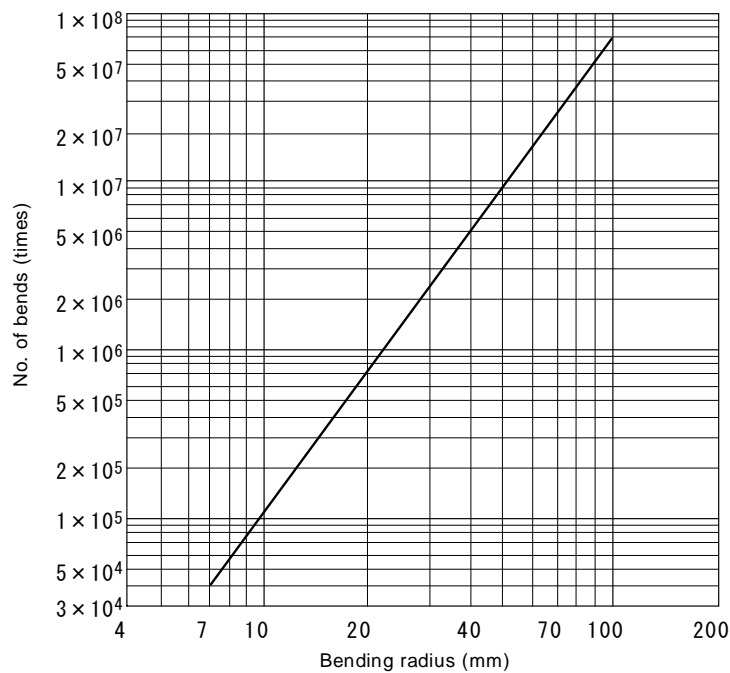


**Detector cable bending life**
(The optional detector cable and wire of our company: A14B2343)

**Note:** The values in this graph are calculated values and are not guaranteed.

## 3-3   Noise measures

Noise includes that which enters the servo drive unit from an external source and causes the servo drive unit to malfunction, and that which is radiated from the servo drive unit or motor and causes the peripheral devices or drive unit itself to malfunction. The servo drive unit output is a source of noise as the DC voltage is switched at a high frequency. If the peripheral devices or drive unit malfunction because of the noise, measures must be taken to suppressed this noise. These measures differ according to the propagation path of the noise.

### (1) General measures for noise

- Avoid wiring the servo drive unit's power supply wire and signal wires in parallel or in a bundled state. Always use separate wiring. Use a twisted pair shield wire for the detector cable, the control signal wires for the bus cable, etc., and for the control power supply wire. Securely ground the shield.
- Use one-point grounding for the servo drive unit and motor.

### (2) Measures against noise entering from external source and causing servo drive unit to malfunction

If a device generating noise is installed near the servo drive unit, and the servo drive unit could malfunction, take the following measures.
- Install a surge killer on devices (magnetic contactor, relay, etc.) that generate high levels of noise.
- Install a data line filter on the control signal wire.
- Ground the detector cable shield with a cable clamp.

### (3) Measures against noise radiated from the servo drive unit and causing peripheral devices to malfunction

The types of propagation paths of the noise generated from the servo drive unit and the noise measures for each propagation path are shown below.

| Noise generated from servo drive unit | | | |
|---|---|---|---|
| | Airborne propagation noise | | Noise directly radiated from servo drive unit — Path [1] |
| | Magnetic induction noise | Path [4] and [5] | Noise radiated from power line — Path [2] |
| | Static induction noise | Path [6] | Noise radiated from servomotor — Path [3] |
| | Cable propagation noise | | Noise propagated over power line — Path [7] |
| | | | Noise lead in from grounding wire by leakage current — Path [8] |

**Generated noise of drive system**

| Noise propaga-tion path | Measures |
|---|---|
| [1] [2] [3] | When devices such as instruments, receivers or sensors, which handle minute signals and are easily affected by noise, or the signal wire of these devices, are stored in the same panel as the servo drive unit and the wiring is close, the device could malfunction due to airborne propagation of the noise. In this case, take the following measures.<br>(a) Install devices easily affected as far away from the servo drive unit as possible.<br>(b) Lay the signals wires easily affected as far away from the input wire with the servo drive unit.<br>(c) Avoid parallel wiring or bundled wiring of the signal wire and power wire.<br>(d) Insert a line noise filter on the input/output wire or a radio noise filter on the input to suppress noise radiated from the wires.<br>(e) Use a shield wire for the signal wire and power wire, or place in separate metal ducts. |
| [4] [5] [6] | If the signal wire is laid in parallel to the power wire, or if it is bundled with the power wire, the noise could be propagated to the signal wire and cause malfunction because of the magnetic induction noise or static induction noise. In this case, take the following measures.<br>(a) Install devices easily affected as far away from the servo drive unit as possible.<br>(b) Lay the signals wires easily affected as far away from the input wire with the servo drive unit.<br>(c) Avoid parallel wiring or bundled wiring of the signal wire and power wire.<br>(d) Use a shield wire for the signal wire and power wire, or place in separate metal ducts. |
| [7] | If the power supply for the peripheral devices is connected to the power supply in the same system as the servo drive unit, the noise generated from the servo drive unit could back flow over the power supply wire and cause the devices to malfunction. In this case, take the following measures.<br>(a) Install a radio noise filter on the servo drive unit's power wire.<br>(b) Install a line noise filter on the servo drive unit's power wire. |
| [8] | If a closed loop is structured by the peripheral device and servo drive unit's grounding wires, the leakage current could penetrate and cause the devices to malfunction. In this case, change the device grounding methods and the grounding place. |

# Chapter 4   Options and Peripheral Devices

| | |
|---|---|
| ◇ **DANGER** | Wait at least 10 minutes after turning the power OFF, confirm that the CHARGE lamp has gone out, and check the voltage with a tester, etc., before connecting the options or peripheral devices. Failure to observe this could lead to electric shocks. |

| | |
|---|---|
| ⚠ **CAUTION** | 1. Always use the designated option.<br>Failure to do so could lead to faults or fires.<br>2. Take care to the installation environment of the option regenerative resistor so that cutting chips and oil do not come in contact.<br>There is a risk of short-circuit accidents at the resistor terminal block and of the oil adhered on the resistor burning. These can cause fires. |

## 4-1 Regenerative option

### 4-1-1 Combinations with servo drive units

Confirm the regenerative resistor capacity and possibility of connecting with the servo drive unit. Refer to section "13-4 Selection of regenerative resistor" for details on selecting an option regenerative resistor.

| Corresponding servo drive unit | Standard built-in regenerative resistor | | External option regenerative resistor | | | | |
|---|---|---|---|---|---|---|---|
| | | | MR-RB032 | MR-RB12 | MR-RB32 | MR-RB30 | MR-RB50 |
| | Regenerative capacity | | 30W | 100W | 300W | 300W | 500W |
| | | Resistance value | 40Ω | 40Ω | 40Ω | 13Ω | 13Ω |
| MR-J2-10CT | No built-in resistor | | ○ | | | | |
| MR-J2-20CT | 10W | 100Ω | ○ | ○ | | | |
| MR-J2-40CT | 10W | 100Ω | ○ | ○ | | | |
| MR-J2-60CT | 10W | 40Ω | ○ | ○ | | | |
| MR-J2-70CT | 20W | 40Ω | | ○ | ○ | | |
| MR-J2-100CT | 20W | 40Ω | | ○ | ○ | | |
| MR-J2-200CT | 100W | 13Ω | | | | ○ | ○ |
| MR-J2-350CT | 100W | 13Ω | | | | ○ | ○ |

| No. | Abbrev. | Parameter name | Explanation |
|---|---|---|---|
| #002 | ∗RTY | Regenerative option type | Set the regenerative resistor type.<br><br>⬚ 0 0 0 0 (Initialized setting value)<br><br><table><tr><th>Setting value</th><th>Descriptions</th></tr><tr><td>0</td><td>Drive unit standard built-in resistor (10CT has no built-in resistor.)</td></tr><tr><td>1</td><td>Setting prohibited</td></tr><tr><td>2</td><td>MR-RB032 (30W)</td></tr><tr><td>3</td><td>MR-RB12 (100W)</td></tr><tr><td>4</td><td>MR-RB32 (300W)</td></tr><tr><td>5</td><td>MR-RB30 (300W)</td></tr><tr><td>6</td><td>MR-RB50 (500W)</td></tr><tr><td>7 ~ F</td><td>Setting prohibited</td></tr></table> |

| | |
|---|---|
| ⚠ **CAUTION** | The regenerative option and servo drive unit cannot be set to a combination other than that designated. Failure to use the correct combination could lead to fires. |

## 4-1-2　Outline dimension drawing of option regenerative resistor

### &lt;MR-RB032&gt;

[Unit : mm]
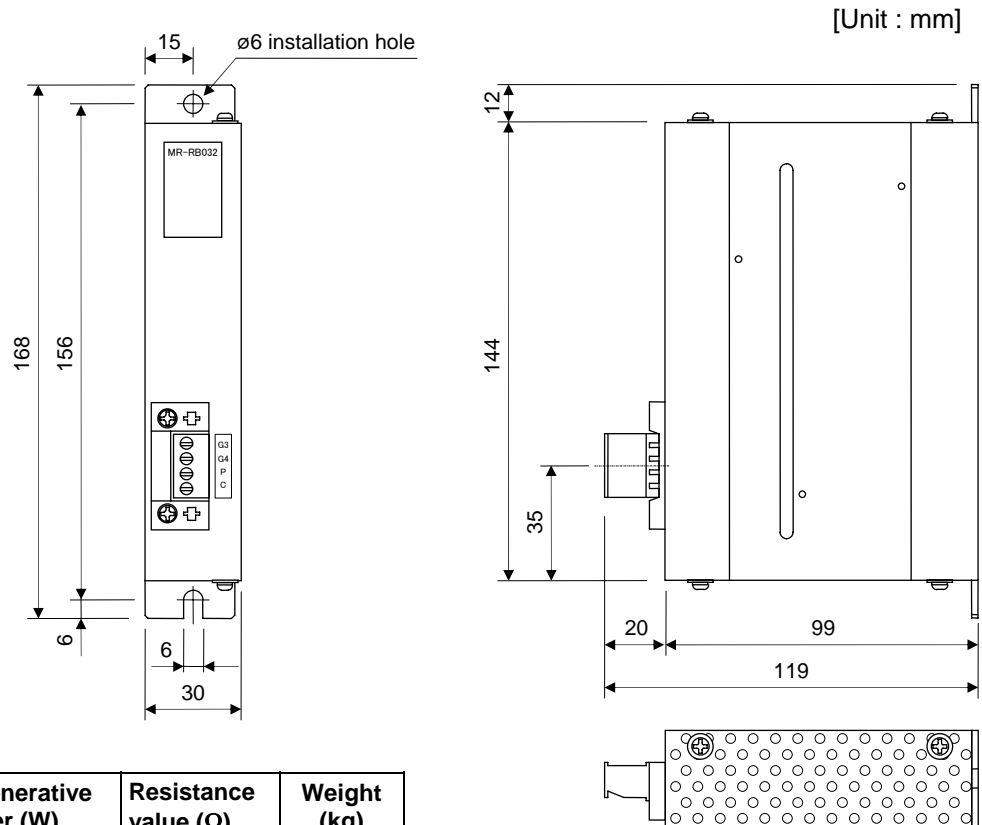


| Regenerative option | Regenerative power (W) | Resistance value (Ω) | Weight (kg) |
|---|---|---|---|
| MR-RB032 | 30 | 40 | 0.5 |

### &lt;MR-RB12&gt;

[Unit : mm]
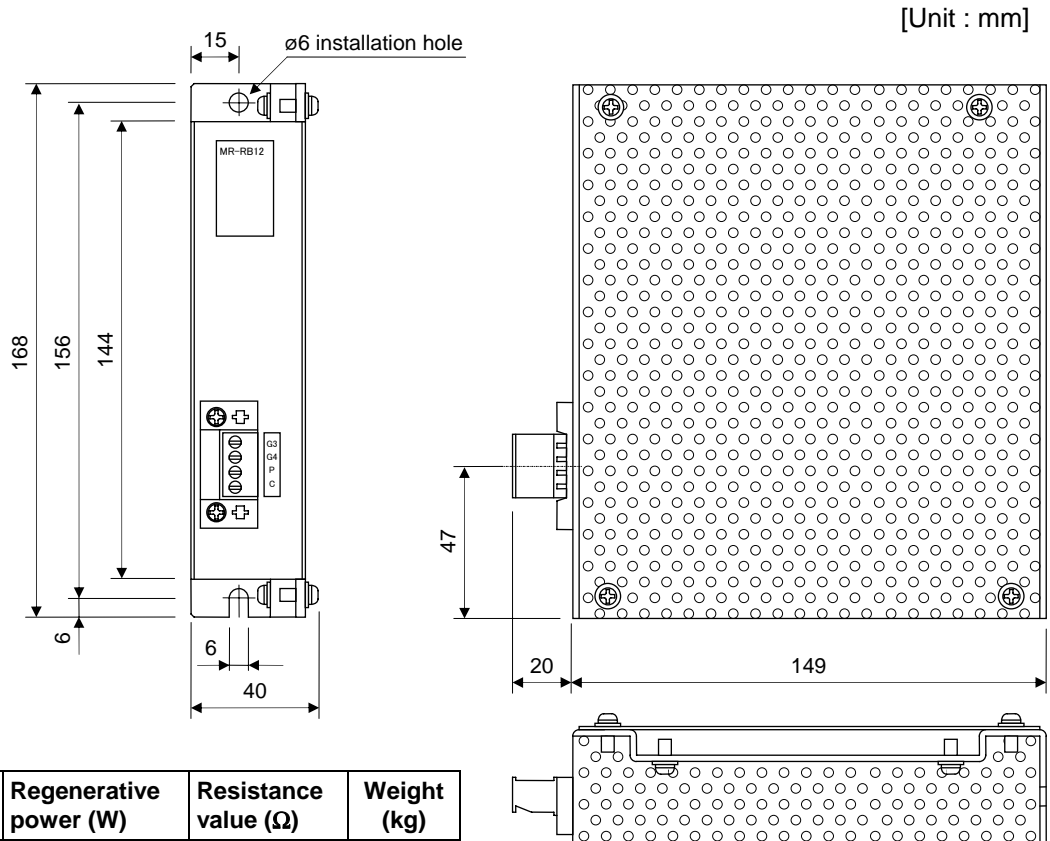


| Regenerative option | Regenerative power (W) | Resistance value (Ω) | Weight (kg) |
|---|---|---|---|
| MR-RB12 | 100 | 40 | 0.8 |

**<MR-RB32, MR-RB30>**

[Unit : mm]
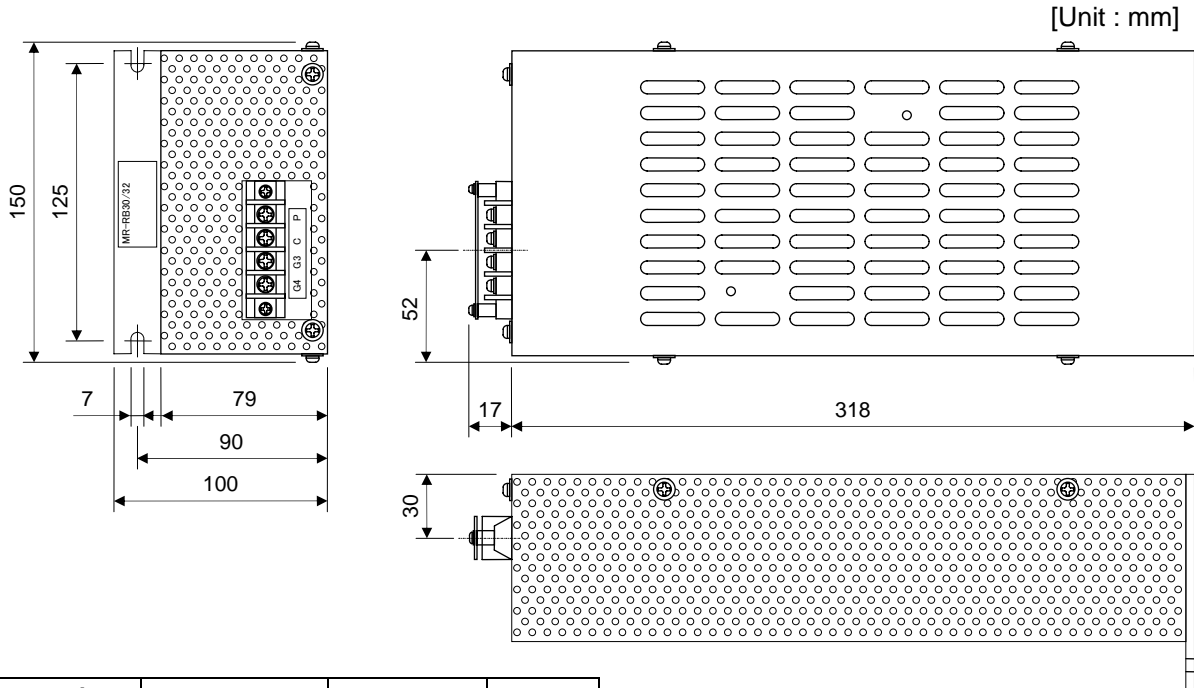
| Regenerative option | Regenerative power (W) | Resistance value (Ω) | Weight (kg) |
|---|---|---|---|
| MR-RB32 | 300 | 40 | 2.9 |
| MR-RB30 | 300 | 13 | 2.9 |

**<MR-RB50>**

[Unit : mm]
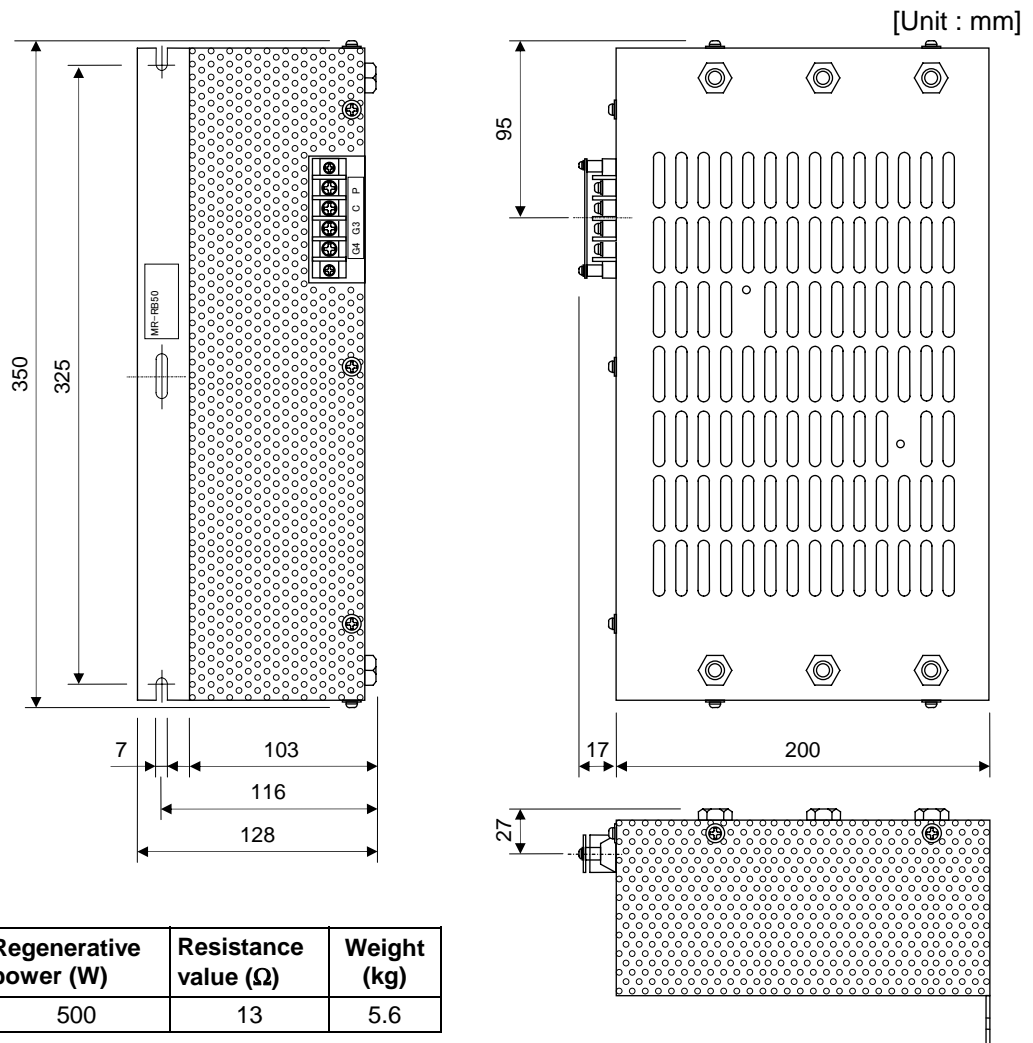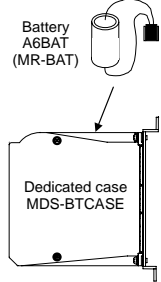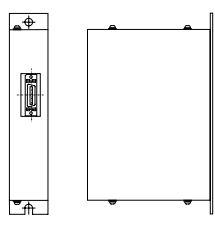
| Regenerative option | Regenerative power (W) | Resistance value (Ω) | Weight (kg) |
|---|---|---|---|
| MR-RB50 | 500 | 13 | 5.6 |

4 - 4

## 4-2   Battery option (MDS-A-BT, A6BAT)

This battery option may be required to establish absolute position system. Select a battery option from the table below depending on the servo system.

| Type | A6BAT (MR-BAT) | A6BAT (MR-BAT) | MDS-A-BT- □□ |
|---|---|---|---|
| Installation type | Drive unit with battery holder type | Dedicated case type | Unit and battery integration type |
| Hazard class | Not applicable | Not applicable (24 or less) | Class9 (excluding MDS-A-BT-2) |
| Number of connectable axes | 1 axis | Up to 8 axes (When using dedicated case) | 2 to 8 axes |
| Battery change | Possible | Possible | Not possible |
| Appearance | (1) | (2) | (3) |
|  | Battery MR-BAT | Battery A6BAT (MR-BAT) Dedicated case MDS-BTCASE | |

### (1) Cell battery ( A6BAT )

### < Specifications >

| Battery option type | | Cell battery A6BAT (MR-BAT) |
|---|---|---|
| Lithium battery series | | ER17330V |
| Nominal voltage | | 3.6V |
| Nominal capacity | | 1700mAh |
| Battery safety | Hazard class | - |
|  | Battery shape | Single battery |
|  | Number of batteries used | A6BAT (MR-BAT) ×1 |
|  | Lithium alloy content | 0.48g |
|  | Mercury content | 1g or less |
| Number of connectable axes | | 1 axis /   (per 1 battery) |
| Battery continuous backup time | | Approx. 10000 hours |
| Battery useful life (From date of unit manufacture) | | 5 years |
| Data save time in battery replacement | | HC-SF/HC-RF/HC-MF/HA-FF series: approx. 20 hours at time of delivery, approx. 10 hours after 5 years |
| Back up time from battery warning to alarm occurrence (Note) | | Approx. 80 hours |
| Mass | | 17g |

**(Note)** This time is a guideline, so does not guarantee the back up time. Replace the battery with a new battery as soon as a battery warning occurs.

**< Installing the cell battery >**

| | |
|---|---|
| ⚠ **CAUTION** | The internal circuit of the servo drive unit can be damaged by static electricity. Always observe the following points.<br>① Always ground the body and work table.<br>② Never touch the conductive parts such as the connector pins or electrical parts by hand. |

Mount the battery into the servo drive unit with the following procedure.

① Open the operation section window. (For the MR-J2-200CT/-350CT, also remove the front cover.)
② Mount the battery into the battery holder.
③ Insert the battery connector into CON1 until a click is heard.



CON1

Battery holder
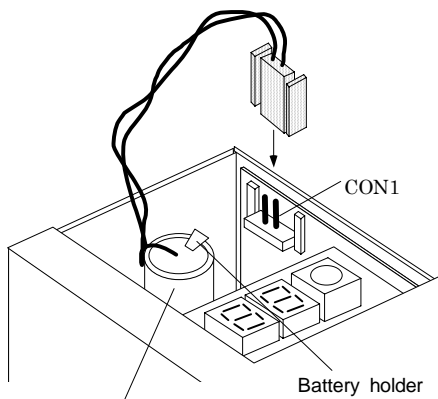
Battery A6BAT (MR-BAT)

**For MR-J2-10CT to MR-J2-100CT**

CON1

Battery holder
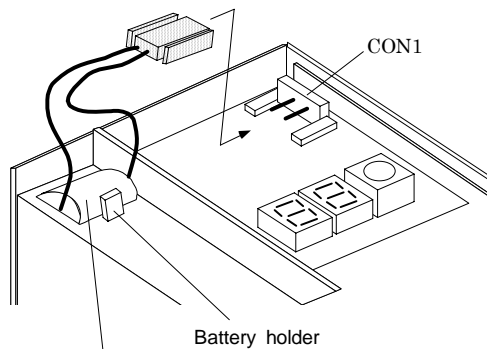
Battery A6BAT (MR-BAT)

**For MR-J2-200CT and MR-J2-350CT**

**< Outline dimension drawings >**



Battery connector
HNC2-2.5S-2
HNC-2.5-C-B02

$130\pm5$

$\phi 16.5\pm0.5$

$19.0\pm1$

$\phi 16.5\pm0.5$

$34.5\pm1$
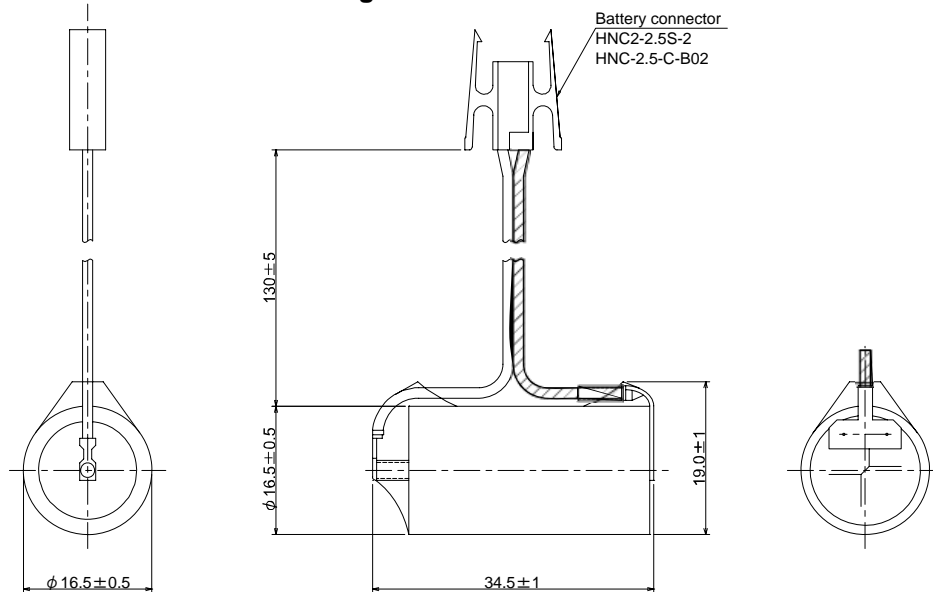
## (2) Cell battery ( A6BAT )

Always use the cell battery (A6BAT) in combination with the dedicated case (MDS-BTCASE).

### < Specifications >

| Battery option type | | Cell battery |
|---|---|---|
| | | **A6BAT (MR-BAT)** |
| Lithium battery series | | ER17330V |
| Nominal voltage | | 3.6V |
| Nominal capacity | | 1700mAh |
| Battery safety | Hazard class | - |
| | Battery shape | Single battery |
| | Number of batteries used | A6BAT (MR-BAT) ×1 |
| | Lithium alloy content | 0.48g |
| | Mercury content | 1g or less |
| Number of connectable axes | | 1 axis ／ (per 1 battery) |
| Battery continuous backup time | | Approx. 10000 hours |
| Battery useful life (From date of unit manufacture) | | 5 years |
| Data save time in battery replacement | | HC-SF/HC-RF/HC-MF/HA-FF series: approx. 20 hours at time of delivery, approx. 10 hours after 5 years |
| Back up time from battery warning to alarm occurrence (Note) | | Approx. 80 hours |
| Weight | | 17g |

**(Note)** This time is a guideline, so does not guarantee the back up time. Replace the battery with a new battery as soon as a battery warning occurs.

### < Specifications of the dedicated case MDS-BTCASE >

| Type | MDS-BTCASE |
|---|---|
| Number of batteries installed | Up to 8 A6BATs (MR-BATs) （Install either 2, 4, 6 or 8 A6BATs (MR-BATs)） |
| Number of connectable axes | Max. 8 axes (It varies depending on the number of batteries installed.) When A6BAT (MR-BAT) x2, 1 to 2 axis/axes When A6BAT (MR-BAT) x 4, 3 to 4 axes When A6BAT (MR-BAT) x 6, 5 to 6 axes When A6BAT (MR-BAT) x 8, 7 to 8 axes |

### < Installing the cell battery >

Open the cover of the dedicated case. Connect the battery connector and then put the battery inside.

Battery A6BAT (MR-BAT)

Battery connector

Dedicated case MDS- BTCASE
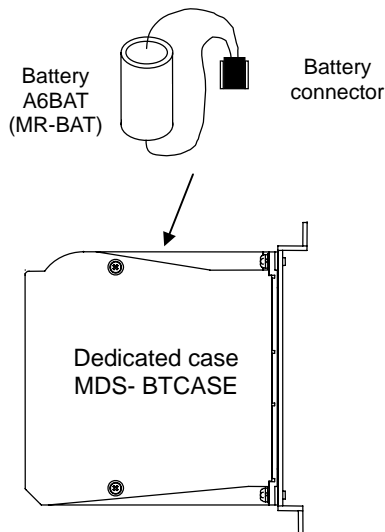
**< Installing A6BAT (MR-BAT) to battery case >**

**(a)** Incorporate batteries in order, from the connector CON1 on the top of the case.
In the same way, install batteries to holders in order, from the holder on the top.



**Example of incorporated batteries**
(Photo: 8 batteries incorporated)

**Corresponding to MDS-A-BT-2**
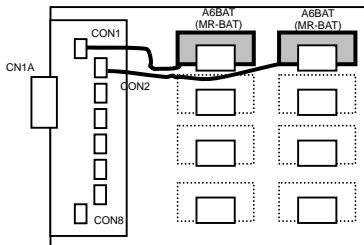


**Corresponding to MDS-A-BT-4**
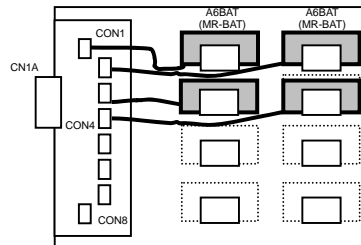


**Corresponding to MDS-A-BT-6**
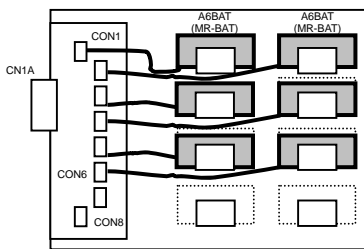


**Corresponding to MDS-A-BT-8**
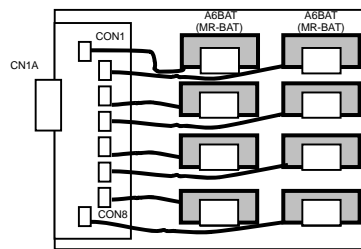


**(b)** Attach a seal indicating the number of incorporated batteries to the part shown below.



Attach the seal here.

バッテリー数シール
number of batteries

| 2 | 4 | 6 | 8 |

（Attach only numbers）
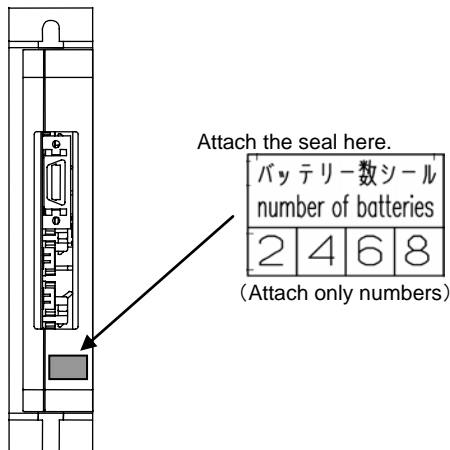
**< Outline dimension drawing of the dedicated case MDS-BTCASE >**

Panel drawing
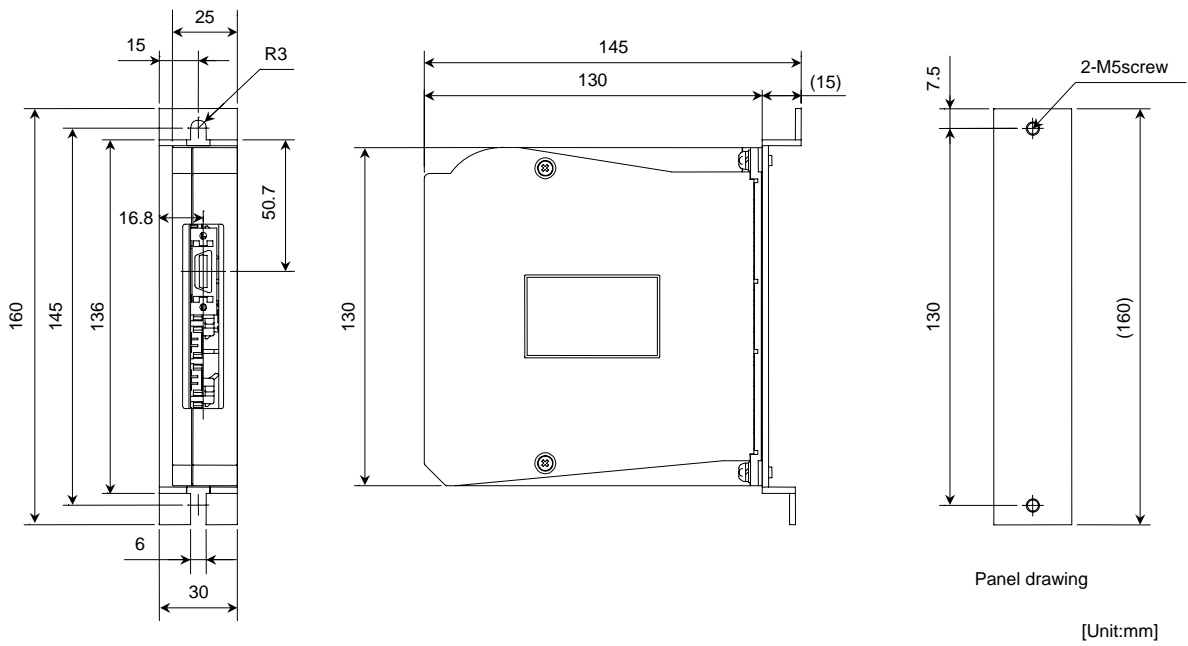
[Unit:mm]

## (3) Battery unit (MDS-A-BT-□)

### < Specifications >

| Battery option type | | Battery unit | | | |
|---|---|---|---|---|---|
| | | MDS-A-BT-2 | MDS-A-BT-4 | MDS-A-BT-6 | MDS-A-BT-8 |
| Lithium battery series | | ER6V | | | |
| Nominal voltage | | 3.6V | | | |
| Nominal capacity | | 4000mAh | 8000mAh | 12000mAh | 16000mAh |
| Battery safety | Hazard class | Class 9 | | | |
| | Battery shape | Set battery | | | |
| | Number of batteries used | ER6V x 2 | ER6V x 4 | ER6V x 6 | ER6V x 8 |
| | Lithium alloy content | 1.3g | 2.6g | 3.9g | 5.2g |
| | Mercury content | 1g or less | | | |
| Number of connectable axes | | Up to 2 axes | Up to 4 axes | Up to 6 axes | Up to 8 axes |
| Battery continuous backup time | | Approx. 12000 hours | | | |
| Battery useful life (From date of unit manufacture) | | 7 years | | | |
| Data save time in battery replacement | | HC-SF/HC-RF/HC-MF/HA-FF series: approx. 20 hours at time of delivery, approx. 10 hours after 5 years | | | |
| Back up time from battery warning to alarm occurrence (Note) | | Approx. 100 hours | | | |
| Mass | | 600g | | | |

(Note) **This time is a guideline, so does not guarantee the back up time. Replace the battery with a new battery as soon as a battery warning occurs.**

### < Outline dimension drawings >
  ● **MDS-A-BT-2/-4/-6/-8**



[Unit: mm]

**<Connection>**
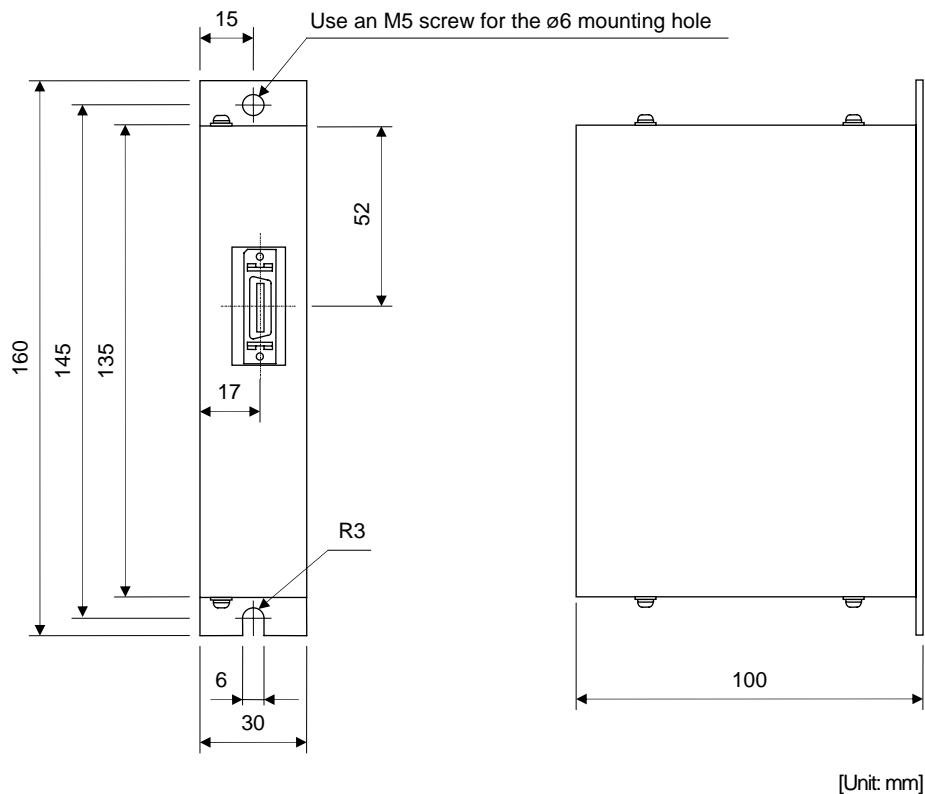
The battery unit is connected with a bus cable (SH21) between the amplifiers instead of the terminator.
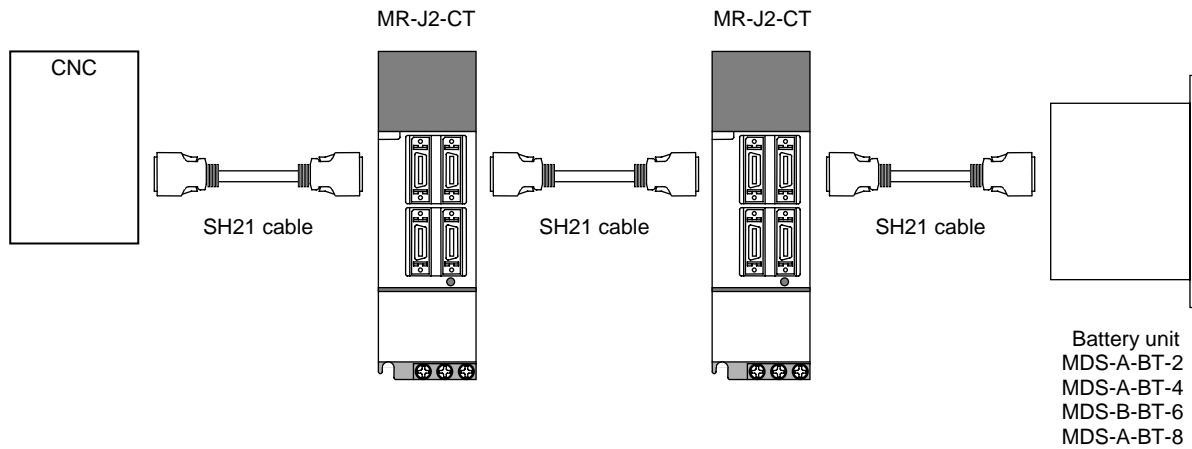


| | 1. On January 1, 2003, new United Nations requirements, "United Nations Dangerous Goods Regulations Article 12", became effective regarding the transportation of lithium batteries. The lithium batteries are classified as hazardous materials (Class 9) depending on the unit. (Refer to "Transportation restrictions for lithium batteries".) |
|---|---|
| ⚠ **CAUTION** | 2. The lithium battery must be transported according to the rules set forth by the International Civil Aviation Organization (ICAO), International Air Transportation Association (IATA), International Maritime Organization (IMO), and United States Department of Transportation (DOT), etc. The packaging methods, correct transportation methods, and special regulations are specified according to the quantity of lithium alloys. The battery unit exported from Mitsubishi is packaged in a container (UN approved part) satisfying the standards set forth in this UN Advisory. |
| | 3. To protect the absolute value, do not shut off the servo drive unit control power supply if the battery voltage becomes low (warning 9F). |
| | 4. Contact the Service Center when replacing the MDS-A-BT Series and cell battery. |
| | 5. The battery life (backup time) is greatly affected by the working ambient temperature. The above data is the theoretical value for when the battery is used 8 hours a day/240 days a year at an ambient temperature of 25°C. Generally, if the ambient temperature increases, the backup time and useful life will both decrease. |

## 4-3   Relay terminal block

Signals input/output from the CN3 connector on the front of the servo drive unit can be sent to the terminal block. Connect the terminal block to the CN3 connector with an SH21 cable. This can also be used with the servo drive unit MDS-B-SVJ2 Series.

| Abbrev. | Name | Descriptions |
|---|---|---|
| CN3A | Connector 3 input/output A | Connect from the CN3 connector with an SH21 cable. Common for any connector, so each signal will pass through. Generally when the CN3 control signal is being used, each signal can be output from the relay terminal block by relaying through these connectors. |
| CN3B | Connector 3 input/output B | |
| CN3C | Connector 3 input/output C | |
| VDD | Internal power supply output | This is the 24V power supply output in the drive unit. When using an internal power supply, use relayed once through the COM terminal. |
| COM | Common power supply | Connect VDD when using the drive unit internal power supply. Connect the + side of the external power supply when using an external power supply. |
| EMG | External emergency stop input | This is the input terminal for external emergency stops. |
| DOG | Dog | Input the near-point dog signal when carrying out a dog-type zero point return. |
| MO1 | Monitor output 1 | This is the D/A output ch.1. Measure the voltage across MO1-LG. |
| MO2 | Monitor output 2 | This is the D/A output ch.2. Measure the voltage across MO2-LG. |
| PE | Plate ground | This has the same potential as the drive unit FG or cable shield. |
| SG | 24V power supply ground | This is the ground when using digital input/output. |
| MC | Contactor control output | This is the output terminal for contactor control. |
| MBR | Motor brake control output | This is the output terminal for motor brake control. |
| LG | 5V power supply ground | This is the ground when using D/A output. |

**< Outline dimension drawing >**

MR-J2CN3TM
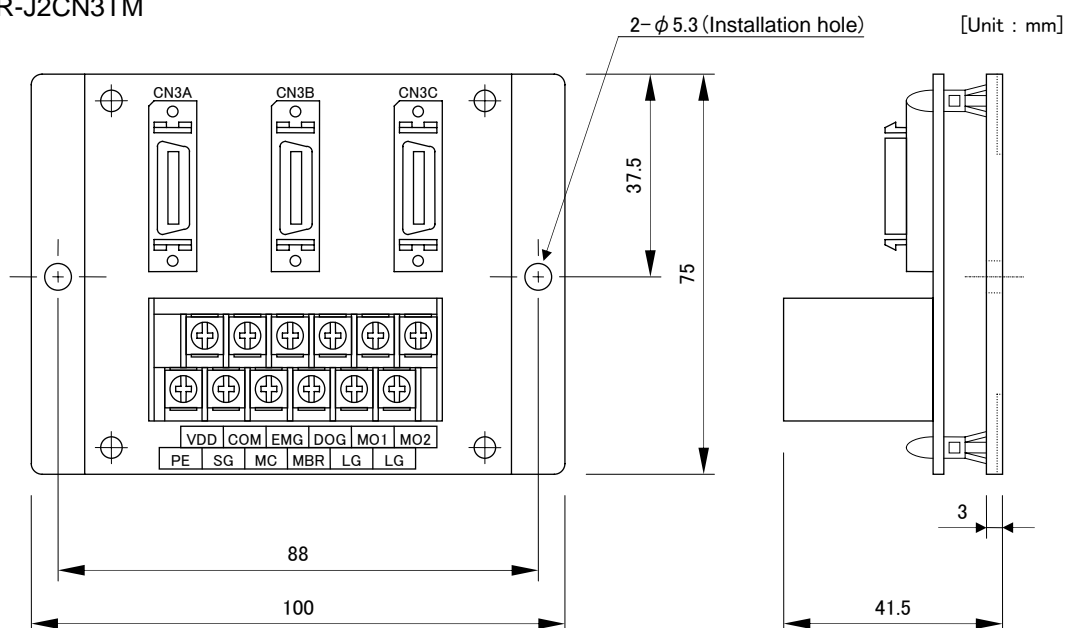
## 4-4   Cables and connectors

The cables and connectors that can be ordered from Mitsubishi Electric Corp. as option parts are
shown below. Cables can only be ordered in the designated lengths shown on the following pages.
Purchase a connector set, etc., to create special length cables when required.



MR-J2-CT

MR-J2-CT

NC

① NC bus cable connector set

② Terminator

⑤ Cable for personal computer

Battery unit

Relay terminal block      Personal computer

HC-SF
HC-RF

⑥ Power supply connector
⑧ Brake connector
③ Detector cable connector set

HA-FF∗∗C-UE

⑧ Brake connector
⑦ Power supply connector
③ Detector cable connector set

HA-FF
HC-MF

④ Detector cable connector set

HC-MF∗∗-S15

⑩ Power supply connector

### 4-4-1　Cable option list

#### (1)　Cables

| Part name | | | Type | Descriptions | |
|---|---|---|---|---|---|
| For CN1A, CN1B | Communication cable for NC unit - Drive unit Drive unit - Drive unit | | SH21 Length: 0.35, 0.5, 0.7, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 6, 7, 8, 9, 10, 15, 20, 30m ( FCUA-R000 and MR-J2HBUS□M can also be used. ) | Servo drive unit side connector (Sumitomo 3M) Connector: 10120-6000EL Shell kit: 10320-3210-000 | Servo drive unit side connector (Sumitomo 3M) Connector: 10120-6000EL Shell kit: 10320-3210-000 |
| | Terminator connector | | A-TM | Terminator connector | |
| For CN2 | Detector cable for HC-SF, HC-RF, HA-FF∗∗C-UE | IP65 and EN Standard compatible | Straight MR-ENCBL□M-H The value in □ indicates the length. 2, 5, 10, 20, 30m | Servo drive unit side connector (Sumitomo 3M) Connector: 10120-3000VE Shell kit: 10320-52F0-008 | Servomotor detector side connector (DDK) Connector: MS3106A20-29S(D190) Straight back shell: CE02-20BS-S Clamp: CE3057-12A-3 |
| | | For general environment | Straight MR-JHSCBL□M-H The value in □ indicates the length. 2, 5, 10, 20, 30m | Servo drive unit side connector (Sumitomo 3M) Connector: 10120-3000VE Shell kit: 10320-52F0-008 | Servomotor detector side connector (DDK) Plug: MS3106B20-29S Clamp: MS3057-12A |
| | Detector cable for HA-FF, HC-MF | For general environment | Straight MR-JCCBL□M-H The value in □ indicates the length. 2, 5, 10, 20, 30m | Servo drive unit side connector (Sumitomo 3M) Connector: 10120-3000VE Shell kit: 10320-52F0-008 | Servomotor detector side connector (Japan AMP) Connector: 172161-9 Connector pin: 170359-1 Clamp: MTI-0002 |
| | ⑨ Detector cable for HC-MF∗∗-S15 | IP65 compatible | Straight MR-RMCBL□M The value in □ indicates the length. 2, 5, 10, 20, 30m | Servo drive unit side connector (Sumitomo 3M) Connector: 10120-3000VE Shell kit: 10320-52F0-008 | Servomotor detector side connector (Hirose Electric) Plug: RM15WTJA-10S Clamp: RM15WTP-CP(7) |
| For CN3 | ⑤ Communication cable for DOS/V | | MR-CPCATCBL3M Length : 3m | Servo drive unit side connector (3M or equivalent part) Connector: 10120-6000EL Shell kit: 10320-3210-000 | DOS/V series Personal computer side connector GM-9LM (Honda Tsushin) |

**(Note)** The connector maker may change without notice.

## (2)   Connector sets

| Part name | | | | Type | Descriptions | |
|---|---|---|---|---|---|---|
| For CN1A, CN1B | ① Communication connector set for NC - Drive unit Drive unit - Drive unit | | | FCUA-CS000 | Servo drive unit side connector (Sumitomo 3M) Connector: 10120-3000VE Shell kit: 10320-52F0-008 | Servo drive unit side connector (Sumitomo 3M) Connector: 10120-3000VE Shell kit: 10320-52F0-008 |
| For CN2 | ④ Detector connector set for HC-SF, HC-RF, HA-FF∗∗C-UE | IP65 and EN Standard compatible | Straight | MR-ENCNS Compliant cable range ø6.8 ~ ø10 | Servo drive unit side connector (Sumitomo 3M) Connector: 10120-3000VE Shell kit: 10320-52F0-008 | Servomotor detector side connector (DDK) Connector: MS3106A20-29S(D190) Back shell: CE02-20BS-S Clamp: CE3057-12A-3 |
| | | For general environment | Straight | MR-J2CNS | Servo drive unit side connector (Sumitomo 3M) Connector: 10120-3000VE Shell kit: 10320-52F0-008 | Servomotor detector side connector (DDK) Connector: MS3106B20-29S Cable clamp: CE3057-12A |
| | ⑤ Detector connector set for HA-FF, HC-MF | For general environment | Straight | MR-J2CNM | Servo drive unit side connector (Sumitomo 3M) Connector: 10120-3000VE Shell kit: 10320-52F0-008 | Servomotor detector side connector (DDK) Connector: 172161-9 Connector pin: 170359-1 Clamp: MTI-0002 |
| | ⑨ Detector connector set for HC-MF∗∗-S15 | IP65 compatible | Straight | MR-RMCS Compliant cable range ø6.5 ~ ø7.5 | Servo drive unit side connector (Sumitomo 3M) Connector: 10120-3000VE Shell kit: 10320-52F0-008 | Servomotor detector side connector (Hirose Electric) Plug: RM15WTJA-10S Clamp: RM15WTP-CP(7) |
| For motor power supply | ⑥ Power supply connector for HC-SF52 ~ 152, HC-SF53 ~ 153, HC-RF103 ~ 203 | IP67 and EN Standard compatible | Straight | PWCE22-23S Compliant cable range ø9.5 ~ ø13 ( MR-PWCNS1 can also be used. ) | | Servomotor side power supply connector (DDK) Connector: CE05-6A22-23SD -B-BSS Clamp: CE3057-12A-2 (D265) |
| | | | Angle | PWCE22-23L Compliant cable range ø9.5 ~ ø13 | | Servomotor side power supply connector (DDK) Connector: CE05-8A22-23SD -B-BAS Clamp: CE3057-12A-2 (D265) |
| | | For general environment | Straight | FCUA-CN802 | | Servomotor side power supply connector (DDK) Connector: MS3106B22-23S Clamp: MS3057-12A |
| | | | Angle | FCUA-CN806 | | Servomotor side power supply connector (DDK) Connector: MS3108B22-23S Clamp: MS3057-12A |

**(Note)** The connector maker may change without notice.

| Part name | | | | Type | Descriptions |
|---|---|---|---|---|---|
| For motor power supply | ⑥ Power supply connector for HC-SF202~352, HC-SF203~353 | IP67 and EN standard compatible | Straight | PWCE24-10S<br>Compliant cable range<br>ø13 ~ ø15.5<br>⎱MR-WCNS2 can⎰ also be used. | Servomotor side power supply connector (DDK)<br>Connector : CE05-6A24-10SD-B-BSS<br>Clamp　　 : CE3057-16A-2 (D265) |
| | | | Angle | PWCE24-10L<br>Compliant cable range<br>ø13 ~ ø15.5 | Servomotor side power supply connector (DDK)<br>Connector : CE05-8A24-10SD-B-BAS<br>Clamp　　 : CE3057-16A-2 (D265) |
| | | For general environment | Straight | FCUA-CN803 | Servomotor side power supply connector (DDK)<br>Connector : MS3106B24-10S<br>Clamp　　 : MS3057-16A |
| | | | Angle | FCUA-CN807 | Servomotor side power supply connector (DDK)<br>Connector : MS3108B24-10S<br>Clamp　　 : MS3057-16A |
| | ⑦ Power supply connector for HA-FF∗∗C-UE | For general environment | Straight | MR-PWCNF | Servomotor side power supply connector<br>Connector : CE05-6A14S-2SD-B<br>　　　　　 (DDK)<br>Clamp　　 : YSO14-9-11 (Daiwa) |
| | ⑩ Power supply connector for HC-MF∗∗-S15 | IP65 compatible | Straight | MR-RM4S (□)<br>The value in □ indicates the cable clamp diameter.<br>8, 9,10 mm<br>Compliant cable range<br>Clamp diameter ±0.5mm | Servomotor side power supply connector (Hirose Electric)<br>Plug　　 : RM15WTJA-4S<br>Clamp : RM15WTP-CP(8/9/10) |
| For motor brakes | ⑧ Brake connector for HC-SF202B~352B, HC-SF203B~353B, HA-FF∗∗CB-UE | IP67 and EN standard compatible | Straight | BRKP10SL-4S<br>Compliant cable range<br>ø5 ~ ø8.3<br>⎱MR-BKCN can⎰ also be used. | Servomotor side brake connector<br>Connector : MS3106A10SL-4S<br>　　　　　 (D190) (DDK)<br>Clamp　　 : YSO10-5-8 (Daiwa) |
| | | | Angle | BRKP10SL-4L<br>Compliant cable range<br>ø5 ~ ø8.3 | Servomotor side brake connector<br>Connector : MS3106A10SL-4S<br>　　　　　 (D190) (DDK)<br>Clamp　　 : YLO10-5-8 (Daiwa) |
| | | For general environment | Straight | FCUA-CN804 | Servomotor side brake connector<br>(Japan Aviation Electronics)<br>Connector : MS3106B10SL-4S<br>Clamp　　 : MS3057-4A |
| | | | Angle | FCUA-CN808 | Servomotor side brake connector<br>(Japan Aviation Electronics)<br>Connector : MS3108B10SL-4S<br>Clamp　　 : MS3057-4A |

**(Note)** The connector maker may change without notice.

### 4-4-2   Connector outline dimension drawings

**Servo drive unit CN2 connector**

Maker: Sumitomo 3M                                    [Unit: mm]
**<Type>**
 Connector: 10120-3000VE
 Shell kit: 10320-52F0-008

12.0
10.0

22.0   14.0

39.0
23.8

33.3   12.7

---
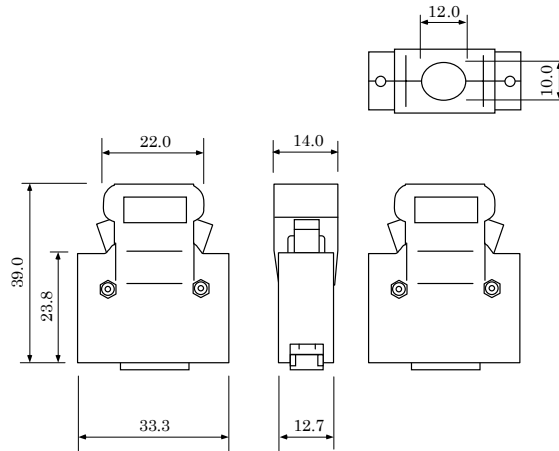
Maker: Sumitomo 3M                                    [Unit: mm]
**<Type>**
 Connector: 10120-6000EL
 Shell kit: 10320-3210-000

Because this connector is an
integrated molding part of
the cable, it is not an option
setting in the connector set.
The terminator connector
(A-TM) also has the same
outline.

11.5

20.9

42.0
33.0

29.7

---
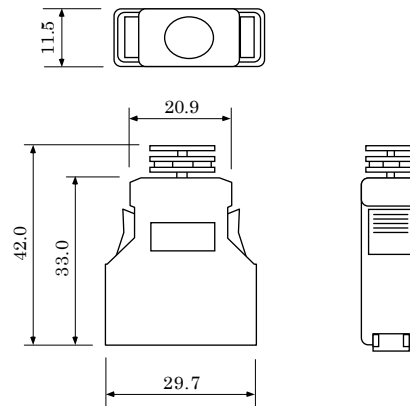
**D-SUB connector for personal computer**

Maker: Honda Tsushin                                  [Unit: mm]
**<Type>**
For PC98: GM-25L (25 pins)
For DOS/V: GM-9L (9 pins)

A   F
C

D

$\phi$ E  (Cable entry)

B
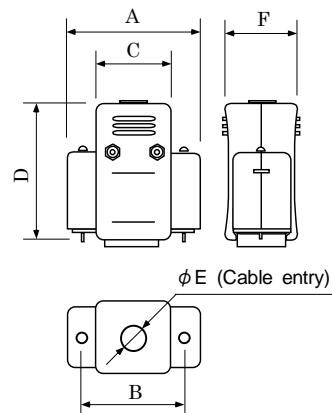
| Type | A | B | C | D | E | F |
|------|-----|-------|------|----|----|------|
| GM-9L | 33 | 24.99 | 18.5 | 33 | 6 | 17.9 |
| GM-25L | 55 | 47.04 | 40 | 46 | 10 | 20.6 |

**Connectors for detector and motor power supply (IP67 and EN Standard compatible)**

Straight plug
Maker : DDK
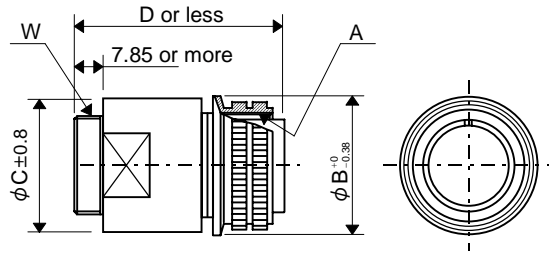


[Unit: mm]

| Type | A | B $^{+0}_{-0.38}$ | C±0.8 | D or less | W |
|---|---|---|---|---|---|
| CE05-6A22-23SD-B-BSS | $1\frac{3}{8}$-18UNEF-2B | 40.48 | 38.3 | 61 | $1\frac{3}{16}$-18UNEF-2A |
| CE05-6A24-10SD-B-BSS | $1\frac{1}{2}$-18UNEF-2B | 43.63 | 42.0 | 68 | $1\frac{7}{16}$-18UNEF-2A |

Angle plug
Maker : DDK
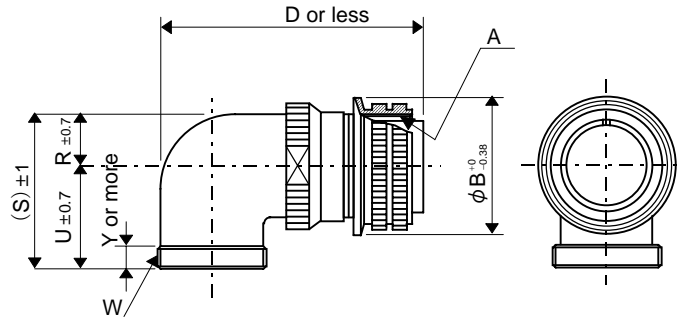


[Unit: mm]

| Type | A | B $^{+0}_{-0.38}$ | D or less | W | R±0.7 | U±0.7 | (S)±1 | Y or more |
|---|---|---|---|---|---|---|---|---|
| CE05-8A22-23SD-B-BAS | $1\frac{3}{8}$-18UNEF-2B | 40.48 | 75.5 | $1\frac{3}{16}$-18UNEF-2A | 16.3 | 33.3 | 49.6 | 7.5 |
| CE05-8A24-10SD-B-BAS | $1\frac{1}{2}$-18UNEF-2B | 43.63 | 86.3 | $1\frac{7}{16}$-18UNEF-2A | 18.2 | 36.5 | 54.7 | 7.5 |

Cable clamp
Maker : DDK
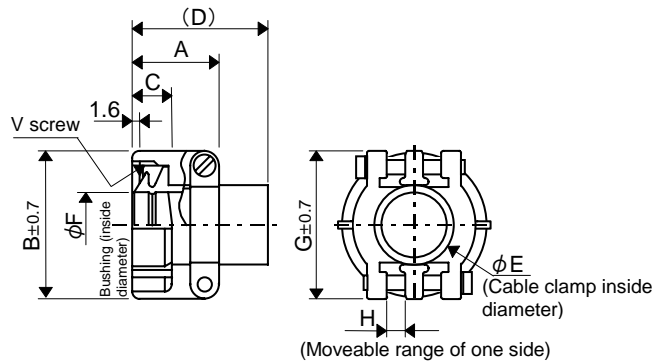


[Unit:mm]

| Type | Shell size | Total length A | Outside dia. B | Effective screw length C | D | E | F | G | H | Installation screws (V) | Bushing | Compliant cable |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CE3057-12A-2 (D265) | 20, 22 | 23.8 | 35 | 10.3 | 41.3 | 19 | 13 | 37.3 | 4 | $1\frac{3}{16}$-18UNEF-2B | CE3420-12-2 | ø9.5~ø13 |
| CE3057-12A-3 (D265) | | | | | | | 10 | | | | CE3420-12-3 | ø6.8~ø10 |
| CE3057-16A-2 (D265) | 24 | 26.2 | 42.1 | 10.3 | 41.3 | 23.8 | 15.5 | 42.9 | 4.8 | $1\frac{7}{16}$-18UNEF-2B | CE3420-16-2 | ø13~ø15.5 |

## Connectors for detectors, motor power supply and brakes (IP67 and EN Standard compatible)

Straight plug
Maker : DDK
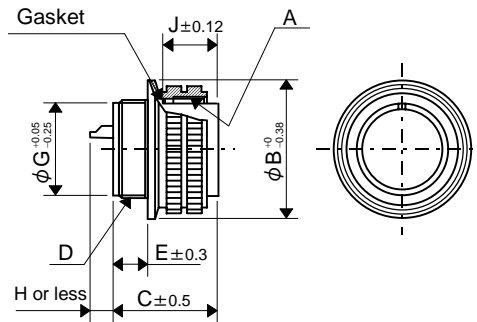


[Unit: mm]

| Type | A | B $^{+0}_{-0.38}$ | C±0.5 | D | E±0.3 | G $^{+0.05}_{-0.25}$ | J±0.12 |
|---|---|---|---|---|---|---|---|
| MS3106A10SL-4S (D190) | $^5/_8$-24UNEF-2B | 22.22 | 23.3 | $^9/_{16}$-24UNEF-2A | 7.5 | 12.5 | 13.49 |
| MS3106A20-29S (D190) | $1^1/_4$-18UNEF-2B | 37.28 | 34.11 | $1^1/_8$-18UNEF-2A | 12.16 | 26.8 | 18.26 |

Straight plug
Maker : DDK
Type : CE05-6A14S-2SD-B
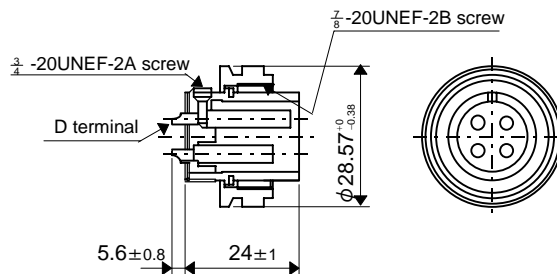
[Unit:mm]



Straight back shell
Maker : DDK
Type : CE02-20BS-S
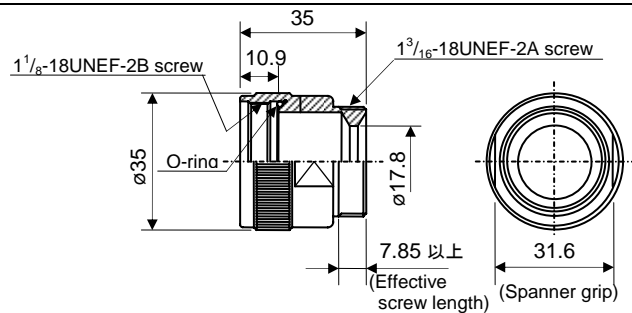
[Unit:mm]



## Connectors for motor power supply and brakes (IP67 and EN Standard compatible)

Cable clamp
Maker : Daiwa
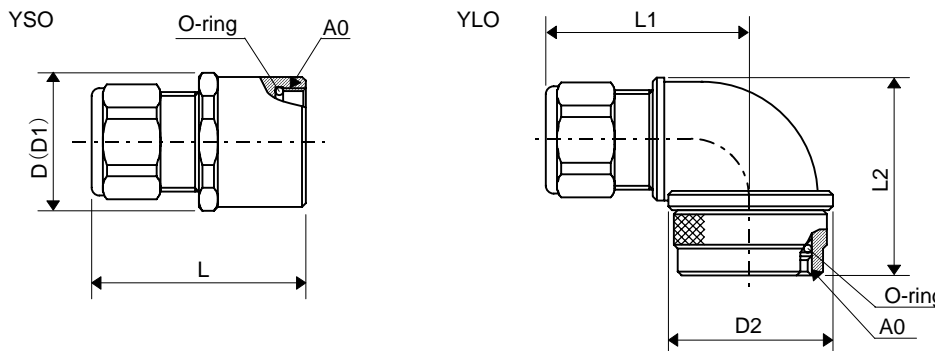


[Unit:mm]

| Type | Accommodating outside diameter | American standard screw thread Aø | Length before tightening | | | Side to side | Corner to corner | |
|---|---|---|---|---|---|---|---|---|
| | | | L | L1 | L2 | D | D1 | D2 |
| YSO10-5 ~ 8, YLO10-5 ~ 8 | ø5 ~ 8.3 | $^9/_{16}$-24UNEF-2B | 43 | 39 | 42.5 | 24 | 26 | 26 |
| YSO14-9 ~ 11 | ø8.3 ~ 11.3 | $^3/_4$-20UNEF-2B | 44 | 43.5 | 44.5 | 26 | 28 | 35 |

**Connectors for detectors, motor power supply and brakes (for general environment)**

Straight plug
Maker : DDK
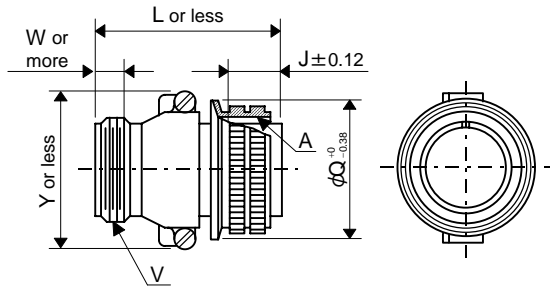


[Unit: mm]

| Type | Coupling screw | Length of coupling section | Total length | Connection nut outside diameter | Cable clamp installation screw | Effective screw length | Max. width |
|---|---|---|---|---|---|---|---|
| | A | J ± 0.12 | L or less | $\phi Q^{+0}_{-0.38}$ | V | W or more | Y or less |
| MS3106B20-29S | $1^1/_4$-18UNEF | 18.26 | 55.57 | 37.28 | $1^3/_{16}$-18UNEF | 9.53 | 47 |
| MS3106B22-23S | $1^3/_8$-18UNEF | 18.26 | 55.57 | 40.48 | $1^3/_{16}$-18UNEF | 9.53 | 50 |
| MS3106B24-10S | $1^1/_2$-18UNEF | 18.26 | 58.72 | 43.63 | $1^7/_{16}$-18UNEF | 9.53 | 53 |

Angle plug
Maker : DDK
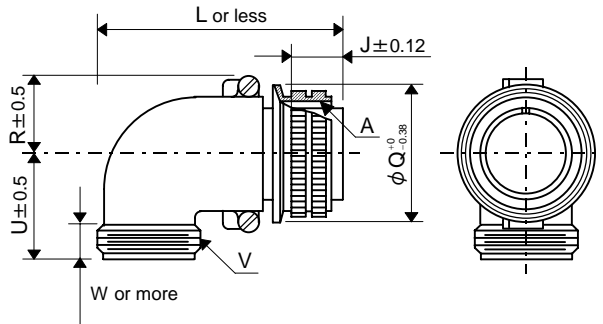


[Unit: mm]

| Type | Coupling screw | Length of coupling section | Total length | Connection nut outside diameter | | | Cable clamp installation screw | Effective screw length |
|---|---|---|---|---|---|---|---|---|
| | A | J ± 0.12 | L or less | $\phi Q^{+0}_{-0.38}$ | R±0.5 | U±0.5 | V | W or more |
| MS3108B22-23S | $1^3/_8$-18UNEF | 18.26 | 76.98 | 40.48 | 24.1 | 33.3 | $1^3/_{16}$-18UNEF | 9.53 |
| MS3108B24-10S | $1^1/_2$-18UNEF | 18.26 | 86.51 | 43.63 | 25.6 | 36.5 | $1^7/_{16}$-18UNEF | 9.53 |

Straight plug
Maker : Japan Aviation
　　　　Electronics
Type: MS3106B10SL-4S
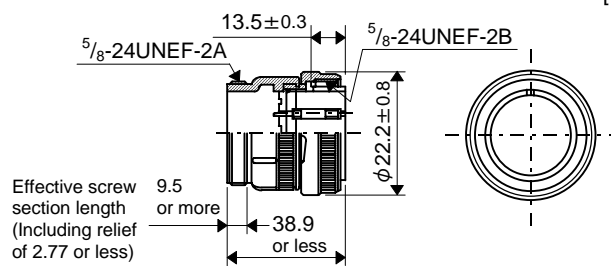
[Unit:mm]



Angle plug
Maker : Japan Aviation
　　　　Electronics
Type: MS3106B10SL-4S
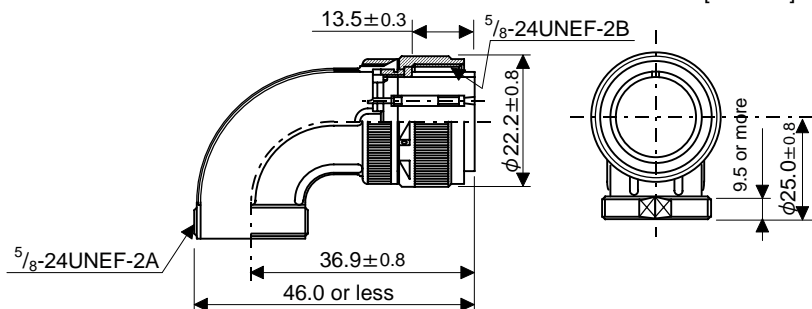
[Unit:mm]

**Connectors for detectors, motor power supply and brakes (for general environment)**

Cable clamp
Maker : DDK
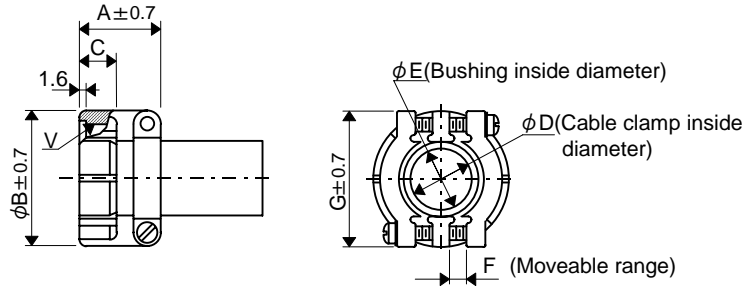
[Unit: mm]

| Type | Shell size | Total length | Outside diameter | Effective screw length | | | | | Installation screw | Bushing |
|---|---|---|---|---|---|---|---|---|---|---|
| | | A±0.7 | øB±0.7 | C | øD | øE | F | G±0.7 | V | |
| MS3057-4A | 10SL, 12S | 20.6 | 20.6 | 10.3 | 7.9 | 5.6 | 1.6 | 22.2 | $^5/_8$-24UNEF | AN3420-4 |
| MS3057-12A | 20, 22 | 23.8 | 35.0 | 10.3 | 19.0 | 15.9 | 4.0 | 37.3 | $1^3/_{16}$-18UNEF | AN3420-12 |
| MS3057-16A | 24, 28 | 26.2 | 42.1 | 10.3 | 23.8 | 19.1 | 4.8 | 42.9 | $1^7/_{16}$-18UNEF | AN3420-16 |

**HA-FF, HC-MF motor detector connector (for general environment)**

Maker: Japan AMP                                                        [Unit: mm]
**<Type>**
 Connector: 1-172161-9
 Connector pin: 170359-1
 Crimp tool: 755330-1

A crimp tool is required for
wiring to the connector.
Contact Japan AMP (Ltd.)
for the crimping tool.
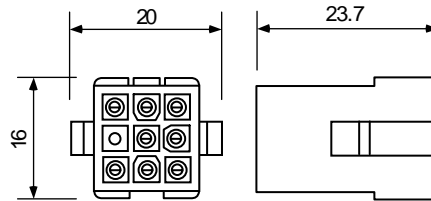
**Connectors for HC-MF∗∗-S15 motor detector and power supply (IP65 compatible)**

Straight plug                                                          [Unit:mm]
Maker : Hirose Electric
Type  : RM15WTJA-4S
        RM15WTJA-10S

RM15WTJA-4S        RM15WTJA-10S
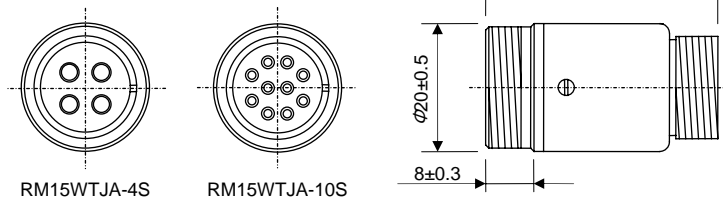
Cable clamp                                                           [Unit:mm]
Maker : Hirose Electric
Type  : RM15WTP-CP (□)
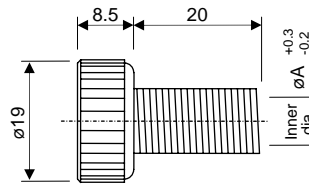
| Cable clamp type | Cable clamp dia. | Spring inner dia. øA |
|---|---|---|
| RM15WTP-CP   (7) | ø7 | 8.0 |
| RM15WTP-CP   (8) | ø8 | 10.5 |
| RM15WTP-CP   (9) | ø9 | 10.5 |
| RM15WTP-CP  (10) | ø10 | 10.5 |

### 4-4-3    Flexible conduits

Basically, splash proofing can be ensured if cab-tire cable and connectors with IP65 or higher specifications are used. However, to further improve the oil resistance (chemical resistance to oil), weather resistance (resistance to the environment when used outdoors, etc.), durability, tensile strength, flattening strength, etc., run the cable through a flexible conduit when wiring.
The following shows an example of a flexible conduit. Contact the connector maker for more information.

### (1)  Method for connecting to a connector with back shell
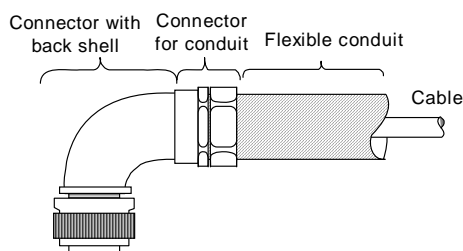


| Application | Applicable motors | Type | | | |
|---|---|---|---|---|---|
| | | DDK | | Japan Flex | |
| | | Connector (straight) | Connector (angle) | Connector for conduit | Flexible conduit |
| For power supply | HC-SF52~152 HC-SF53~153 HC-RF103~203 | CE05-6A22-23S D-B-BSS | CE05-8A22-23S D-B-BAS | RCC-104CA2022 | VF-04 (Min. inside dia.: 14) |
| | | | | RCC-106CA2022 | VF-06 (Min. inside dia.: 19) |
| | HC-SF202 ~ 352 HC-SF203 ~ 353 | CE05-6A24-10S D-B-BSS | CE05-8A24-10S D-B-BAS | RCC-106CA2428 | VF-06 (Min. inside dia.: 19) |
| | | | | RCC-108CA2428 | VF-08 (Min. inside dia.: 24.4) |
| | HA-FF053C-UE~63C-UE | Select according to section "(2) Method for connecting to the connector main body". | | | |

**(Note)**   None of the parts in this table can be ordered from Mitsubishi Electric Corp.



| Application | Applicable motors | Type | | | |
|---|---|---|---|---|---|
| | | DDK | | Japan Flex | |
| | | Connector/ back shell (straight) | Connector/ back shell (angle) | Connector for conduit | Flexible conduit |
| For brakes | HC-SF202B ~ 352B HC-SF203B ~ 353B HA-FF**CB-UE | Select according to section "(2) Method for connecting to the connector main body". | | | |
| For detectors | HC-SF HC-RF HA-FF**C-UE | Connector MS3106A20-29S (D190) Back shell CE02-20BS-S | Connector MS3106A20-29 S (D190) Back shell CE-20BA-S | RCC-104CA2022 | VF-04 (Min. inside dia.: 14) |
| | | | | RCC-106CA2022 | VF-06 (Min. inside dia.: 19) |

**(Note)**   None of the parts in this table can be ordered from Mitsubishi Electric Corp.

## (2)  Method for connecting to the connector main body
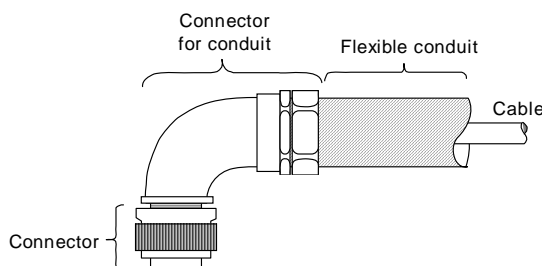


| Application | Applicable motors | Type | | |
|---|---|---|---|---|
| | | DDK | DAIWA DENGYO Co., Ltd. | |
| | | Connector (straight) | Connector for conduit | Flexible conduit |
| For power supply | HC-SF52 ~ 152, HC-SF53 ~ 153 HC-RF103 ~ 203 | CE05-6A22-23SD-B | MSA-16-22 (Straight) MAA-16-22 (Angle) | FCV16 (Min. inside dia.: 15.8) |
| | | | MSA-22-22 (Straight) MAA-22-22 (Angle) | FCV22 (Min. inside dia.: 20.8) |
| | HC-SF202~352, HC-SF203~353 | CE05-6A24-10SD-B | MSA-22-24 (Straight) MAA-22-24 (Angle) | FCV22 (Min. inside dia.: 20.8) |
| | | | MSA-28-24 (Straight) MAA-28-24 (Angle) | FCV28 (Min. inside dia.: 26.4) |
| | HA-FF053C-UE~63C-UE | CE05-6A14S-2SD-B | MSA-12-14 (Straight) MAA-12-14 (Angle) | FCV12 (Min. inside dia.: 12.3) |
| For brakes | HC-SF202B ~ 352B, HC-SF203B ~ 353B, HA-FF∗∗CB-UE | MS3106A10SL-4S (D190) | MSA-10-10 (Straight) MAA-10-10 (Angle) | FCV10 (Min. inside dia.: 10.0) |
| For detectors | HC-SF HC-RF HA-FF∗∗CB-UE | MS3106A20-29S (D190) | MSA-16-20 (Straight) MAA-16-20 (Angle) | FCV16 (Min. inside dia.: 15.8) |
| | | | MSA-22-20 (Straight) MAA-22-20 (Angle) | FCV22 (Min. inside dia.: 20.8) |

**(Note)**   None of the parts in this table can be ordered from Mitsubishi Electric Corp.

### 4-4-4   Cable wire and assembly

#### (1)   Cable wire

The following shows the specifications and processing of the wire used in each cable.
Manufacture the cable using the recommended wire or equivalent parts.

| Recommended wire type (Cannot be directly ordered from Mitsubishi Electric Corp.) | Finished outside diameter | Sheath material | No. of pairs | Wire characteristics | | | | Applica-tion |
|---|---|---|---|---|---|---|---|---|
| | | | | Config-ur ation | Conductor resistance | Withstand voltage | Insulation resistance | |
| UL20276 AWG28 7pair | 5.6mm | PVC | 7 | 7 strands/ 0.13mm | 222Ω/km or less | AC350/ 1min | 1MΩ/km or more | Personal computer communi- cation cable |
| UL20276 AWG28 10pair | 6.1mm | PVC | 10 | 7 strands/ 0.13mm | 222Ω/km or less | AC350/ 1min | 1MΩ/km or more | NC unit bus cable |
| A14B2343 (Note) | 7.2mm | PVC | 6 | 14 strands/ 0.08mm | 105Ω/km or less | AC500/ 1min | 1500MΩ/km or more | Detector cable |

**(Note)**   Junko Co. (Dealer: Toa Denki)

#### (2)   Cable assembly

Assemble the cable as shown in the following drawing, with the cable shield wire securely connected to the ground plate of the connector.
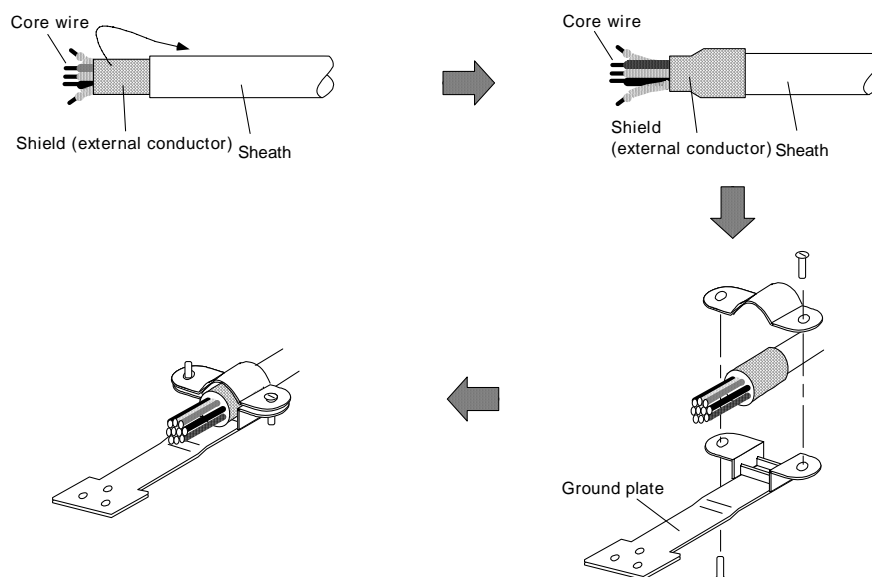


#### (3)   Cable protection tube (noise countermeasure)

If influence from noise is unavoidable, or further noise resistance is required, selecting a flexible tube and running the signal cable through this tube is effective. This is also an effective countermeasure for preventing the cable sheath from being cut or becoming worn.

A cable clamp (MS3057) is not installed on the detector side, so be particularly careful of broken wires in applications involving bending and vibration.

| Supplier | Tube | Connector | | |
|---|---|---|---|---|
| | | Drive unit side | Installation screws | Motor detector side |
| Japan Flex | FBA-4 (FePb wire braid sheath) | RBC-104 (straight) RBC-204 (45°) RBC-304 (90°) | G16 G16 G16 | RCC-104-CA2022 |
| Daiwa | Hi-flex PT #17 (FePb sheath) | PSG-104 (straight) PLG-17 (90°) PS-17 (straight) | Screw diameter   ø26.4 Screw diameter   ø26.4 PF1/2 | PDC20-17 |
| Sankei Works | Purika Tube PA-2 (FePb sheath) | BC-17 (straight) | Wire conduit tube screws : 15 | PDC20-17 |

**(Note)**   None of the parts in this table can be ordered from Mitsubishi Electric Corp.

### 4-4-5   Option cable connection diagram

⚠ **CAUTION**   Do not mistake the connection when manufacturing the detector cable. Failure to observe this could lead to faults, runaway or fires.

#### (1)  NC unit bus cable

##### < SH21 cable connection diagram >

This is an actual connection diagram for the SH21 cable supplied by Mitsubishi.
Manufacture the cable as shown below. The cable can be up to 30m long.
Refer to section "4-4-4 Cable wire and assembly" for details on wire.
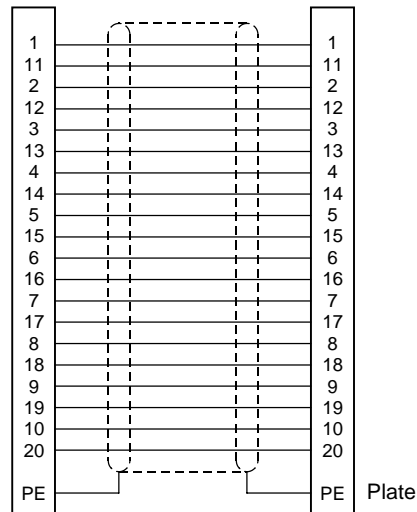
**(2)  Detector cable for HC-SF, HC-RF and HA-FF\*\*C-UE motors**

**< MR-JHSCBL☐M-H cable connection diagram >**

This is an actual connection diagram for the MR-JHSCBL☐M-H cable supplied by Mitsubishi.
The connection differs according to the cable length.
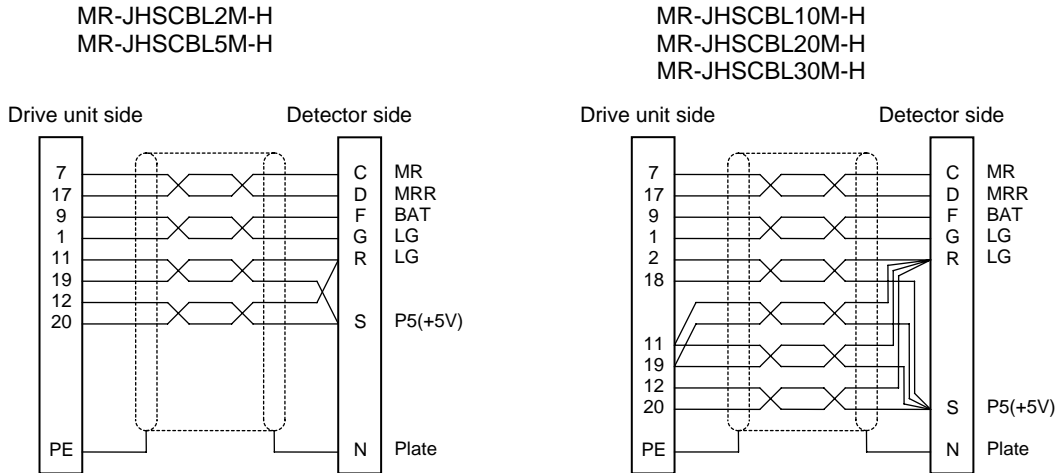
MR-JHSCBL2M-H                                   MR-JHSCBL10M-H
MR-JHSCBL5M-H                                   MR-JHSCBL20M-H
                                                MR-JHSCBL30M-H



**< Connection diagram for cable manufacturing >**

Manufacture the cable as shown below. The cable can be up to 50m long.

Refer to section "4-4-4 Cable wire and assembly" for details on wire.



By connecting across CONT and LG on the detector side, the detector communication will be set to 4-wire (separated transmission/reception lines type) communication.
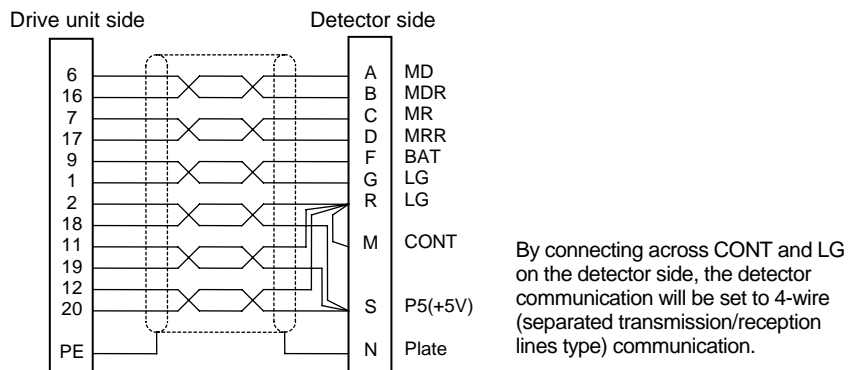
| No. | Abbreviation | Parameter name | Explanation |
|---|---|---|---|
| #102 | *Cont2 | Control parameter 2 | Set the following parameters for the 4-wire detector communication. |

| Bit | F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Defalut value | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |

| bit | Meaning when set to "0" | Meaning when set to "1" |
|---|---|---|
| 6 | 2-wire detector communication | 4-wire detector communication |

⚠ **CAUTION**

1. The cable manufacturing connection diagram shows the connection for a 4-wire detector communication (separated transmission/reception lines type). This motor's detector communication is normally 2-wire communication (common transmission/reception lines type). However, 4-wire type communication is more effective against noise than the 2-wire type.
2. To use 4-wire communication, the parameters must be set in addition to the settings made with the cable.
   Set #102 *Cont2.bit6 to 1.
3. Do not connect the pins that have no particular description. (Leave these OPEN.)
4. Consult with Mitsubishi when manufacturing a cable longer than 50m.

### (3)  Detector cable for HC-MF, HA-FF motors

#### < MR-JCCBL□M-H cable connection diagram >

This is an actual connection diagram for the MR-JCCBL□M-H cable supplied by Mitsubishi.
The connection differs according to the cable length.

MR-JCCBL2M-H
MR-JCCBL5M-H

MR-JCCBL10M-H
MR-JCCBL20M-H
MR-JCCBL30M-H
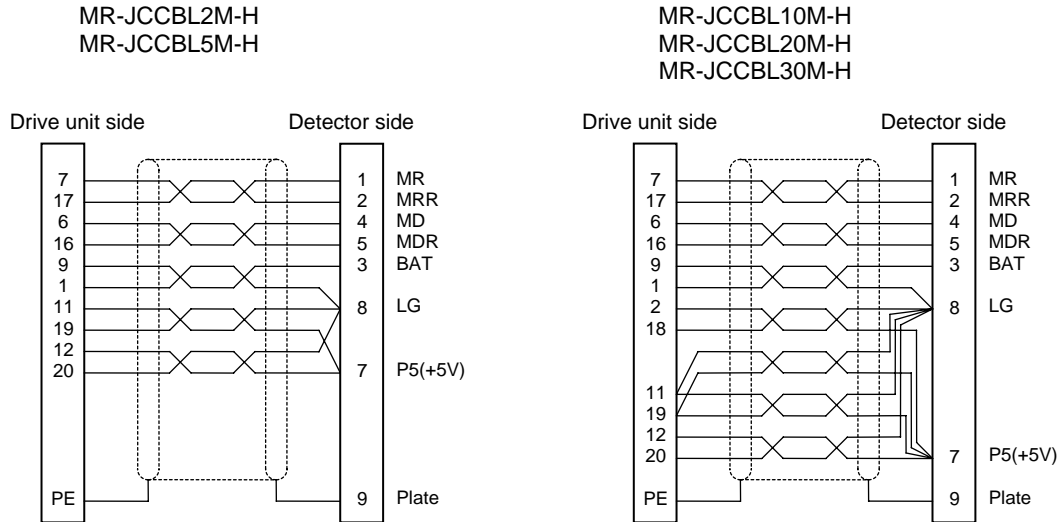


#### < Connection diagram for cable manufacturing >

Manufacture the detector cable as shown below. The cable can be up to 50m long.
Refer to section "4-4-4 Cable wire and assembly" for details on wire.



By connecting across CONT and LG on the detector side, the detector communication will be set to 4-wire (separated transmission/reception lines type) communication.

---
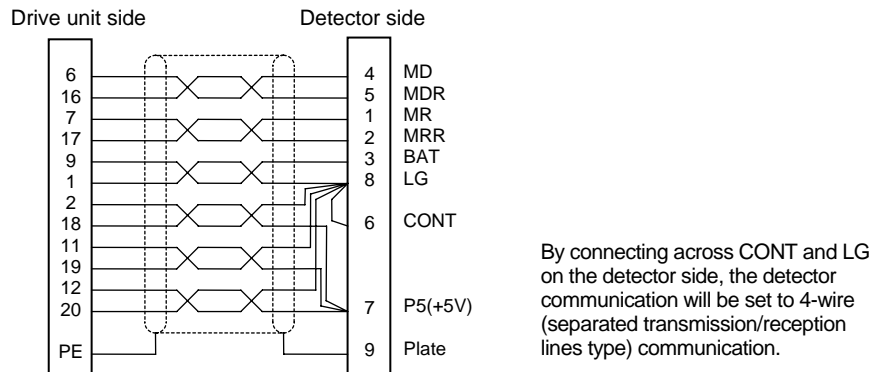
💡 **POINT**

The MR-JCCBL□M-H cable is a general-purpose cable that can be used with other detectors. If the MR-JCCBL□M-H cable is used with the HA-FF or HC-MF types, the communication will be 2-wire detector communication (common transmission/reception lines type), and the MD and MDR signals will not be used.

---

⚠ **CAUTION**

1. The cable manufacturing connection diagram shows the connection for a 4-wire detector communication (separated transmission/reception lines type). This motor's detector communication is normally 2-wire communication (common transmission/reception lines type). However, 4-wire type communication is more effective against noise than the 2-wire type.
2. To use 4-wire communication, the parameters must be set in addition to the settings made with the cable.
   Set #102 *Cont2.bit6 to 1.
3. Do not connect the pins that have no particular description. (Leave these OPEN.)
4. Consult with Mitsubishi when manufacturing a cable longer than 50m.

---

**(4)  Personal computer communication cable**

**< Personal computer communication cable connection diagram >**
> This is the actual connection diagram for the personal computer communication cables supplied by Mitsubishi.



MR-CPC98CBL3M
(For PC98)

Drive unit side      Personal computer side

| 1 | | | |
| 2 | | 2 | SD |
| 11 | | 7 | RD |
| 12 | | 3 | SG |
| | | 4 | RS |
| | | 5 | CS |
| PE | | | |

D-SUB 25 pin

MR-CPCATCBL3M
(For DOS/V)

Drive unit side      Personal computer side

| 1 | | | |
| 2 | | 3 | TxD |
| 11 | | 5 | GND |
| 12 | | 2 | RxD |
| | | 4 | DTR |
| | | 6 | DSR |
| | | 7 | RTS |
| | | 8 | CTS |
| PE | | | |

D-SUB 9 pin
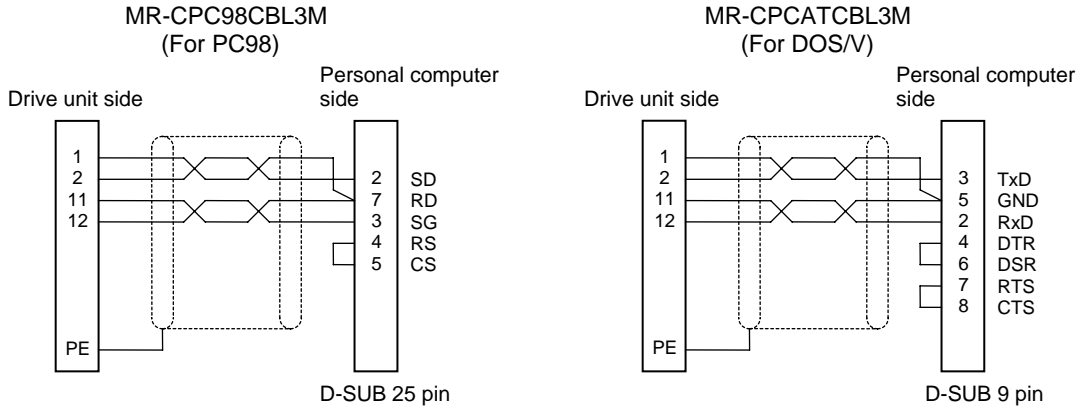
**< Connection diagram for cable manufacturing >**
> Follow the connection diagrams above when manufacturing cables. Refer to section "4-4-4 Cable wire and assembly" for details on wire types.

---

⚠ **CAUTION**

1. The PC98 notebook also has half-pitch, 14-pin type connectors. Check the shape of the RS-232-C connector on the personal computer being used.
2. The wiring distances will differ according to the working environment, but can be up to 15m in an office, etc., where there is little noise present.

---

## 4-5   Setup software

The setup software is used to set and change the parameters, check the operation state and carry out test operation from the personal computer using the servo drive unit's communication function.

### 4-5-1   Setup software specifications

| Item | Details (Note 1) |
|---|---|
| Type | Japanese: FWS-B02B012<br>English    : FWS-B05B013 |
| Communication signal | RS-232-C compliance |
| Transmission speed | 9600bps |
| Monitor | Batch display, high-speed display, graphic display |
| Alarm | Alarm display, alarm history |
| Diagnosis | Input/output signal display, power ON cumulative display, automatic tuning status display, absolute position monitor |
| Parameter | Data setting list display, change list display, detailed information display |
| Test operation | Automatic operation, manual operation, jog operation, reference point return, absolute position reference point setting |
| File operation | Data write, save, print |

**(Note 1)**   This software may not run correctly depending on the personal computer being used.

**(Note 2)**   Refer to "Setup Software Instruction Manual(BNP-B2208)" for details.

### 4-5-2   System configuration

The following items are required to use this software.

| Model | Details |
|---|---|
| OS | Windows 95/98/2000/XP |
| Display | 640 × 400 or more color, or 16 tone monochrome,<br>Windows 95/98/2000/XP compatible |
| Keyboard | Compatible with personal computer |
| Mouse | Windows 95/98/2000/XP compatible. Note that a serial mouse cannot be used. |
| Printer | Windows 95/98/2000/XP compatible |
| Communication cable | MR-CPCATCBL3M<br>When not using this cable, refer to section 4-4-5 (4), and manufacture a cable. |

**(Note)**     Windows is a registered trademark of Microsoft Corporation.

## 4-6   Selection of wire

Select the wire size for each servo drive unit capacity as shown below.

| Drive unit type | Wire size (Note 1) | | | | | Crimp terminal (Note 2) | |
|---|---|---|---|---|---|---|---|
| | L1, L2, L3 ⏚ (Note 3) | L11, L21 | U, V, W (Note 4) | P, C (Note 5) | Magnetic brakes | Type | Tool |
| MR-J2-10CT | IV1.25SQ (AWG16) | IV1.25SQ (AWG16) | IV1.25SQ (AWG16) | IV2SQ (AWG14) | IV1.25SQ (AWG16) | 32959 | 47387 |
| MR-J2-20CT | | | | | | | |
| MR-J2-40CT | | | | | | | |
| MR-J2-60CT | IV2SQ (AWG14) | | IV2SQ (AWG14) | | | | |
| MR-J2-70CT | | | | | | | |
| MR-J2-100CT | | | | | | | |
| MR-J2-200CT | 3.5 (AWG12) | | 3.5 (AWG12) | | | 32968 | 59239 |
| MR-J2-350CT | 5.5 (AWG10) | | 5.5 (AWG10) | | | | |

**(Note 1)**   As a standard, the wire is a 600V vinyl wire (the conductor must be copper).
**(Note 2)**   This indicates the UL/c-UL Standard compliant wire. (AMP). Refer to section 2-2-3 for the L11, L21, P and C below 100CT.
**(Note 3)**   This value is for the single drive unit. Refer to the following table when wiring across several drive units.
**(Note 4)**   The wires (U, V, W) in the table are for when the distance between the servomotor and servo drive unit is 30m or less.
**(Note 5)**   Twist and wire the connecting wire for the regenerative option (P, C).


When wiring L1, L2, L3 and the ground wire across several servo drive units, use the following table and select the wire size from the total capacity of the motors connected downward.

| Total motor capacity | 1kW or less | 2.5kW or less | 6kW or less | 9kW or less | 12kW or less |
|---|---|---|---|---|---|
| Wire size (mm$^2$) | IV1.25SQ (AWG16) | IV2SQ (AWG14) | IV3.5SQ (AWG12) | IV5.5SQ (AWG10) | IV8SQ (AWG8) |

**(Note)**   Compare with the choice of a single drive unit, and choose the thicker one.

## 4-7   Selection of circuit protectors

Use the following table to obtain the circuit protector rated current from the total rated capacity (J2-CT total output capacity) of the motor driving the MR-J2-CT to be connected to the circuit protector to be selected, and select the circuit protector.

When the MDS-B-SVJ2 Series servo drive unit is being used, select the circuit protector in the same manner from the total rated output (J2-CT+SVJ2 total output capacity) of the motor including the J2-CT and SVJ2.

When the MDS-B-SPJ2 spindle drive unit or converter unit will share circuit protectors, select from the total circuit protector rated current of each SVJ2 total output capacity and SPJ2 spindle drive unit or converter unit. However, separate the MR-J2-CT servo drive unit circuit protector from the others, and select the NF60 type (60A) or smaller capacity dedicated for MR-J2-CT servo drive units if the total circuit protector rated current exceeds 60A.

### Circuit protector rated current table

| J2-CT (+SVJ2) total rated capacity | 1.5kW or less | 3.5kW or less | 7kW or less | 10kW or less | 13kW or less | 16kW or less |
|---|---|---|---|---|---|---|
| Circuit protector rated current | 10A | 20A | 30A | 40A | 50A | 60A |

| | | | | | |
|---|---|---|---|---|---|
| **MDS-B-SPJ2** | MDS-B-SPJ2-02<br>MDS-B-SPJ2-04<br>MDS-B-SPJ2-075<br>MDS-B-SPJ2-15 | MDS-B-SPJ2-22<br>MDS-B-SPJ2-37 | MDS-B-SPJ2-55 | MDS-B-SPJ2-75 | MDS-B-SPJ2-110 |
| **Converter unit** | MDS-A-CR-10<br><br>MDS-A-CR-15 | MDS-A/B-CV-37<br>MDS-A-CR-22<br>MDS-A-CR-37 | MDS-A/B-CV-55<br>MDS-A-CR-55 | MDS-A/B-CV-75<br>MDS-A-CR-75 | MDS-A-CR-90<br>MDS-A/B-CV-110 |
| Circuit protector rated current | 10A | 20A | 30A | 40A | 50A |



### Circuit protector selection table

| Circuit protector rated current | 10A | 20A | 30A | 40A | 50A | 60A |
|---|---|---|---|---|---|---|
| Recommended circuit protector (Mitsubishi Electric Corp.: Option part) | NF30-CS3P10A | NF30-CS3P20A | NF30-CS3P30A | NF50-CP3P40A | NF50-CP3P50A | NF60-CP3P60A |

Separately ordered parts: These parts are not handled by either the NC Dept. or dealers.

---

**(Example 1)**

The circuit protector is selected when one MR-J2-60CT (HC-SF52) axis and three MDS-B-SVJ2-10 (HC102) axes are connected.

The total motor output of all J2-CT and SVJ2 axes is calculated as shown below.

$$0.5kW + 1.0kW \times 3 = 3.5kW$$

Thus, the total circuit protector rated current is 20A, and from that the NF30-CP3P20A circuit protector is selected.

---

**(Example 2)**

The circuit protector is selected when one MR-J2-60CT (HC-FF63) axis, one MR-J2-200CT (HC-SF202) axis, and an MDS-B-CR-90 (HC102) are connected.

The MR-J2-CT side capacity is calculated as shown below.

$$0.6kW + 2.0kW = 2.6kW$$

From that, the circuit protector rated current of 20A is obtained from the table.

The MDS-B-CV-90 circuit protector rated current of 50A is obtained from the table.

Thus, the total circuit protector rated current is 70A, and from that the circuit protector is separated from the converter unit, and the NF30-CS3P20A circuit protector is selected for the MR-J2-CT. (Refer to the section "MDS-A/B Series Specification Manual" to select the converter circuit protector.)

---

| ⬦! **DANGER** | Install independent circuit protectors and contactors as the MR-J2-CT main circuit power supply if the total current capacity exceeds 60A when the power supply is shared between the converter and a large capacity SPJ2 spindle drive unit.<br>Circuit protectors may not operate for short-circuits in small capacity drive units if they are shared with a large capacity unit, and this could cause fires. For the MR-J2-CT, use an NF60 type or lower capacity breaker. |
| --- | --- |

## 4-8   Selection of contactor

Select the contactor based on section "4-8-1 Selection from rush current" when the system connected to the contactor to be selected is an MR-J2-CT or MDS-B-SVJ2 and 3.7kW or less MDS-B-SPJ2 spindle drive unit.
When a converter unit or 5.5kW or more MDS-B-SPJ2 spindle drive unit is included, calculate both the capacities in sections "4-8-1 Selection from rush current" and "4-8-2 Selection from input current", and select the larger of the two capacities.

| | |
|---|---|
| **POINT** | The contactors can be directly driven from the SVJ2 contactor control output (24VDC) is a DC/AC interface unit is added. |

### 4-8-1   Selection from rush current

Use the following table to select the contactors so the total rush current for each unit does not exceed the closed circuit current amount.

**Rush current table**

| **MR-J2-CT** | MR-J2-10CT MR-J2-20CT | MR-J2-40CT MR-J2-60CT | MR-J2-70CT MR-J2-100CT | MR-J2-200CT MR-J2-350CT |
|---|---|---|---|---|
| **Rush current** | 45A | 50A | 70A | 100A |

| **MDS-B-SVJ2** | MDS-B-SVJ2-01 MDS-B-SVJ2-03 MDS-B-SVJ2-04 | MDS-B-SPJ2-06 | MDS-B-SVJ2-07 | MDS-B-SVJ2-10 MDS-B-SVJ2-20 |
|---|---|---|---|---|
| **Rush current** | 45A | 50A | 70A | 100A |

| **MDS-B-SPJ2** | MDS-B-SPJ2-02 MDS-B-SPJ2-04 | MDS-B-SPJ2-075 | MDS-B-SPJ2-15 MDS-B-SPJ2-22 MDS-B-SPJ2-37 | MDS-B-SPJ2-55 MDS-B-SPJ2-75 MDS-B-SPJ2-110 |
|---|---|---|---|---|
| **Rush current** | 45A | 50A | 100A | 15A |

| **Converter unit** | MDS-A-CR-10 ~ MDS-A-CR-90 MDS-A/B-CV-37 ~ MDS-A/B-CV-75 | MDS-A/B-CV-110 |
|---|---|---|
| **Rush current** | 15A | 40A |

**Contactor selection table 1**

| Contactor closed current capacity (Total rush current) | 110A | 200A | 220A | 300A | 400A | 550A | 650A | 850A |
|---|---|---|---|---|---|---|---|---|
| Recommended contactor (Mitsubishi Electric Corp.: Option part) | S-N10 AC200V | S-N18 AC200V | S-N20 AC200V | S-N25 AC200V | S-N35 AC200V | S-K50 AC200V | S-K65 AC200V | S-K80 AC200V |

Separately ordered parts: These parts are not handled by either the NC Dept. or dealers.

| | |
|---|---|
| **POINT** | The rush current of the MDS-B-SPJ2 spindle drive unit decreases at capacities of 5.5kW or more. |

**(Example 1)**

The contactor is selected for the MDS-B-SVJ2-10 (HC102) with 3 axes and one MR-J2-350CT (HC-SF352) axis connected.

< Selection only from rush current >
(350CT $\times$ 1 axis rush current) + (SVJ2-10 $\times$ 3 axes rush current)
= 1 $\times$ 100A + 3 $\times$ 100A = 400A
Therefore, S-N35 200VAC is selected.

### 4-8-2    Selection from input current

Use the following table to select the contactors so the total input current for each unit does not exceed the rated continuity current.

**Input current table**

| J2-CT (+SVJ2) total output capacity | 1.5kW or less | 3.5kW or less | 7kW or less | 10kW or less | 13kW or less | 16kW or less |
|---|---|---|---|---|---|---|
| **Input current** | 10A | 20A | 30A | 40A | 50A | 60A |

| **MDS-B-SPJ2** | MDS-B-SPJ2-02 MDS-B-SPJ2-04 MDS-B-SPJ2-075 MDS-B-SPJ2-15 | MDS-B-SPJ2-22 MDS-B-SPJ2-37 | MDS-B-SPJ2-55 | MDS-B-SPJ2-75 | MDS-B-SPJ2-110 |
|---|---|---|---|---|---|
| **Input current** | 10A | 20A | 30A | 40A | 50A |

| **Converter unit** | MDS-A-CR-10 MDS-A-CR-15 | MDS-A/B-CV-37 MDS-A-CR-22 MDS-A-CR-37 | MDS-A/B-CV-55 MDS-A-CR-55 | MDS-A/B-CV-75 MDS-A-CR-75 | MDS-A-CR-90 MDS-A/B-CV-110 |
|---|---|---|---|---|---|
| **Input current** | 10A | 20A | 30A | 40A | 50A |

**Contactor selection table 2**

| Contactor rated continuity current (Total input current) | 20A | 32A | 50A | 60A |
|---|---|---|---|---|
| Recommended contactor (Mitsubishi Electric Corp.: Option part) | S-N10 AC200V | S-N20 AC200V | S-N25 AC200V | S-N35 AC200V |

Separately ordered parts: These parts are not handled by either the NC Dept. or dealers.

---

**(Example 2)**

The contactor is selected for the MR-J2-70CT (HC-MF73) with 4 axes and an MDS-B-CV-75 connected.

< Selection from rush current >
(70CT $\times$ 3 axes rush current) + (MDS-B-CV-75 rush current) = $3 \times 75A + 15A = 225A$
Therefore, S-N25 200VAC.

< Selection from input current >
(70CT $\times$ 3 axes input current) + (MDS-B-CV-75 input current) = 20A + 40A = 60A
Therefore, S-N35 200VAC.
From these, the S-N35 200VAC is selected as having the larger of the two capacities.

## 4-9    Control circuit related

### 4-9-1    Circuit protector

When installing a circuit protector dedicated for the control power input, use a circuit protector with inertial delay to prevent malfunctioning in respect to the rush current generated when the power is turned ON. The size and conductivity time of the rush current fluctuate according to the power supply impedance and potential.

| Servo drive unit | Rush current | Conductivity time |
|---|---|---|
| MR-J2-10CT ~ 100CT | 70 ~ 100A | 0.5 ~ 1ms |
| MR-J2-200CT ~ 350CT | 100 ~ 130A | 0.5 ~ 1ms |

| Recommended circuit protector (Mitsubishi Electric Corp.: Option part) | CP30-BA type with medium-speed inertial delay |
|---|---|
| Rated current of circuit protector | 1.0A per axis |

Separately ordered parts: These parts are not handled by either the NC Dept. or dealers.

### 4-9-2    Relays

Use the following relays for the input/output interface (motor brake output: MBR, contactor output: MC, near point dog : DOG external emergency stop : EMGX.)

| Interface name | Selection example |
|---|---|
| For digital input signal (DOG, EMGX) | Use a minute signal relay (twin contact) to prevent a contact defect.<br>**<Example>** OMRON: G2A type, MY type |
| For digital output signal (MBR, MC) | Use a compact relay with 24VDC, 40mA or less.<br>**<Example>** OMRON: MY type |

Contact: OMRON Corporation        http://www.omron.co.jp/

### 4-9-3 Surge absorber

When controlling a magnetic brake of a servomotor in DC OFF circuit, a surge absorber must be installed to protect the relay contacts and brakes. Commonly a varistor is used.

#### (1) Selection of varistor

When a varistor is installed in parallel with the coil, the surge voltage can be adsorbed as heat to protect a circuit. Commonly a 120V product is applied. When the brake operation time is delayed, use a 220V product. Always confirm the operation with an actual machine.

#### (2) Specifications

Select a varistor with the following or equivalent specifications. To prevent short-circuiting, attach a flame resistant insulation tube, etc., onto the leads as shown in the following outline dimension drawing.

**Varistor specifications**

| Varistor type | Varistor voltage rating (range) | Rating | | | | | | | Max. limit voltage | Electrostatic capacity (reference value) |
| | | Tolerable circuit voltage | | Surge current withstand level (A) | | Energy withstand level (J) | | Power | | |
| | (V) | AC (V) | DC (V) | 1 time | 2 times | 10 /1000us | 2ms | (W) | (V) | (pF) |
| **ERZV10D121** | 120 (108 to 132) | 75 | 100 | 3500 | 2500 | 20 | 14.5 | 0.4 | 200 | 1400 |
| **TND10V-121K** | | | | | | | | | | |
| **ERZV10D221** | 220 (198 to 242) | 140 | 180 | 3500 | 2500 | 39 | 27.5 | 0.4 | 360 | 410 |
| **TND10V-221K** | | | | | | | | | | |

(Note 1) Selection condition: When ON/OFF frequency is 10 times/min or less, and exciting current is 2A or less

(Note 2) ERZV10D121 and ERZV10D221 are manufactured by Panasonic Electronic Devices Co.,Ltd.

TND10V-121K,TND10V-221K are manufactured by Nippon Chemi-Con Corporation

Contact: Panasonic Electronic Devices Co.,Ltd.   : http://panasonic.co.jp/ped/

Nippon Chemi-Con Corporation     : http://www.chemi-con.co.jp/

#### (3) Outline dimension drawing

• ERZV10D121, ERZV10D221



```
              11.5
            |←—→|
                          [Unit: mm]

              (  )
               ||
        20.0   ||———— Insulation tube
               ||
```
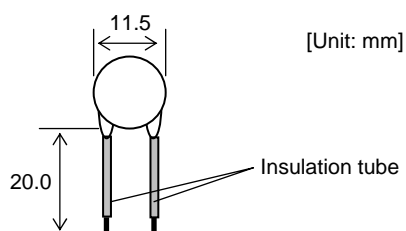
| 💡 **POINT** | Normally use a product with 120V varistor voltage. If there is no allowance for the brake operation time, use the 220V product. A varistor whose voltage exceeds 220V cannot be used, as such varistor will exceed the specifications of the relay in the |
|---|---|

# Chapter 5  Operation Control Signal

## 5-1    System configuration

### 5-1-1    Built-in indexing function

Conventional NC servo drive units received acceleration/deceleration commands to the target position from the NC and controlled the motor. With the MR-J2-CT, the acceleration/deceleration commands that were until now received from the NC are created in the drive unit, and the motor is controlled. The operation commands for the MR-J2-CT are all carried out from the user PLC via the R-register. The response signals from the MR-J2-CT indicating the operation status are also returned to the user PLC R-register. These signals are automatically communicated with the MR-J2-CT by the NC via high-speed serial communication.

**Conventional servo control system**

**MR-J2-CT servo control system**
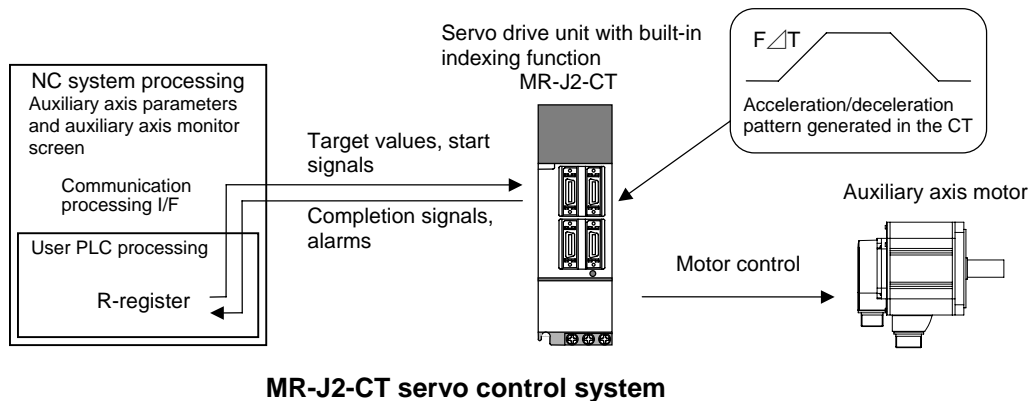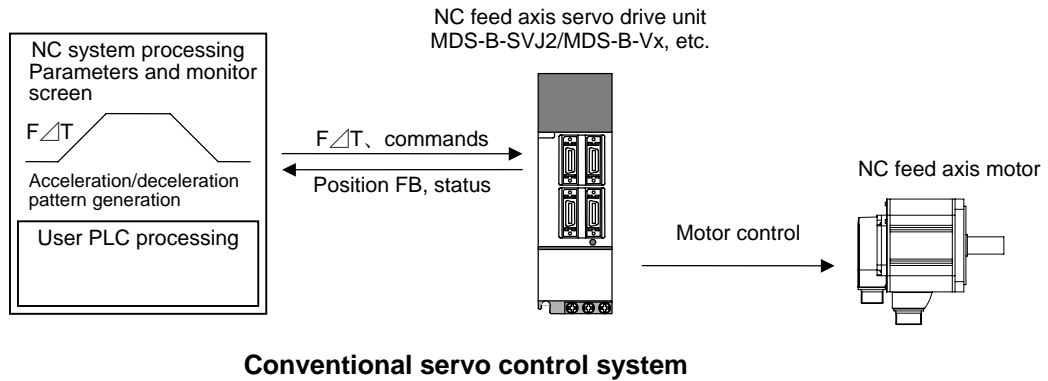
| | | POINT | 1. The MR-J2-CT carries out position control as a single drive unit; it is a positioning-dedicated servo drive unit. Use a conventional servo drive unit (MDS-B-SVJ2, MDS-B-Vx Series) when interpolation control is required.<br>2. The connections between the NC and MR-J2-CT, monitor screens, parameter input methods, etc., differ according to the NC, so refer to the appropriate instruction manual for the NC being used. |

### 5-1-2  Parameters

All parameters, including absolute position data, are saved in the MR-J2-CT. Using separately sold setup software, it is possible to rewrite the parameters and set the reference point from the personal computer using RS-232-C serial communication, and adjustment, test operation, etc., of individual auxiliary axes is supported. Note that because the parameters and absolute position data are saved in the drive unit, this data must be written to the new drive unit when the drive unit is replaced.
When replacing the drive unit, first upload the parameters from the old drive unit and store them in the memory of the NC, then download them into the new drive unit. The absolute position data is constantly backed up in the NC, so download that data into the new drive unit. This function is mounted on all NC's supporting MR-J2-CT drive units. Refer to the appropriate instruction manual of the NC being used for information on the operation method.
If the parameters cannot be uploaded from the old drive unit, download the NC backup parameters. Note that because the parameters are reset by the auto-tuning function, the control immediately after drive unit replacement may be unstable. However, if the drive unit continues to be used in that condition the auto-tuning will cause the parameters to reach a convergent value, and the characteristics will improve.

MR-J2-CT

NC internal memory

• Parameters
• Backup reference point data

Operation is necessary to backup parameters.

High-speed serial communication

RS-232-C serial communication

Personal computer (setup software)

• Parameter revision
• Reference point setting
• Various monitoring

MR-J2-CT internal memory
• Parameters
• Reference point data
• Alarm history
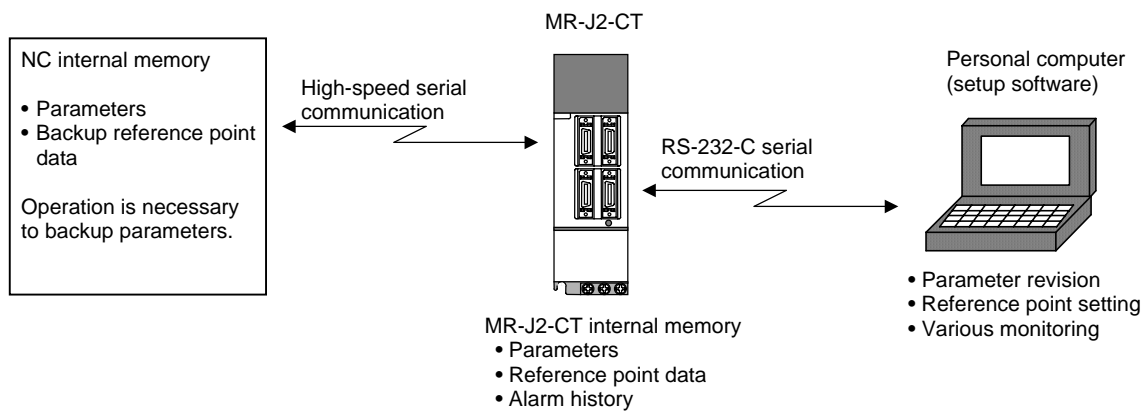
## 5-2 R register

The MR-J2-CT is controlled by the input/output from the PLC program to the R-registers in the table below. The R-register addresses differ according to the NC type and MR-J2-CT axis No. settings. (The order in the table below is an example.)

### (1) List of operation commands (NC → servo drive unit)

| | bit7 / bitF | bit6 / bitE | bit5 / bitD | bit4 / bitC | bit3 / bitB | bit2 / bitA | bit1 / bit9 | bit0 / bit8 |
|---|---|---|---|---|---|---|---|---|
| **Control command 1** (CTCM1) | H | RDF | ∗IT− | ∗IT+ | MRST | ∗PRT1 | QEMG | ∗SVF |
| | Handle feed operation mode selection | READY OFF | Interlock (−) | Interlock (+) | Master reset | Data protect | PLC emergency stop | Servo OFF |
| | S | ZST | AZS | | ZRN | J | MAN | AUT |
| | Incremental feed operation mode selection | Reference point setting | Reference point default setting mode selection | | Reference point return mode selection | JOG operation mode selection | Manual operation mode selection | Automatic operation mode selection |
| **Control command 2** (CTCM2) | PR2 | PR1 | MP2 | MP1 | PUS | STS | DIR | ST |
| | Operation parameter selection 2 | Operation parameter selection 1 | Incremental feed magnification factor 2 | Incremental feed magnification factor 1 | Stopper positioning commands valid | Random point feed commands valid | Rotation direction | Operation start |
| | | | | | | | | |
| | | | | | | | | |
| **Control command 3** (CTCM3) | ST128 | ST64 | ST32 | ST16 | ST8 | ST4 | ST2 | ST1 |
| | Station selection 128 | Station selection 64 | Station selection 32 | Station selection 16 | Station selection 8 | Station selection 4 | Station selection 2 | Station selection 1 |
| | | | | | | | | ST256 |
| | | | | | | | | Station selection 256 |
| **Control command 4** (CTCM4) | OVR | OV64 | OV32 | OV16 | OV8 | OV4 | OV2 | OV1 |
| | Speed override valid | Speed override 64 | Speed override 32 | Speed override 16 | Speed override 8 | Speed override 4 | Speed override 2 | Speed override 1 |
| | | | | | | | | |
| | | | | | | | | |
| **Command position** (CTCML) **Command position** (CTCMH) | Command position when random point feed commands are valid. (32bit) | | | | | | | |

### (2) List of operation status signals (servo drive unit → NC)

| | bit7 / bitF | bit6 / bitE | bit5 / bitD | bit4 / bitC | bit3 / bitB | bit2 / bitA | bit1 / bit9 | bit0 / bit8 |
|---|---|---|---|---|---|---|---|---|
| **Status 1** (CTST1) | ADJ | TLQ | MVN | MVP | AX1 | SMZ | INP | RDY |
| | Machine being adjusted | Torque limited | Axis moving (−) | Axis moving (+) | Axis selection output | Smoothing zero | In-position | Servo READY |
| | NEAR | JST | JSTA | SA | MA | HO | RST | ZP |
| | Near set position | Set position reached | Automatic set position reached | Servo READY | Controller ready | In handle feed operation mode | Resetting | Reference point reached |
| **Status 2** (CTST2) | SO | AZSO | DOG | ZRNO | ARNN | JO | MANO | AUTO |
| | In incremental feed operation mode | In reference point default setting mode | Near-point dog | In reference point return mode | Returning to reference point | In JOG operation mode | In manual operation mode | In automatic operation mode |
| | ZSE | ZSF | ZSN | ABS | BAT | AL4 | AL2 | AL1 |
| | Default setting error finished | Default setting completed | Absolute position data loss | Absolute position power off movement exceeded | Battery voltage low | Alarm 4 | Alarm 2 | Alarm 1 |
| **Status 3** (CTST3) | STO128 | STO64 | STO32 | STO16 | STO8 | STO4 | STO2 | STO1 |
| | Station position 128 | Station position 64 | Station position 32 | Station position 16 | Station position 8 | Station position 4 | Station position 2 | Station position 1 |
| | | | | | | | | STO256 |
| | | | | | | | | Station position 256 |
| **Status 4** (CTST4) | PSW8 | PSW7 | PSW6 | PSW5 | PSW4 | PSW3 | PSW2 | PSW1 |
| | Position switch 8 | Position switch 7 | Position switch 6 | Position switch 5 | Position switch 4 | Position switch 3 | Position switch 2 | Position switch 1 |
| | | | | | | | PSI | PSF | PMV |
| | | | | | | | In stopper | Positioning completed | In positioning operation |

⚠ **CAUTION**
1. The array of R-register addresses in the table is an example. The R-register assignments differ for each NC, so refer to the appropriate instruction manual for the NC being used.
2. Signals indicated with an asterisk (∗) are handled as B contacts (Valid at OFF "0").

## 5-3　Explanation of operation commands (NC → servo drive unit)

| **Abbreviation** | ∗SVF | **Signal name** | Servo OFF | CTCM1.bit0 |
|---|---|---|---|---|

When the servo OFF signal is set to "0" (B contact), the control axis enters the servo OFF status. No matter which operation mode the servo is in and turned OFF, the axis movement will stop, and the servo will turn OFF. The axis movement restarts when the servo is turned ON again.
If the axis moves for any reason while the servo is OFF, it can be selected whether to compensate that movement amount when the servo turns ON the next time. Select with parameter "#102 cont2 Control parameter 2 bit1".

  **(1)　When carrying out movement amount compensation (#102 bit1=1)**
     When the servo is OFF, the coordinates are always updated by the amount the axis has moved. When the servo is OFF, the coordinates show the machine position.

  **(2)　When not carrying out movement amount compensation (#102 bit1=0)**
     When the servo is OFF, the coordinates are not updated even when the axis moves. When the servo is OFF, the coordinates show the machine position when the servo is OFF.
     When the servo is turned ON, the axis is moved to the position where the servo was turned OFF.
     When the servo is OFF and the axis movement exceeds the excessive error width (whichever was selected among parameter #155, #163, #171, and #179), a servo alarm occurs.

  **(Caution)** The actual servo OFF operation is validated after the In-position (INP) is completed. When using a mechanical clamp, carry out the clamp operation after confirming the In-position status.

  **< Memo>** When the power is turned ON, the servo OFF signal turns OFF ("0") and the servo OFF function becomes valid. It is necessary to turn the servo OFF to ON ("1"), and release the servo OFF before operation using the NC user PLC.

| **Abbreviation** | QEMG | **Signal name** | PLC emergency stop | CTCM1.bit1 |
|---|---|---|---|---|

This signal from the NC (host controller) built-in PLC causes the direct emergency stop function to work. When this signal is ON, this servo drive unit enters the emergency stop state. It is released when the signal is turned OFF.
When the emergency stop signal output is validated, an emergency stop signal for other drive units is also output by this signal in an emergency stop state.

| **Abbreviation** | ∗PRT1 | **Signal name** | Data protect 1 | CTCM1.bit2 |
|---|---|---|---|---|

This is a signal to protect the parameters stored in the MR-J2-CT.
When this signal is OFF, parameters cannot be downloaded using the setup software. Note that this signal is invalid for the write functions from the NC, not from the setup software.

| **Abbreviation** | MRST | **Signal name** | Master reset | CTCM1.bit3 |
|---|---|---|---|---|

This signal resets the MR-J2-CT.
When the master reset (MRST) signal is ON, the following reset operations are carried out.
  (1) The axis movement decelerates to a stop.
  (2) Alarms that can be released by the reset are released.
  (3) Resetting (RST) signal is output.
  (4) The operation alarm is released while resetting.

| **Abbreviation** | ∗IT+ | **Signal name** | Interlock + | CTCM1.bit4 |
|---|---|---|---|---|

When the control axis is moving in the + direction, this signal decelerates and stops the axis movement immediately.
When this signal is OFF from before movement, the motion is stopped in the same manner as without starting. In any case the movement is started or restarted by turning this signal ON.

| **Abbreviation** | ∗IT− | **Signal name** | Interlock − | CTCM1.bit5 |
|---|---|---|---|---|

This is the same as above, the only difference being that the direction differs from the interlock + (IT+) signal.

| **Abbreviation** | RDF | **Signal name** | READY OFF | CTCM1.bit6 |
|---|---|---|---|---|

This is a signal to turn OFF the READY status.
When put into a READY OFF status, the power supply to the servomotor is shut off, and the contactor control output is simultaneously turned OFF. If the motor is in operation, it will stop by a dynamic brake stop or a deceleration control stop. Servo ready complete (SA) and Servo ready (RDY) are also turned OFF, but an alarm does not occur. When this signal is turned OFF, the machine immediately returns to the original state.

| **Abbreviation** | H | **Signal name** | Handle mode selection | CTCM1.bit7 |
|---|---|---|---|---|

This signal selects the handle feed mode.
The axis will move for the amount determined by input pulse multiplied by feed magnification after this signal is turned ON, each signal [operation parameter selection (PR1, PR2), and incremental feed magnification (MP1, MP2)] is determined, and the handle pulse is input.

  **(Caution 1)** Turning this signal ON when other operation modes are ON will result in a "M01 0101 No operation mode" type operation alarm.
  **(Caution 2)** The handle mode acceleration/deceleration time is the acceleration/deceleration time constant 2 linear acceleration/deceleration of the selected operation parameter group.

| **Abbreviation** | AUT | **Signal name** | Automatic operation mode selection | CTCM1.bit8 |
|---|---|---|---|---|

This signal selects the automatic operation mode.
When the station No. is designated and the operation start (ST) is ON, the movement toward the designated station begins.
  **(Caution)** Turning the manual operation mode selection signal ON when other operation mode selection signals are ON will result in a "M01 0101 No operation mode" type operation alarm.

| **Abbreviation** | MAN | **Signal name** | Manual operation mode selection | CTCM1.bit9 |
|---|---|---|---|---|

This signal selects the manual operation mode.
When the rotation direction is designated and the operation start signal (ST) is turned ON, the axis will begin moving, and the rotation will continue in the designated direction until the operation start signal (ST) is turned OFF. When the operation start signal (ST) turns OFF, the axis will be positioned to the nearest station.
  **(Caution)** Turning the JOG mode selection signal ON when other operation mode selection signals are ON will result in a "No operation mode" type operation alarm.

| **Abbreviation** | J | **Signal name** | JOG mode selection | CTCM1.bitA |
|---|---|---|---|---|

This signal selects the JOG mode.
When the rotation direction is designated and the operation start signal (ST) is turned ON, the axis will begin moving, and the rotation will continue in the designated direction until the operation start signal (ST) is turned OFF. Unlike the manual operation mode, when the operation start signal (ST) is turned OFF, the axis immediately decelerate to a stop.
  **(Caution)** Turning the JOG mode selection signal ON when other operation mode selection signals are ON will result in a "No operation mode" type operation alarm.

| **Abbreviation** | ZRN | **Signal name** | Reference point return mode selection | CTCM1.bitB |
|---|---|---|---|---|

This signal selects the reference point return mode.
When the reference point return mode signal (ZRN) is ON, the mode is designated for reference point return. After the reference point return mode signal is turned ON, and the operation parameter group is selected, the reference point return is begun by turning the operation start signal (ST) ON.
In the incremental specifications, the first reference point return after turning the power ON will be dog-type. However, after the first time, the dog-type or memory-type reference point return will be set by the parameter "#101 cont1 Control parameter bit1". When the absolute position coordinate system is established in the absolute position specifications, the reference point return will be memory-type every time.

| **Abbreviation** | AZS | **Signal name** | Reference point initialization mode selection | CTCM1.bitD |
|---|---|---|---|---|

This signal selects the mode that initializes the reference point for the absolute position detection system. When this signal is turned ON, the reference point initialization mode is held until the NC power is turned OFF. (Cannot be canceled)
When the stopper method is selected, the operation parameter group 4 torque limit value and the excessive error detection width are automatically selected.

| **Abbreviation** | ZST | **Signal name** | Reference point set | CTCM1.bitE |
|---|---|---|---|---|

This signal turns ON when designating the reference point position with the reference point initialization for the absolute position detection system. When this signal is turned ON by the initialization mode of the reference point system, that position is set as the absolute position reference point.

| **Abbreviation** | S | **Signal name** | Incremental feed mode selection | CTCM1.bitF |
|---|---|---|---|---|

This signal selects the incremental feed mode.
The axis movement will begin after this signal is turned ON, each signal [operation parameter selection (PR1, PR2), incremental feed magnification (MP1, MP2), and rotation direction (DIR)] is determined, and the operation start signal (ST) is turned ON.

  **(Caution 1)** Turning this signal ON when other operation modes are ON will result in a "No operation mode" type operation alarm.

  **(Caution 2)** In the incremental mode, the axis will inch, even if the start signal ST is OFF.

Incremental mode selection (s)

Incremental feed magnification selection (MP1, MP2)

Operation parameter selection (PR1, PR2)

Rotation direction selection (DIR)

Reset (RST)

Start signal (ST)

Axis movement

| Abbreviation | ST | Signal name | Operation start | CTCM2.bit0 |
|---|---|---|---|---|

This signal starts the operation in each operation mode. When this signal is turned ON, the operation will start. The operation start signal (hereafter "start signal") is handled as a status, so the ON status must be maintained until the operation is finished.

**[Operation movement in each operation mode]**

**(1) Automatic operation mode**
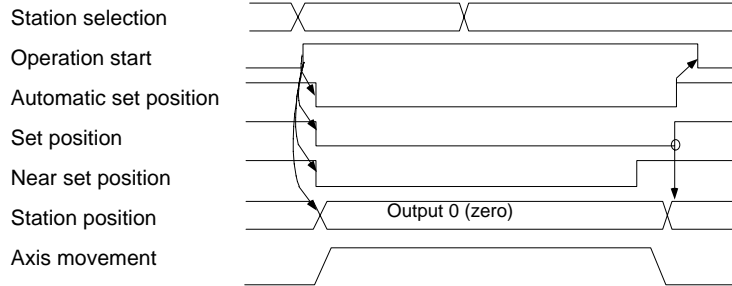


The station selection signal (ST1 to ST256) and operation parameter selection (PR1, PR2) are established before inputting the operation start signal. These signals are read in by the startup of the start signal, so they are held even if they are changed after the startup.

When the start signal is input, the output signals related to the set position all turn OFF. The station position output will be output as 0. Because the automatic set position (JSTA) and set position (JST) is output when the positioning is completed, the operation start signal turns OFF. Even when the start signal turns OFF, the output signal related to the set position is held as it is.

When the start signal ST is turned OFF during axis movement, the axis will stop at the nearest station. Note that for a linear axis, if there is not a nearest point in the movement direction, the commanded station becomes the nearest point.

**< Memo>** When the shortcut function is OFF for the rotating axis, the positioning direction can be designated with the rotation direction (DIR).

**(2) Manual operation mode**
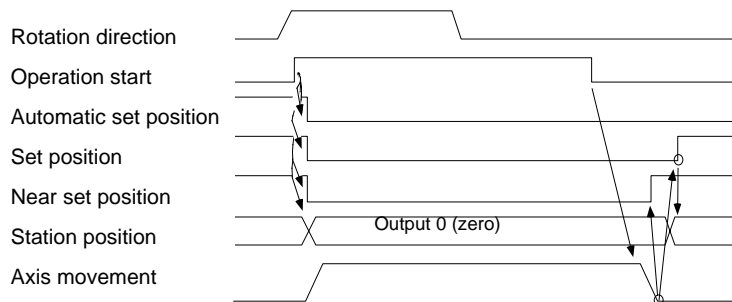


The rotation direction (DIR) and operation parameter selection (PR1, PR2) are established before inputting the operation start signal. These signals are read in by the startup of the start signal, so they are held even if they are changed after the startup.

When the start signal is input, the output signals related to the set position all turn OFF. The station position output will be output as 0.

While the start signal is ON, the rotation direction continues in the designated direction. When the start signal is turned OFF, positioning is carried out to the nearest station that can be stopped at in the rotation direction. Note that for a linear axis, if there is no nearest point in the movement direction, the axis will immediately decelerate to a stop.

When positioning is completed, a set position (JST) is output.

**< Memo>** The automatic set position (JSTA) will not be output.

| **Abbreviation** | ST | **Signal name** | Operation start | CTCM2.bit0 |
|---|---|---|---|---|

**(3) JOG operation mode**



The rotation direction (DIR) and operation parameter selection (PR1, PR2) are established before inputting the operation start signal. These signals are read in by the startup of the start signal, so they are held even if they are changed after the startup.

When the start signal is input, the output signals related to the set position all turn OFF. The station position output will be output as 0.

While the start signal is ON, the rotation direction continues in the designated direction. When the start signal is turned OFF, the axis decelerates to a stop.

The set position (JST) and near set position (NEAR) are output if the axis is stopped within each tolerable width from the station position.

| **Abbreviation** | DIR | **Signal name** | Rotation direction designation | CTCM2.bit1 |
|---|---|---|---|---|

This signal designates the rotation direction of the operation in each operation mode.

It is input before the operation start (ST), to designate the rotation direction.

This signal is invalid in the automatic operation mode when the shortcut control is set and selected by the parameter.

When the shortcut control is not selected, positioning is carried out according to the direction designated by this signal.

This signal is read in at the operation start (ST). Consequently, it is ignored after starting, even if the signal changes.

The actual motor rotation direction is reversed by changing the setting of parameter #102.bit3.

| DIR signal | Axis rotation direction | Station movement direction |
|---|---|---|
| 0 | Forward run | Direction of increasing station No. |
| 1 | Reverse run | Direction of decreasing station No. |

| **Abbreviation** | STS | **Signal name** | Random point feed command valid | CTCM2.bit2 |
|---|---|---|---|---|

This signal selects the mode that executes the positioning in $0.001°$ units toward the random position (coordinate) transferred from the NC. When the random point feed command valid is executed, it is necessary to turn ON the automatic operation mode selection (AUT) simultaneously.

| **Abbreviation** | PUS | **Signal name** | Pressing positioning command valid | CTCM2.bit3 |
|---|---|---|---|---|

This signal selects the mode that executes random point feed including pressing operation. The positioning coordinates are the random position (coordinates) transferred from the NC as with the random point feed command.

When the random coordinate command is executed, it is necessary to simultaneously turn ON the automatic operation mode select (AUT). It is not necessary to simultaneously turn ON the random point feed command valid (STS). (An operation error will occur)

| **Abbreviation** | MP1, MP2 | **Signal name** | Incremental feed magnification 1 and 2 | CTCM2.bit4 to 5 |
|---|---|---|---|---|

This signal selects the incremental feed amount, and the handle feed magnification.
In the handle feed, the selection is the movement amount per handle notch.

| **MR2 signal** | **MR1 signal** | **Feed amount** |
|---|---|---|
| 0 | 0 | 0.001° |
| 0 | 1 | 0.01° |
| 1 | 0 | 0.1° |
| 1 | 1 | 1° |

| **Abbreviation** | PR1, PR2 | **Signal name** | Operation parameter selection 1, 2 | CTCM2.bit6 to 7 |
|---|---|---|---|---|

This signal selects one set of parameter group to actually be used from the four sets of parameter group 4 that designate the axis feed operation. The operation group cannot be changed while the operation start (ST) signal is input (The group is held in the drive unit.)

**Operation parameters (four sets)**

**Operation parameter group 4**
**Operation parameter group 3**
**Operation parameter group 2**
**Operation parameter group 1**
• Automatic feedrate
• Manual feedrate
• Acceleration/deceleration time constant 1
• Acceleration/deceleration time constant 2
• Torque limit
• Excessive error detection width
• Set position detection width
• Near set position detection width

Selection →

**Operation parameter**
• Automatic feedrate
• Manual feedrate
• Acceleration/deceleration time constant 1
• Acceleration/deceleration time constant 2
• Torque limit
• Excessive error detection width
• Set position detection width
• Near set position detection width

| **PR2 signal** | **PR1 signal** | **Selected operation parameter group** |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 2 |
| 1 | 0 | 3 |
| 1 | 1 | 4 |

| **Abbreviation** | ST1 to ST256 | **Signal name** | Station selection 1~256 | CTCM3.bit0 to 8 |
|---|---|---|---|---|

This signal designates the index station No. in the automatic operation mode.
The index station No. is input before operation start (ST) is input in the automatic operation mode.
This signal is input with as a 9-digit binary. Input 000000001 corresponds to station No. 1.
This signal is read in at the startup of the operation Start (ST). Consequently, it is ignored after starting, even if the signal changes.
When this signal is set to 000000000, and the automatic operation is started, a one station rotation special command will result. (Note that this cannot be used when the station positions are determined in non-uniform assignments.)

| **Abbreviation** | OV1 to OV64 | **Signal name** | Speed override 1 to 64 | CTCM4.bit0 to 6 |
|---|---|---|---|---|

This signal designates the override value added to the selected feedrate. The override value is designated by a binary.

$$\text{Effective feedrate} = \frac{\text{Selected speed} \times \text{speed override}}{100}$$

| **Abbreviation** | OVR | **Signal name** | Speed override valid | CTCM4.bit7 |
|---|---|---|---|---|

This is a signal to validate the speed override. When this signal is turned OFF, the set feedrate becomes the operation speed without calculating the override.

## 5-4   Explanation of operation status signals (servo drive unit → NC)

| Abbreviation | RDY | Signal name | Servo READY | CTST1.bit0 |
|---|---|---|---|---|

This signal indicates that the servo system is in an operable status.
This signal turns ON in the following situations:
  (1)   When the servo system diagnosis is normally completed after turning the power ON.
  (2)   After a servo alarm occurrence, when that alarm has been released by the reset (MRST).
  (3)   When the emergency stop has been released.
  (4)   When the READY OFF (RDF) and servo OFF (∗SVF) has been released.
This signal turns OFF in the following situations:
  (1)   When the servo READY (SA) signal is turned OFF.
  (2)   When the servo OFF signal is input, and the drive unit is in a servo OFF state.

| Abbreviation | INP | Signal name | In-position | CTST1.bit1 |
|---|---|---|---|---|

This signal notifies that the control axis is in-position.
This signal turns ON in the following situation:
  (1)   When the smoothing zero (SMZ) signal is turned ON, and the droop is within the range set in the parameters.
This signal turns OFF in the following situations:
  (1)   When the smoothing zero (SMZ) signal is turned OFF. (When there is a movement command.)
  (2)   When the droop exceeds the range set in the parameters.

  **(Caution 1)** The "in-position (INP)" signal may turn ON, even during movement, when the axis is moving at extremely low speeds.
  **(Caution 2)** The in-position detection range is set in the parameter "#006 INP In-position detection width".
  **(Caution 3)** On the servo ready OFF state, smoothing zero (SMZ) signal turns OFF when the travel amount of servomotor is detected, Therefore, in-position signal (INP) also turns OFF, too. "Axis moving +" signal (MVP) or "axis moving -" signal (MVN) turns ON depending on the detected movement direction. Note that the "smoothing zero" signal (SMZ), "axis moving +" signal (MVP) or "axis moving -" signal (MVN) will not change on the servo OFF state without error correction   setting because detected servomotor travel amount becomes a droop amount.



| Abbreviation | SMZ | Signal name | Smoothing zero | CTST1.bit2 |
|---|---|---|---|---|

This signal indicates that the acceleration/deceleration process in the built-in controller is finished, and that no command to the control section remains.

| **Abbreviation** | AX1 | **Signal name** | Axis selection output | CTST1.bit3 |
|---|---|---|---|---|

This signal indicates that the control axis has received the movement command.
This signal turns ON in the following cases, and turns OFF after smoothing zero (SMZ) is detected.

**[In automatic operation mode]**
   The operation start (ST) turns ON, and is ON while the axis is moving.

**[In manual operation mode]**
   The operation start (ST) turns ON, and is ON while the axis is moving.

**[In JOG mode]**
   The operation start (ST) turns ON, and is ON while the axis is moving.

**[In reference point return mode]**
   This signal turns ON while the operation start (ST) signal is ON, and the axis is moving. Note that after the near-point dog is detected and the axis slows to creep speed, the axis selection output signal remains ON until the reference point is reached, even if the feed selection signal is turned OFF.
   When the interlock is applied, this signal remains ON even when the servo is OFF. This signal will turn OFF during emergency stop.

Feed selection +, – (+J, –J)

Axis movement

Axis selection output (AX1)

| **Abbreviation** | MVP | **Signal name** | In Axis movement + | CTST1.bit4 |
|---|---|---|---|---|

This signal turns ON when the axis starts moving in the + direction, and turns OFF after smoothing zero (SMZ) is detected or the axis starts moving in the – direction.

| **Abbreviation** | MVN | **Signal name** | In Axis movement – | CTST1.bit5 |
|---|---|---|---|---|

This signal turns ON when the axis starts moving in the – direction, and turns OFF after smoothing zero (SMZ) is detected or the axis starts moving in the + direction.

| **Abbreviation** | TLQ | **Signal name** | Torque limited | CTST1.bit6 |
|---|---|---|---|---|

This signal turns ON when the motor output torque (motor current) is limited at the torque limit value of the selected operation parameter group.

| **Abbreviation** | ADJ | **Signal name** | Adjusting machine | CTST1.bit7 |
|---|---|---|---|---|

This signal indicates that the machine is being adjusted by the setup software adjusting function.
When this signal turns ON, the signal from the setup software is validated and the control signal from the NC side cannot be received.

| **Abbreviation** | ZP | **Signal name** | Reference point reached | CTST1.bit8 |
|---|---|---|---|---|

This signal indicates that the control axis is on the reference point.
This signal turns ON in the following situation:
  (1)  When the reference point is reached in the reference point return mode. The signal will not turn ON when the reference point is reached by another mode or command.

This signal turns OFF in the following situations:
  (1)  When moved from the reference point by a movement command, etc.
  (2)  When the machine is in an emergency stop status due to an emergency stop or servo alarm occurrence, etc.
  (3)  When the axis moved by the servo OFF.

| **Abbreviation** | RST | **Signal name** | Resetting | CTST1.bit9 |
|---|---|---|---|---|

This signal indicates that the built-in controller is being reset.
This signal turns ON in the following situations:
  (1)   When the MRST signal turns ON.
  (2)   When the MRST signal is turned ON, and the built-in controller is being reset.
  (3)   When in an emergency stop status.

| **Abbreviation** | HO | **Signal name** | In handle mode | CTST1.bitA |
|---|---|---|---|---|

This signal indicates that the handle mode has been selected.

| **Abbreviation** | MA | **Signal name** | Controller preparation complete | CTST1.bitB |
|---|---|---|---|---|

This signal notifies that the positioning controller built in the drive unit is in a status to carry out normal operation.
This signal turns ON in the following situation:
  (1)   When normal operation has begun after turning the power ON.

The signal turns OFF in the following situations:
  (1)   When the power is turned OFF.
  (2)   When an MR-J2-CT error such as a CPU error, or memory error, etc. is detected.
  (3)   When a servo error that cannot be released unless the MR-J2-CT is first turned OFF occurs.

| **Abbreviation** | SA | **Signal name** | Servo preparation complete | CTST1.bitC |
|---|---|---|---|---|

This signal indicates that the servo system is in a status to carry out normal operation. Conversely, when this signal is not ON, it shows that the servo (position control) is not operating.
This signal turns ON in the following situations:
  (1)   When the servo system diagnosis is normally completed after turning the power ON.
  (2)   After a servo alarm occurrence, when that alarm has been released by the master reset (MRST).
  (3)   When the emergency stop has been released.
  (4)   When the READY OFF (RDF) signal is turned OFF.

This signal turns OFF in the following situations:
  (1)   When the controller READY (MA) signal is turned OFF.
  (2)   When a servo alarm occurs.
  (3)   When the machine is in an emergency stop status.
  (4)   When the READY OFF (RDF) signal is turned ON.
When an MR-J2-,CT error such as a CPU error, or memory error, etc. is detected.

  **(Caution 1)** With the servo OFF (∗SVF), the servo preparation complete (SA) will not turn OFF as long as there are no separate conditions for turning the SA OFF.
  **(Caution 2)** In OFF condition (3), all I/O output points will turn OFF.

| **Abbreviation** | JSTA | **Signal name** | Automatic set position reached | CTST1.bitD |
|---|---|---|---|---|

In the automatic operation, this signal notifies that the positioning to the commanded station No. is complete. The same tolerable ON width is as set position reached is used.

This signal turns ON in the following situation:

(1) In the automatic operation mode, when the positioning to the designated station No. is complete. The signal actually turns ON before the positioning is complete, when the tolerable width is entered.

The signal turns OFF in the following situations:

(1) When the start signal is input in any of the operation modes.
(2) When the axis deviates outside the tolerable width.

**(Caution 1)** In automatic operation, this signal will not turn ON when positioning to the nearest station is carried out by the start signal OFF.

**(Caution 2)** When this signal is ON, it will not turn OFF if the same station No. index is started.

**(Caution 3)** When the positioning to the station is completed by the manual mode, if the same station No. index is started, this signal will turn ON. However, there will be no movement.

**(Caution 4)** Once turned OFF, this signal will not turn ON again even if the tolerable width is returned to.

| **Abbreviation** | JST | **Signal name** | Set position reached | CTST1.bitE |
|---|---|---|---|---|

This signal notifies that the positioning to the station position is complete.

It is ON when the machine position is at any of the station positions. The tolerable ON width is set beforehand as a parameter.

This signal turns ON in the following situations:

(1) When the positioning to the station is complete in automatic or manual operation. The signal actually turns ON before the positioning is complete, when the tolerable width is entered.
(2) When the stop position after JOG operation is the station position or within the tolerable width.
(3) When the reference point return position corresponds to those of the stop position in (2).

Other than the above conditions, this signal normally monitors the machine position, and carries out comparisons between stations. Therefore, this signal is output even when the machine moves to a station position outside the operation.

This signal turns OFF in the following situations:

(1) When the start signal is input in any of the operation modes. When the operation is started by a start signal, this signal will not turn ON, even when a station position is passed during operation.
(2) When the axis deviates outside the tolerable width.

| **Abbreviation** | NEAR | **Signal name** | Near set position | CTST1.bitF |
|---|---|---|---|---|

This signal notifies that the machine position is near the station.

It operates in the same manner as the set position (JST), but the tolerable width setting is treated separately. Generally, the tolerable width setting values are set larger than those for the set position, and a mechanical clamp operation is begun just before completion of the positioning, etc.

| **Abbreviation** | AUTO | **Signal name** | In automatic operation mode | CTST2.bit0 |
|---|---|---|---|---|

This signal indicates that the automatic operation mode has been selected.

| **Abbreviation** | MANO | **Signal name** | In manual operation mode | CTST2.bit1 |
|---|---|---|---|---|

This signal indicates that the manual operation mode has been selected.

| **Abbreviation** | JO | **Signal name** | In JOG operation mode | CTST2.bit2 |
|---|---|---|---|---|

This signal indicates that the JOG operation mode has been selected.

| **Abbreviation** | ARNN | **Signal name** | In reference point return | CTST2.bit3 |
|---|---|---|---|---|

This signal indicates that the machine is in dog-type reference point return.

| **Abbreviation** | ZRNO | **Signal name** | In reference point return mode | CTST2.bit4 |
|---|---|---|---|---|
| This signal indicates that the reference point return mode has been selected. ||||||

| **Abbreviation** | DOG | **Signal name** | Near-point dog | CTST2.bit5 |
|---|---|---|---|---|
| The input status of the near-point dog for the reference point return is output as is. This is used to confirm the near-point dog signal.<br>(The near-point dog signal is input from connector CN3.) ||||||

| **Abbreviation** | AZSO | **Signal name** | Reference point initialization mode | CTST2.bit6 |
|---|---|---|---|---|
| This signal indicates that the reference point initialization mode has been selected.<br>Before switching from another mode to the absolute position reference point initialization mode, smoothing zero (command acceleration/deceleration delay is zero) is confirmed. ||||||

| **Abbreviation** | SO | **Signal name** | In incremental feed operation mode | CTST2.bit7 |
|---|---|---|---|---|
| This signal indicates that the incremental mode has been selected. ||||||

| **Abbreviation** | AL1 | **Signal name** | Alarm 1 | CTST2.bit8 |
|---|---|---|---|---|
| This signal indicates that an alarm has occurred requiring the power to be turned ON again after the cause is removed. ||||||

| **Abbreviation** | AL2 | **Signal name** | Alarm 2 | CTST2.bit9 |
|---|---|---|---|---|
| This signal indicates that an alarm has occurred which can be released by the master reset signal after the cause is removed. ||||||

| **Abbreviation** | AL4 | **Signal name** | Alarm 4 | CTST2.bitA |
|---|---|---|---|---|
| This signal indicates that an operation alarm or absolute position alarm has occurred. ||||||

| **Abbreviation** | BAT | **Signal name** | Battery voltage low | CTST2.bitB |
|---|---|---|---|---|
| This signal indicates that the voltage of the absolute position system battery is low. ||||||

| **Abbreviation** | ABS | **Signal name** | Absolute position power OFF movement exceeded | CTST2.bitC |
|---|---|---|---|---|
| This signal indicates that the axis moved beyond the tolerable amount while the control power was OFF in the absolute position system. ||||||

| **Abbreviation** | ZSN | **Signal name** | Absolute position loss | CTST2.bitD |
|---|---|---|---|---|
| This signal indicates that the absolute position data has been lost in the absolute position system. ||||||

| **Abbreviation** | ZSF | **Signal name** | Initialization error completed | CTST2.bitE |
|---|---|---|---|---|
| This signal indicates that in the absolute position system the reference point initialization has completed normally, and that the absolute position coordinates have been established. ||||||

| **Abbreviation** | ZSE | **Signal name** | Initialization set error finished | CTST2.bitF |
|---|---|---|---|---|
| This signal indicates that the reference point initialization has not finished normally in the absolute position system. ||||||

| **Abbreviation** | STO1 to STO256 | **Signal name** | Station position 1 to 256 | CTST3.bit0 to 8 |
|---|---|---|---|---|
| This signal shows the present station No. in as a 9-digit binary.<br>This signal outputs the station position when the set position reached (JST) signal is ON, and outputs a "0" when the set position reached signal is OFF. | | | | |

| **Abbreviation** | PSW1 to 8 | **Signal name** | Position switch 1 to 8 | CTST4.bit0 to 7 |
|---|---|---|---|---|
| This signal turns ON when the axis is within the setting range of the respective position switches. | | | | |

| **Abbreviation** | PMV | **Signal name** | In positioning operation | CTST4.bit8 |
|---|---|---|---|---|
| This signal indicates that the positioning is being carried out in the pressing positioning mode operation. The positioning finishes, smoothing zero is confirmed, and the signal turns OFF. | | | | |

| **Abbreviation** | PFN | **Signal name** | Positioning complete | CTST4.bit9 |
|---|---|---|---|---|
| This signal indicates that the positioning is finished in the pressing positioning mode operation. This signal turns ON when the "In positioning operation" (PMV) turns OFF. It is held until the next start. | | | | |

| **Abbreviation** | PSI | **Signal name** | Pressing in | CTST4.bitA |
|---|---|---|---|---|
| This signal is ON while moving the set pressing amount in operation in the pressing positioning mode. | | | | |

# Chapter 6   Setup and Operation

## 6-1 Setup of servo drive unit
### 6-1-1 Parameter initialization

When starting up MR-J2-CT with a machine for the first time, initialize the parameters first. Then, set and adjust the machine specifications. To initialize the parameters, open the window on the top of the drive unit, and set the axis No. setting rotary switch to "7". Then turn the drive unit control power ON. When the drive unit LEDs change from a "dot display (..)" to an "end display (En)", the parameter initialization has been completed. (With software version C4 and below, the initialization is completed when the display changes to the "alarm display".) Set the axis No. setting rotary switch to the specified axis No., turn the drive unit control power ON again and connect with the NC. When the parameters are initialized, the absolute position data will also be initialized, so "Zero Point Initialization Incomplete (Z70 0001)" will always occur when the power is turned ON next.

Display section
The operation status and alarms are displayed.

Setting section
Axis No. setting rotary switch
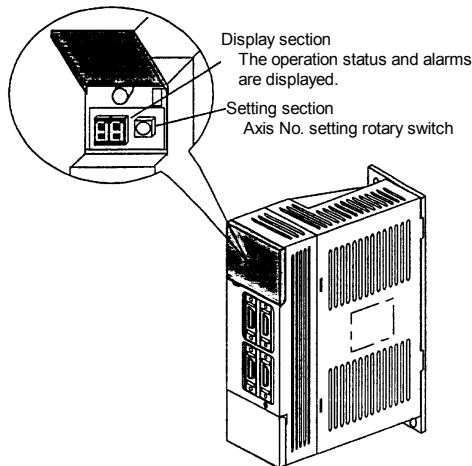
| Rotary switch setting | Set axis No. |
|---|---|
| 0 | 1st axis |
| 1 | 2nd axis |
| 2 | 3rd axis |
| 3 | 4th axis |
| 4 | 5th axis |
| 5 | 6th axis |
| 6 | 7th axis |
| 7 | Parameter initialization |
| 8 | |
| 9 | |
| A | |
| B | Setting prohibited |
| C | |
| D | |
| E | |
| F | Test operation mode |

**⚠ CAUTION**

1. Be aware that if the power is turned ON during parameter initialization (rotary switch = 7), absolute position data and all parameters will be lost.
2. The test operation mode is a mode commanded from the personal computer setup software. Commands and emergency stop signals from the NC are ignored.

### 6-1-2 Transition of LED display after power is turned ON

When the axis No. is set, and the servo drive unit power and NC power are turned ON, the servo drive unit will carry out a self-diagnosis, and the initial signal with the NC will start.

The LEDs on the front of the servo drive unit will change as shown below according to the progression of these processes.

If an alarm occurs, the alarm No. will appear on the LEDs. Refer to "Chapter 10 Troubleshooting" for details on the alarm displays.

LED display

Servo drive unit power ON

Standing by for NC power to be turned ON. | AA | NC power ON → | Ab | Servo drive unit self-diagnosis and internal initialization completed.

AC
Ad     In initial communication execution with the NC.
AE

C 1     In normal operation (servo OFF).
        • Displays the set axis No. (1st axis)

d 1     In normal operation (servo ON).
        • Displays the set axis No. (1st axis)

NC power OFF
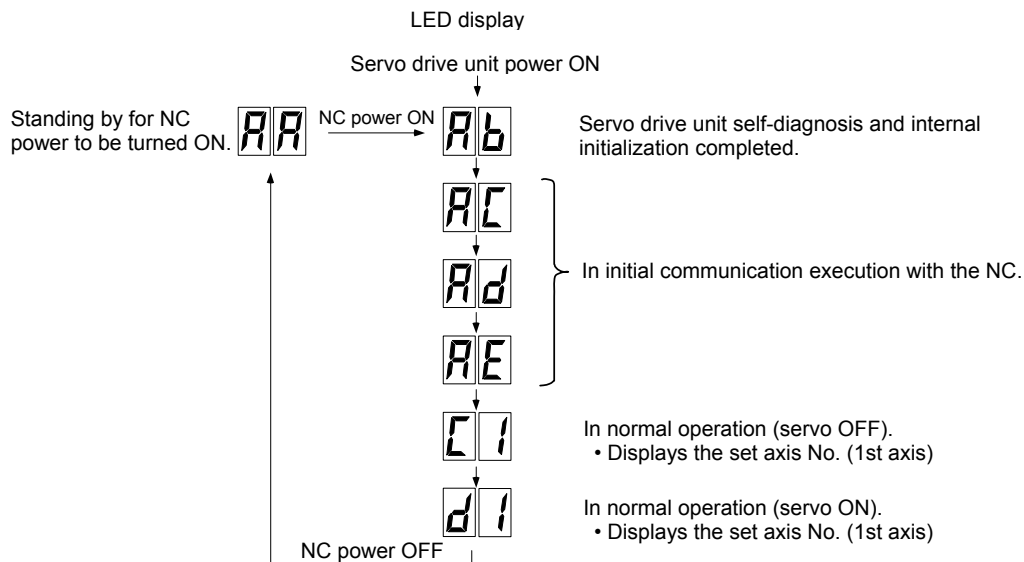
### 6-1-3　Servo parameter default settings

"Servo parameters" mainly mean the parameters (#001 to #099) related to servo control. Because the motor type and detector resolution are automatically set in the MR-J2-CT, set the parameters related to the following specifications first when setting up. The servo gain is automatically adjusted by the auto-tuning. The operation when starting may be unstable. However, the gain will gradually be tuned to the optimum value by the acceleration/deceleration operation of the servomotor. The adjusted parameters will be saved even when the power is turned OFF.

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|-----|---------|---------------|--------------|------|-------------|--------------|
| #0002 | *RTY | Regenerative option type | 0000 | | Set the regenerative resistor type when an external option regenerative resistor is used. Do not set values that have no description.<br><br>　Built-in standard<br>　regenerative resistor : 0000 (Default value)<br>　MR-RB032　　　　 : 0200<br>　MR-RB12　　　　　: 0300<br>　MR-RB32　　　　　: 0400<br>　MR-RB30　　　　　: 0500<br>　MR-RB50　　　　　: 0600 | |
| #0003 | *PC1 | Motor side gear ratio (machine rotation ratio) | 1 | | Set as an integer expressing the reduced fraction of the No. of gear teeth on the motor side and the | 1 ~ 32767 |
| #0004 | *PC2 | Machine side gear ratio (motor rotation ratio) | 1 | | No. of gear teeth on the machine side. If there are multiple gear levels, set the total gear ratio. For rotation axes, set the No. of motor rotations per one machine rotation. | 1 ~ 32767 |
| #0005 | *PIT | Feed pitch | 360 | ° (mm) | Set 360 for rotation axes. (Default value). Set the feed lead for linear axes. | 1 ~ 32767 |

#### (1)　Setting the gear ratio

Set the No. of gear teeth on the motor side in PC1, and the No. of gear teeth on the machine side in PC2. If there are multiple gear levels, set the total gear ratio in a form reduced to its lowest terms. PC2/PC1 becomes the motor speed when the axis is moved the amount set in the feed pitch parameter (PIT).

The final axis rotation becomes 360° for rotation axes. For example, with the magazine shown in the drawing at the right, one magazine cycle is 360°, and the gear ratio is the No. of motor rotations required to rotate the magazine one cycle. For the drawing at the right, the parameter default values are as follows.

　　　* PC1　= 1
　　　* PC2　= 50
　　　* PIT　= 360



Final gear vs. magazine cycle deceleration ratio ＝ 8/40 ＝ 1/5

Motor side gear

Final gear

Gear deceleration ratio ＝1/10
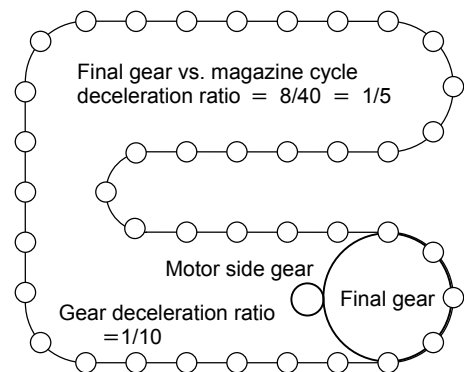
**40-magazine gear ratio setting　＝　1/50**

> **POINT**　For rotation axes, set the motor speed required to rotate the axis end one rotation (position the axis 360°) in the gear ratio.

#### (2)　Setting the feed pitch

Set the feed pitch to 360 for rotation axes. Set the ball screw lead for linear axes that use a ball screw.

For rack and pinion, etc., structures, set the movement amount per final gear (final step of the rotation system) rotation. In this case, set the deceleration ratio to the final gear for the gear ratio.

### 6-1-4   Operation parameter group default settings

#### (1)   Operation parameter group

There are eight types of parameters related to feed control such as feedrate and acceleration/deceleration time constants of the axes in each operation mode. When these are put together in a set, they are called an operation parameter group. A total of four operation parameter groups can be set. By selecting any set of operation parameter selections 1 and 2 (PR1, PR2) from the PLC and operating, the operating conditions can be changed to match the machine status each time. There are also operation modes such as stopper positioning control, in which the drive unit automatically selects the operation parameter group and controls the machine.

**Parameters determining the operation pattern**

Operation parameter group 4        PR1 = 1, PR2 = 1

Operation parameter group 3        PR1 = 0, PR2 = 1

Operation parameter group 2        PR1 = 1, PR2 = 0

Operation parameter group 1        PR1 = 0, PR2 = 0

| Parameter name | Function |
|---|---|
| Automatic operation speed | Automatic operation feedrate |
| Manual operation speed | Manual/JOG operation feedrate |
| Acceleration/deceleration time constant 1 | Linear sections of acceleration/deceleration time constant of all operation modes |
| Acceleration/deceleration time constant 2 | Non-linear sections of acceleration/deceleration time constant of all operation modes |
| Torque limit value | Torque (current) limit value |
| Excessive error detection width | Tolerable position droop (tracking delay) value |
| Set position output width | Tolerable set position signal output value |
| Near set position output width | Tolerable near set position output value |

Four sets

#### (2)   Setting the feedrate

The machine side speed is set as a feedrate in a parameter separately for automatic operation and manual operation. Because the electronic gear automatically calculates the motor speed, etc., setting can be done without being concerned with gear ratio, pitch, detector resolution, etc.
Moreover, the parameter #150 automatic operation speed operation parameter group 1 (Aspeed1) as a clamp speed (feedrate upper limit value). The axis feedrate will be limited at the value set in Aspeed1, even if a higher speed than this is set in another parameter.

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #150 | Aspeed1 | Operation parameter 1 Automatic operation speed | 5000 | °/min (mm/min) | Set the feedrate during automatic operation when each operation parameter group is selected. #150 Aspeed1 functions as the clamp value for the automatic operation speeds and manual operation speeds of all operation groups. A speed exceeding Aspeed1 cannot be commanded, even if set in the parameters. | 1~100000 |
| #158 | Aspeed2 | Operation parameter 2 Automatic operation speed | | | | |
| #166 | Aspeed3 | Operation parameter 3 Automatic operation speed | | | | |
| #174 | Aspeed4 | Operation parameter 4 Automatic operation speed | | | | |
| #151 | Mspeed1 | Operation parameter group 1 Manual operation speed | 2000 | °/min (mm/min) | Set the feedrate during manual operation and JOG operation when each operation parameter group is selected. | 1~100000 |
| #159 | Mspeed2 | Operation parameter group 2 Manual operation speed | | | | |
| #167 | Mspeed3 | Operation parameter group 3 Manual operation speed | | | | |
| #175 | Mspeed4 | Operation parameter group 4 Manual operation speed | | | | |

**POINT**   The operation parameter group 1 automatic operation speed (Aspeed1) works as the clamp speed for all operation speeds. A feedrate exceeding Aspeed1 cannot be commanded.

**(3)  Setting the acceleration/deceleration pattern and acceleration/deceleration time constant**

A constant inclination acceleration/deceleration operation is carried out for all axis movement (In the handle feed operation mode, a constant time linear acceleration/deceleration operation is carried out). As for the acceleration/deceleration time constants, set all linear acceleration/ deceleration times for clamp speed (Aspeed1) in acceleration/deceleration time constant 1 (timeN.1). When operating at speeds less than the clamp speed, the axis will accelerate/decelerate at the same inclination. At this time, set 1 (default value) in the acceleration/deceleration time constant 2 (timeN.2).

S-character (soft) acceleration/deceleration operation is carried out if any value other than 1 is set in the acceleration/deceleration time constant 2 (timeN.2). In this case, set the time of the linear part for acceleration/deceleration time constant 1, and the total time of the non-linear parts (same as the non-linear time at acceleration start and finish) for acceleration/deceleration time constant 2. Thus, the total acceleration/deceleration time becomes the sum of the acceleration/deceleration time constant 1 and acceleration/deceleration time constant 2.

In the handle feed operation mode, only acceleration/deceleration time constant 2 (timeN.2) is used, and a linear acceleration/deceleration operation is carried out.

Speed

Parameter #150
Automatic operation speed
(clamp)

Time

Linear section setting: Acceleration/deceleration time constant 1

Non-linear section setting: Half each of acceleration/deceleration time constant 2
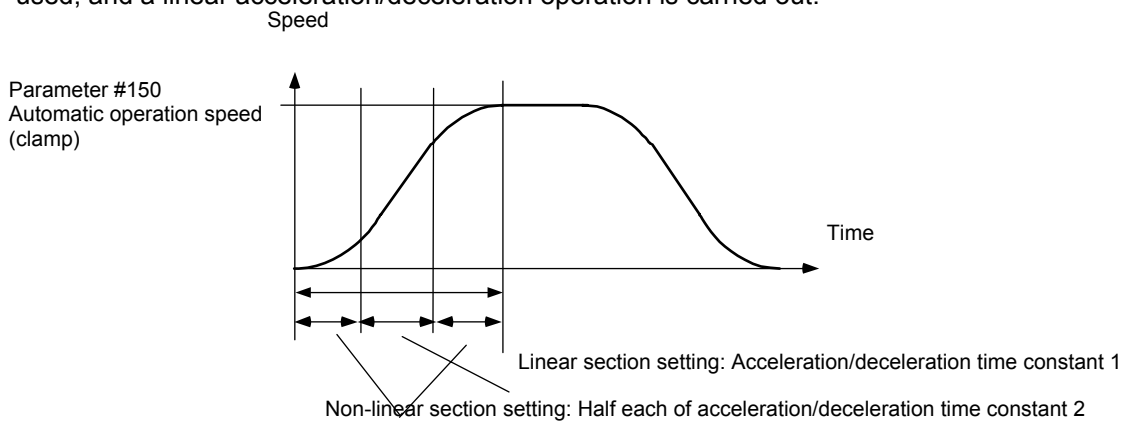
All acceleration/deceleration time is the sum of acceleration/deceleration time 1 + acceleration/deceleration time 2

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #152 | time1.1 | Operation parameter group 1 Acceleration/deceleration time constant 1 | 100 | ms | Set the linear acceleration/deceleration time for the operation parameter group 1 automatic operation speed (clamp speed) when each operation parameter group is selected. When operating at speeds less than the clamp speed, the axis will linearly accelerate/decelerate at the inclination determined above. When this is set together with acceleration/deceleration time constant 2, S-character acceleration/deceleration is carried out. In this case, set the acceleration/deceleration time of the linear part in this parameter. | 1 ~ 9999 |
| #160 | time2.1 | Operation parameter group 2 Acceleration/deceleration time constant 1 | | | | |
| #168 | time3.1 | Operation parameter group 3 Acceleration/deceleration time constant 1 | | | | |
| #176 | time4.1 | Operation parameter group 4 Acceleration/deceleration time constant 1 | | | | |
| #153 | time1.2 | Operation parameter group 1 Acceleration/deceleration time constant 2 | 1 | ms | Set the linear acceleration/deceleration time constant in the handle feed operation mode when each operation parameter group is selected. When S-character acceleration/deceleration is carried out, set the total time of the non-linear parts. When 1 is set in this parameter, linear acceleration/deceleration is carried out. | 1 ~ 9999 |
| #161 | time2.2 | Operation parameter group 2 Acceleration/deceleration time constant 2 | | | | |
| #169 | time3.2 | Operation parameter group 3 Acceleration/deceleration time constant 2 | | | | |
| #177 | time4.2 | Operation parameter group 4 Acceleration/deceleration time constant 2 | | | | |

**POINT**

Set the acceleration/deceleration time constant as the acceleration/deceleration time for the clamp speed (Aspeed1). When operating at speeds less that the clamp speed, the acceleration/ deceleration operation is carried out at the same inclination as when operating at clamp speed.

**(4)  Setting the torque limit value**

Each operation parameter group has an individual torque limit value (current limit value). When set to the default value 500, the torque is automatically limited at the maximum torque determined in the motor specifications. Operate with the default value when not especially limiting the torque.

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #154 | TL1 | Operation parameter group 1 Torque limit value | 500 | % | Set the motor output torque limit value when each operation parameter group is selected. At the default value of 500, the torque is limited at the maximum torque of the motor specifications. Set the default value when torque limiting is not especially required. The set value is the value on the assumption that rating torque is 100%. Motor current value is limited so that the motor output torque becomes the set value, but the value cannot always match the current limit value according to each motor's torque characteristics. | 1 ~ 500 |
| #162 | TL2 | Operation parameter group 2 Torque limit value | | | | |
| #172 | TL3 | Operation parameter group 3 Torque limit value | | | | |
| #178 | TL4 | Operation parameter group 4 Torque limit value | | | | |

**(5)  Setting the excessive error detection width**

Each operation parameter group has an individual excessive error alarm (S03 0052). An alarm is detected when the position droop (position command - position FB) exceeds the setting value. The standard setting value is calculated from the feedrate using the following equation. Excessive error alarms can occur easily when the load inertia is large or the auto-tuning response is lowered, so raise the excessive error detection width in these cases.

$$OD (N) = \frac{Aspeed (N)}{1000} \ (° \text{ or mm})$$

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #155 | OD1 | Operation parameter group 1 Excessive error detection width | 100 | ° (mm) | Set the excessive error detection width when each operation parameter group is selected. An excessive error alarm (S03 0052) is detected when the position droop becomes larger than this setting value. | 0 ~ 32767 |
| #163 | OD2 | Operation parameter group 2 Excessive error detection width | | | | |
| #171 | OD3 | Operation parameter group 3 Excessive error detection width | | | | |
| #179 | OD4 | Operation parameter group 4 Excessive error detection width | | | | |

**(6)  Setting the output width of signals related to the set position**

Set the respective detection widths of the set position reached (JST) and automatic set position reached (JSTA) signals that indicate that the machine positioning is completed. Also set the detection width for the near set position (NEAR) signal that indicates that the machine position is near each station.

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #156 | just1 | Operation parameter group 1 Set position output width | 0.500 | ° (mm) | The signal indicating that the machine position is at any one of the stations is the set position reached (JST) signal. During automatic operation, the automatic set position reached (JSTA) signal is detected under the same conditions. Set the tolerable values at which these signals are output when each operation parameter group is selected. These signals turn OFF when the machine position is separated from the station by more than this value. | 0.000 ~ 99999.999 |
| #164 | just2 | Operation parameter group 2 Set position output width | | | | |
| #172 | just3 | Operation parameter group 3 Set position output width | | | | |
| #180 | just4 | Operation parameter group 4 Set position output width | | | | |
| #157 | near1 | Operation parameter group 1 Near set position output width | 1.000 | ° (mm) | The signal indicating that the machine position is near any one of the station positions is the near set position (NEAR) signal. Set the tolerable values at which these signals are output when each operation parameter group is selected. These values are generally set wider than the set position output width. In terms of operations, this is related to special commands when the station selection is 0. Refer to section "6-4-3 Automatic operation." | 0.000 ~ 99999.999 |
| #165 | near2 | Operation parameter group 2 Near set position output width | | | | |
| #173 | near3 | Operation parameter group 3 Near set position output width | | | | |
| #181 | near4 | Operation parameter group 4 Near set position output width | | | | |

### 6-1-5   Setting during emergency stops

#### (1)   Setting the emergency stop

Emergency stop circuits are wired in the NC bus in the same manner as a normal feed axis servo, but in addition they are also input in the CN3 connector on the front of the drive unit. These emergency stops can be set to valid/invalid in the parameters. The parameters can be set to select whether the emergency stop for trouble occurring in an auxiliary axis extends to other auxiliary axes and feed axis servos, or whether an axis itself emergency stops for alarms occurring in other auxiliary axes or feed axis servos.



**(Caution)**
Each switch status expresses the default value status. Each parameter represents the following states.

| No. | Abbrev. | Parameter name | Explanation |
|---|---|---|---|
| #103 | ∗Emgcont | Emergency stop control | This is a HEX setting parameter. Set bits without a description to their default values. |

| bit | F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Default value | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

| bit | Meaning when "0" is set. | Meaning when "1" is set. |
|---|---|---|
| 0 | External emergency stop valid | External emergency stop invalid (default value) |
| 1 | Dynamic brake stop at emergency stop | Deceleration control stop at emergency stop |
| 2 | NC bus emergency stop input valid | NC bus emergency stop input invalid |
| 3 | NC bus emergency stop output valid | NC bus emergency stop output invalid |

⚠ **CAUTION**

1. When setting so that an emergency stop is ignored, give safety in the system consideration. PLC emergency stops (QEMG) are always valid, regardless of the parameter settings.

2. According to the connected NC model, some model may receive MR-J2-CT emergency stop and detect "EMG emergency stop LINE" if it is connected with the "NC bus emergency stop output" setting of MR-J2-CT valid. At this time, NC emergency stop may not be released even if MR-J2-CT emergency stop is released. To release the NC emergency stop, input the "NC emergency stop" signal once and then release it.

**(2)  Deceleration control during emergency stops**

The method by which the motor stops during emergency stops can be set in the parameters. Either a dynamic brake method or a deceleration control method can be selected. Consider the characteristics in the following table, and select the method appropriate for the machine being used.

| Deceleration stop method during emergency stop | Deceleration control | Dynamic brake |
|---|---|---|
| Stopping distance | A shorter stopping distance is possible than with a dynamic brake. | The stopping distance is longer than with deceleration control. |
| Deceleration torque | Because the stop is carried out using software control, the deceleration torque (deceleration time constant) can be freely set. | The deceleration torque cannot be limited. The deceleration torque also becomes smaller as the speed drops. |
| During alarm occurrence | When an alarm occurs in which motor control itself becomes impossible, the machine stops by a dynamic brake. | The machine can stop by a dynamic brake for all alarm occurrences. |
| SW | The software is interposed in the motor stop control after an emergency stop occurs (software stop). | The software is not interposed in the motor stop control after an emergency stop occurs (hardware stop). |

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #010 | EMGt | Deceleration control time constant | 500 | ms | Set the deceleration time from the clamp speed (Aspeed1). Set the same value as the acceleration/deceleration time constant for normal rapid traverse. | 0 ~ 32768 |

| | **POINT** | When a dynamic brake stop is selected, the software does not play any part in the motor stop control after the emergency stop occurs. |
|---|---|---|

## 6-2   Test operation

Operation using the following mode is also possible before the coordinate zero point (reference point) is confirmed (zero point initial setting incomplete: Z70 0001 occurring.).

### 6-2-1   Test operation

Operation of only the servo drive unit can be carried out without communicating with the NC. The connected personal computer setup software substitutes for the NC commands.
In the test operation mode, operation is possible in all operation modes except the handle mode.
(Note that automatic operation and manual operation are not possible before the reference point is set.)
Absolute position initialization can also be carried out.

#### (1)   Starting the test operation

When the rotary switch that sets the axis No. is set to F, and the power is turned ON, the machine changes to test operation mode.
When the test operation menu from the setup software is selected, and the communication is begun, a servo ON signal is automatically output, and the test operation is prepared for.

#### (2)   Operating the test operation

Operation is conducted in the following manner: In the setup software, select the operation mode, operation parameters, and other selections (in incremental feed, the feed magnification, etc.). Click on the forward run or reverse run button. A start signal will be input, and the operation will begin.

#### (3)   Test operation during normal operation

It is possible to conduct test operation with the setup software, even when normally connected to the NC.
It is possible to change from the setup software to the test operation mode.
In this case, when the test operation mode is switched to, the various signals from the NC are temporarily intercepted, and the commands from the setup software take priority. However, the following signals from the NC are valid.

| Abbreviation | Signal name |
|---|---|
| QEMG | PLC emergency stop |
| MRST | Master reset |
| *IT+, *IT− | Interlock |

---

☀ **POINT**   Refer to the "Setup Software Instruction Manual (BNP-B2208)" for information on how to use the setup software.

### 6-2-2 JOG operation

When the rotation direction is designated and the start signal is input, rotation begins in the designated direction, and continues until the start signal turns OFF. The machine immediately decelerates to a stop when the start signal turns OFF.

#### (1) Setting the JOG operation mode

Set the following signals before inputting an operation start (ST) signal. The settings are validated when the operation start signal is input.

| Abbrev. | Signal name | Explanation |
|---------|-------------|-------------|
| JOG | JOG operation mode selection | Select the JOG operation mode. "M01 0101 No operation mode" will occur if the selected mode duplicates another operation mode. Always leave this signal ON during JOG operation. |
| DIR | Rotation direction | The rotation direction can also be reversed using the parameter #102.bit3 setting. |
| PR1, PR2 | Operation parameter selection 1 and 2 | The machine is operated at the manual operation speed (Mspeed) of the selected operation group. |

#### (2) Starting the JOG operation

Turn ON the "Operation start (ST)" signal. Because this signal is treated as a status, the rotation will continue until the signal turns OFF. When the start signal turns OFF, the machine will immediately decelerate to a stop.

JOG operation mode selection (J)

Value is validated at ST ON.

Rotation direction

Operation parameter selection (PR1, 2)

Operation start (ST)

Movement command (speed command)

Output if within the range set in the parameters.

In JOG operation mode (JO)

"0" is output.

Station position (STO1 to 256)

Smoothing zero (SMZ)

Near set position (NEAR)

Set position reached (JST)

Automatic set position reached (JSTA)

Axis selection output (AX1)

Axis moving (+) (MVP)

Axis moving (−) (MVN)

---

**POINT**

1. If the position where the motor stops is coincidentally within the set position output width of a particular station, a set position reached (JST) signal and that station position (ST01 to 256) will be output.
2. In the JOG operation mode, the automatic set position reached (JSTA) signal does not turn ON even if the machine is positioned on the station.

### 6-2-3   Incremental feed operation

In this mode a constant amount of feed is executed each time a start signal is input.

**(1)   Setting the incremental feed operation mode**

Set the following signals before inputting an operation start (ST) signal. The settings are validated when the operation start signal is input.

| Abbrev. | Signal name | Explanation |
|---------|-------------|-------------|
| S | Incremental feed operation mode selection | Select the incremental feed operation mode. "M01 0101 No operation mode" will occur if the selected mode duplicates another operation mode. |
| DIR | Rotation direction | The rotation direction can also be reversed using the parameter #102.bit3 setting. |
| PR1, PR2 | Operation parameter selection 1 and 2 | The acceleration/deceleration is carried out with the acceleration/deceleration time constant of the selected operation group. |
| MP1, MP2 | Incremental feed magnification factor 1 and 2 | Select the feed amount for each time the operation is started. |

**(2)   Starting the incremental feed operation mode**

Turn ON the operation start (ST) signal. The axis will move the designated feed amount and stop, even if this signal is turned OFF during movement.

### 6-2-4   Handle feed operation

In this mode the axis feed is carried out in response to the amount of handle pulses transferred from the NC via a high-speed serial bus. The axis feed can be carried out using the pulse generator attached to new model NCs.

**(1)   Setting the handle feed operation mode**

Set the following signals.

| Abbrev. | Signal name | Explanation |
|---------|-------------|-------------|
| H | Handle feed operation mode selection | Select the handle feed operation mode. "M01 0101 No operation mode" will occur if the selected mode duplicates another operation mode.<br>The handle input is prioritized for the auxiliary axis (MR-J2-CT) by turning this signal ON. |
| PR1, PR2 | Operation parameter selection 1 and 2 | The acceleration/deceleration is carried out with the acceleration/deceleration time constant 2 of the selected operation group. In this case, constant time acceleration/deceleration is carried out. |
| MP1, MP2 | Incremental feed magnification factor 1 and 2 | Select the movement amount per handle 1 pulse (1 notch). |

**(2)   Starting the handle feed operation mode**

The handle pulse input is prioritized for the auxiliary axis (MR-J2-CT) by inputting the handle feed operation mode selection (H). Confirm the in handle feed operation mode (HO) signal before inputting the handle pulses.

Incremental feed operation mode selection (S)
Operation parameter selection (PR1, 2)
Incremental feed magnification factor (MP1, 2)
Operation start (ST)
Movement command (speed command)
In incremental feed operation mode (SO)
Smoothing zero (SMZ)

Value is validated at ST ON.
Validated only at startup

Handle feed operation mode selection (S)
Operation parameter selection (PR1, 2)
Incremental feed magnification factor (MP1, 2)
Handle pulse input
Movement command (speed command)
In handle feed operation mode (HO)
Smoothing zero (SMZ)

**Incremental feed operation**                    **Handle feed operation**

⚠ **CAUTION**   DIR signal is invalid on the handle feed operation.

## 6-3    Setting the coordinate zero point

It is necessary to determine the coordinate zero point before positioning operation. The index function built into the MR-J2-CT carries out positioning with the coordinate zero point as a reference.

> **POINT**    Refer to Chapter 7 "Absolute position detection system" for the setting method of the absolute position system coordinate zero point.

### 6-3-1    Dog-type reference point return

The dog-type reference point return is a method for establishing the coordinate zero point in an incremental system. The coordinate zero point is determined with the electrically determined reference point (machine specific point) used as a reference. This reference point is determined by the signals (near-point dog signals) turned ON/OFF by the near-point dog and limit switch.

In the motor side position detector there is a Z phase signal that is output once per rotation. Looking from the movable section of the machine driven by the motor, a Z phase signal is output for every set movement amount. The position at which this Z phase is output is called the grid. One specific point of these grid points is recognized as the electrical zero point by the servo drive unit. The dog signal is used as a means to designate/recognize which grid point is the electrical zero point in the servo drive unit.

| Electrical zero point | → | Reference point | → | Coordinate zero point |
|---|---|---|---|---|
| | | Determined by the electrical zero point and reference point shift amount (ZRNshift). The default shift amount is 0, and the electrical zero point and reference point are in the same position. | | Determined by the reference point and the offset amount. The default offset amount is 0, and the electrical zero point, reference point, and coordinate zero point are in the same position. |

#### (1)    Operation principle

The operation to determine the electrical zero point is explained below.
The dog signal is OFF when the limit switch is on the near-point dog. The dog signal is a B contact that is ON, when the limit switch is not on the near-point dog.

(1)    When the machine movable parts are moved, the dog signal limit switch is ON from the near-point dog, and the dog signal is OFF.
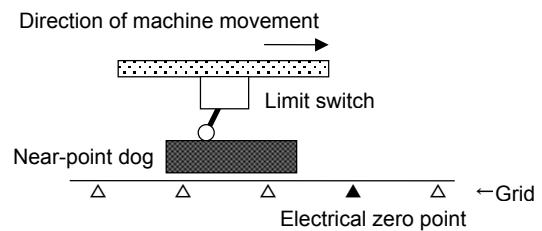


(2)    When the machine movable parts are moved further in the same direction, the limit switch leaves the dog, and the dog signal turns ON.
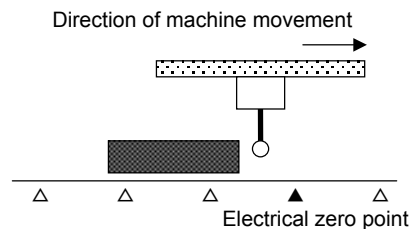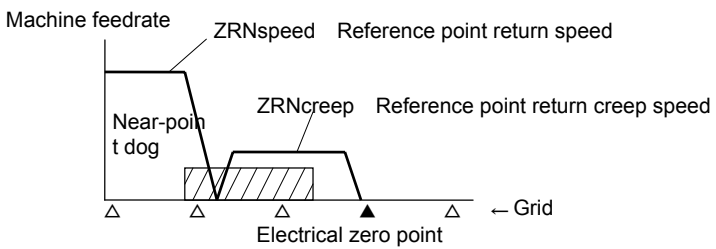


(3)    The servo drive unit recognizes the first grid point after the dog signal turns ON as the electrical zero point.



6 - 13
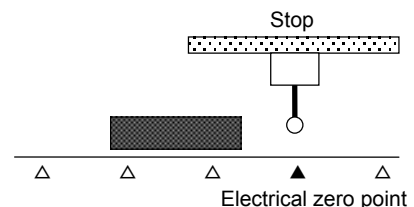
## (2)  Execution procedure

The execution procedure for dog-type reference point return is shown below.

| (1) | Initial setting | Confirm that the parameter "#101 cont1.bit D No zero point" setting is to 0 (zero).<br>**< Memo >**    When "#101 cont1 bit-D No zero point"= 1, the specification will be that there is no reference point. The machine position when the power is turned ON becomes the reference point. |
|---|---|---|
| (2) | Set the speed | Set the parameters that designate the axis feedrate during reference point return "#110 ZRNspeed Reference point return speed" and "#111 ZRNcreep Reference point return creep speed".<br>**< Memo >**    If the reference point return speed is too fast, it may not be able to decelerate fully when the limit switch is ON, and a "dog length insufficient alarm" may occur. If this alarm occurs, decrease the reference point return speed.<br><br>Machine feedrate    ZRNspeed   Reference point return speed<br>ZRNcreep   Reference point return creep speed<br>Near-point dog<br>△    △    △    ▲    △    ← Grid<br>Electrical zero point |
| (3) | Designate the reference point return direction | Determine the motor rotation direction for reference point return execution with parameter "#101 cont1.bit8 Reference point return direction".<br><br>**#101 cont1. bit8 Reference point return direction** / **Approach direction**<br>0 / Motor rotates CW and approaches<br>1 / Motor rotates CCW and approaches |
| (4) | Select the reference point mode | When the "reference point return mode (ZRN)" signal is turned ON, and the start signal is turned ON, reference point return will be executed.<br>The axis automatically stops at the electrical zero point.<br>**< Memo >**    The default settings are electrical zero point = reference point = coordinate zero point. Refer to the next section when setting the reference point and coordinate zero point to a different position than the electrical zero point. |

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #101 | ∗Cont1 | Control parameter 1 | | | This is a HEX setting parameter. Set bits without a description to their default values. | |

| bit | F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Default value | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| bit | Meaning when "0" is set. | Meaning when "1" is set. |
|---|---|---|
| 1 | High-speed zero point return after zero point establishment | Dog-type method for each zero point return operation |
| 8 | Reference point return direction (+) | Reference point return direction (−) |
| 9 | Rotation direction determined by DIR | Rotation direction in the shortcut direction |
| A | Machine reference position becomes the reference point | Electrical zero point becomes the reference position |
| D | Coordinate zero point creation valid | Zero point established at power supply ON position |
| E | Rotation direction in DIR or in the shortcut direction | Rotation direction in the random position command sign direction |
| F | Stopper direction is positioning direction | Stopper direction is for the stopper amount in the sign direction |

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #110 | ZRNspeed | Reference point return speed | 1000 | °/min (mm/min) | Set the clamp value for the feedrate when a reference point return is carried out. The feedrate becomes the manual operation speed of the parameter group selected at that time, but it is clamped by this parameter setting value. | 1~100000 |
| #111 | ZRNcreep | Reference point return creep speed | 200 | °/min (mm/min) | Set the approach speed to the reference point after dog detection during a reference point return. | 1~65535 |

### 6-3-2 Adjusting the dog-type reference point return

The procedure to adjust the reference point return should always be executed in the following order.

```
┌─────────────────┐      ┌─────────────────┐      ┌──────────────────────────┐
│ #113 *grspc     │ ───▶ │ #112 grid mask  │ ───▶ │ #114 ZRNshift            │
│ Grid space      │      │ Grid mask       │      │ Reference point shift    │
│                 │      │ amount          │      │ amount                   │
└─────────────────┘      └─────────────────┘      └──────────────────────────┘
```
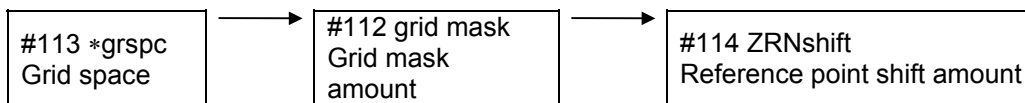
#### (1) Setting the grid spacing

The normal grid spacing is a space per rotation of the detector. When incremental system detection is used, the grid spacing per detector rotation can be pseudo-divided. Using this, the distance from leaving the dog to reaching the electrical zero point becomes shorter, and the time necessary for reference point return can be shortened.



Reference point return operation when grspc = 2 (4 divisions)
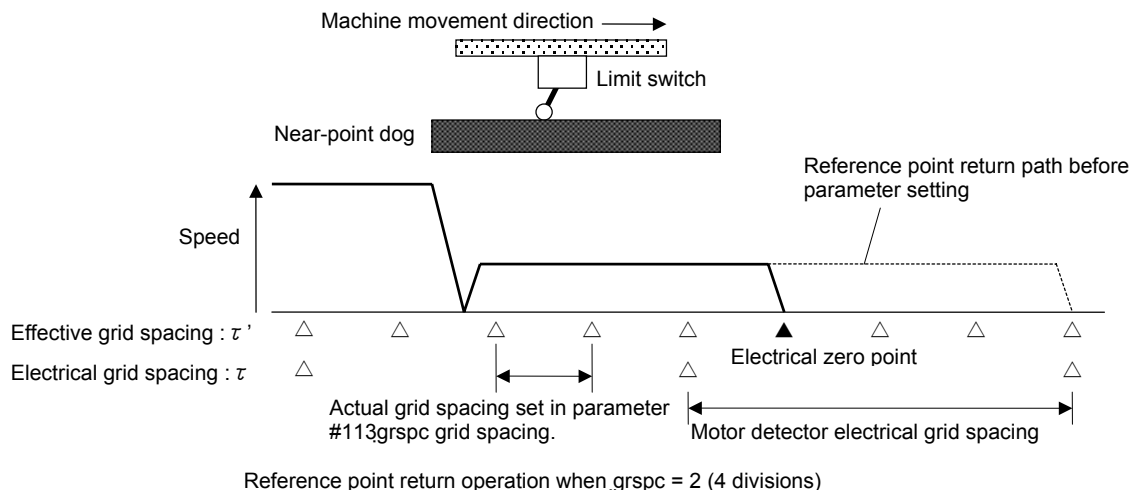
The divided grid spacing is obtained with the following expression.

Electrical grid spacing : $\tau$

$$= \frac{\text{No. of gear teeth on the motor side}}{\text{No. of gear teeth on the machine side}} \times \text{Pitch} = \text{Movement amount per motor rotation}$$

Effective grid spacing $\tau'$ $= \dfrac{\text{Electrical grid spacing } \tau}{2^n}$  (n: #113 grspc grid spacing)

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|-----|---------|----------------|---------------|------|-------------|---------------|
| #113 | *grspc | Grid spacing | 0 | $1/2^n$ divisions | Divide the grid spacing that is the conventional motor rotation movement amount into 2, 4, 8, or 16 divisions. | 0 ~ 4 |

**(2)  Setting the grid mask**
After leaving the dog, the first grid point becomes the reference point. However, if the position where the dog is left and the grid point are close, the second grid encountered may accidentally become the reference point. This is due to variation in the time the limit switch contact takes to turn OFF. Ideally, the position where the dog is left should be in the center of the grid spacing.
The dog installation can be changed and this can be adjusted. However, by pseudo-extending the dog length with the parameter "#112 grid mask Grid mask amount", the dog OFF point can be simply and ideally adjusted.
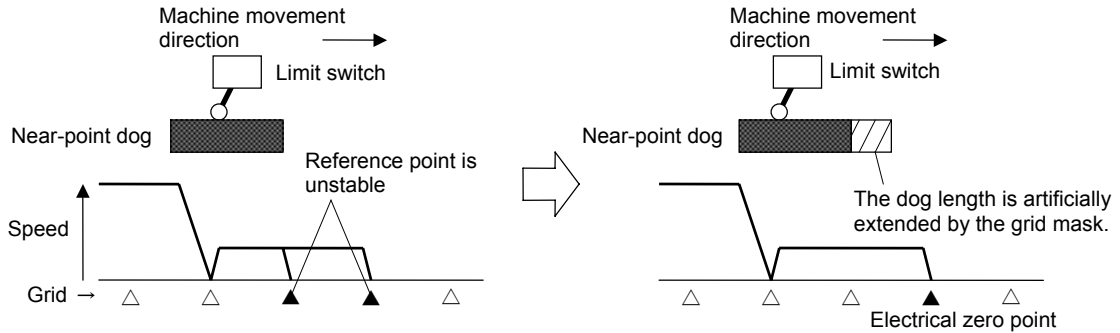
| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #112 | grid mask | Grid mask amount | 0 | 1/1000° (μm) | Set the amount that the dog is artificially extended. Set 1/2 the grid spacing as a standard. | 0 ~ 65536 |

**(3)  Setting the reference point shift amount**
To set the reference point (machine zero point) to a random position, outside the equally spaced grid points, set the shift amount in the parameter "#114 ZRNshift Reference point shift amount".
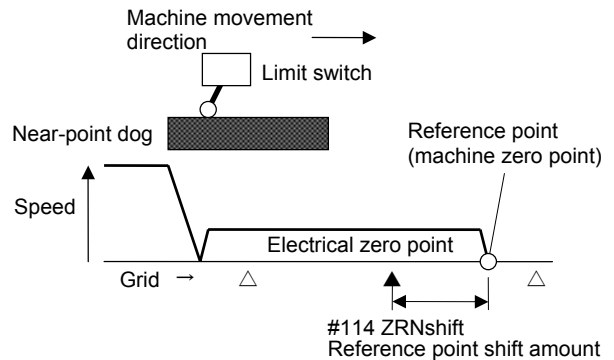
| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #114 | ZRNshift | Reference point shift amount | 0 | 1/1000° (μm) | Set the shift amount in a dog-type reference point return from the electric zero point determined on the grid to the reference point. | 0 ~ 65536 |

**(4)  Adjusting the reference point return speed**
When the near-point dog signal is turned OFF in dog-type reference point returns, the machine stops temporarily, the distance to the electric zero point is obtained, and the movement at creep speed begins. If the near-point dog is short at this time, the machine is not able to stop within the dog, and the changeover to the creep speed occurs away from the dog. Because of this, the initial grid may not be read. In this case, lower the reference point return speed, and adjust so the changeover to creep speed occurs within the dog.
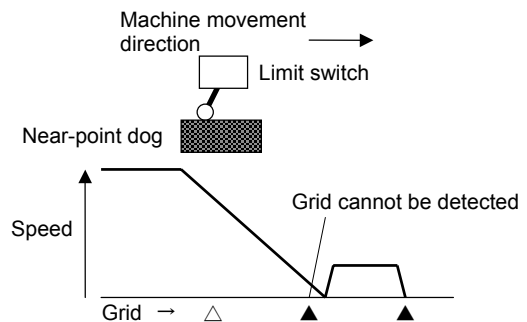
| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #110 | ZRNspeed | Reference point return speed | 1000 | °/min (mm/min) | Set the clamp value of the feedrate during a reference point return. | 1~100000 |

### 6-3-3　Memory-type reference point return

This function registers the reference point in the controller of the incremental system, and executes rapid reference point return.

Only the first reference point return after the power is turned ON is with the dog-type method. All subsequent returns after the first time are carried out with the memory method. Set parameter "#101 Cont1.bit1" to "1" to have the machine carry out dog-type reference point returns subsequent to the first return also.

| #101 Cont1.bit1 | Explanation |
|---|---|
| 0 | A dog-type reference point index operation is carried out before the reference point is determined (first time), but after the reference point is determined positioning to the reference point is carried out at high speed (without being clamped at the ZRNspeed). |
| 1 | For reference point return operations, reference point index operations are carried out each time with the dog-type method regardless of the reference point determination. |

### 6-3-4　Mode with no reference point

In this mode the position when the machine is turned ON in the incremental system becomes the reference point.

It can be changed by the parameter "#101 Cont1.bit D.

| #101 Cont1.bit D | Explanation |
|---|---|
| 0 | A dog-type reference point return operation is required to determine the reference point. |
| 1 | The position where the power was turned ON becomes the reference point. A dog-type reference point return operation is not required. |

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #101 | ∗Cont1 | Control parameter 1 | | | This is a HEX setting parameter. Set bits without a description to their default values. | |

| bit | F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Default value | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| bit | Meaning when "0" is set. | Meaning when "1" is set. |
|---|---|---|
| 1 | High-speed zero point return after zero point establishment | Dog-type method for each zero point return operation |
| 8 | Reference point return direction (+) | Reference point return direction (−) |
| 9 | Rotation direction determined by DIR | Rotation direction in the shortcut direction |
| A | Machine reference position becomes the reference point | Electrical zero point becomes the reference position |
| D | Coordinate zero point creation valid | Zero point established at power supply ON position |
| E | Rotation direction in DIR or in the shortcut direction | Rotation direction in the random position command sign direction |
| F | Stopper direction is positioning direction | Stopper direction is for the stopper amount in the sign direction |

## 6-4   Positioning operations by the station method

This method equally divides one rotation of the rotation axis (360°) and uses the respective division points as positioning targets.

These equally divided respective points are called stations, and are automatically assigned station Nos. in order from the one nearest to the reference point (zero point).

### 6-4-1   Setting the station

#### (1)   Setting the No. of stations

Set the No. of equal divisions of one rotation (360°) of the rotation axis (the No. of stations) in the parameter "#100 station No. of Indexing stations". The No. of stations is an integer from 2~360. Set station 1 in the reference point, and assign the station Nos. from station 2 onwards in order in the motor CW (forward run) direction.
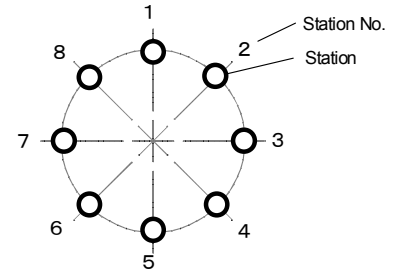
**Example of stations determined with 8 equal divisions**

#### (2)   Setting the station offset

By setting the distance between the reference point and the station No. "1" position (station offset amount), the position of all stations can be shifted.

When the offset amount is 0 (zero), the reference point becomes the station No. "1" position.

Set the station offset amount in parameter "#115 ST. offset Station offset".

Each station is automatically arranged in equal spacing.

---
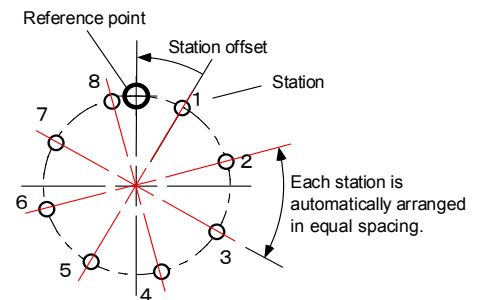
💡 **POINT**

In the dogless method absolute position detection system, the coordinate zero point is determined first, then the reference point is determined by the parameter (the opposite for dog-type). Consequently, even if the station offset is set, the coordinate zero point (station 1 position) will not shift, and the reference point side will shift. In this case, shift the coordinate zero point in the "#116 ABS Base Absolute position zero point" setting.

**(3)  Setting the station No. automatic assignment direction**

The station No. assignment direction can be selected with parameters.

| #102 Cont1.bit3 | Explanation |
|---|---|
| 0 | Assign the station Nos. in the motor rotation CW direction. When forward run is selected in rotation direction (DIR), the motor rotates in the CW direction (in the direction of increasing station Nos.). |
| 1 | Assign the station Nos. in the motor rotation CCW direction. When forward run is selected in rotation direction (DIR), the motor rotates in the CCW direction (in the direction of increasing station Nos.). |

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #100 | ∗station | Index No. of stations | 2 | | Set the No. of stations. In linear axes, the No. of divisions = No. of stations − 1. | 2 ~ 360 |
| #102 | ∗Cont2 | Control parameter 2 | | | This is a HEX setting parameter. Set bits without a description to their default values. | |
| #115 | ST.offset | Station offset | 0.000 | ° (mm) | Set the distance (offset) from the reference point to station 1. | −99999.999 ~ 9999.999 |

For #102 ∗Cont2:

| bit | F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Default value | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |

| bit | Meaning when "0" is set. | Meaning when "1" is set. |
|---|---|---|
| 1 | Error not corrected at servo OFF | Error corrected at servo OFF |
| 2 | Linear axis | Rotation axis |
| 3 | Station assignment direction CW | Station assignment direction CCW |
| 4 | Uniform index | Non-uniform index |
| 5 | DO channel standard assignment | DO channel reverse assignment |
| 6 | 2-wire detector communication | 4-wire detector communication |
| 7 | Incremental detection | Absolute position detection |

### 6-4-2 Setting linear axis stations

**(1) For uniform assignment**

In linear axes, determine the spacing between stations from the stroke length and No. of stations, and assign stations at uniform spacing. Station 1 is assigned to the coordinate zero point (coordinate position = 0). Set the station Nos. in order following the assignment direction parameter (#102.bit3). Thus, the final station is set at the coordinates separated from station 1 by only the linear axis stroke length (#104 tleng).

#102 Cont2.bit3 station assignment direction

Coordinate zero point    Reference point

Station No.    1    2    3    4    5    6    7    8

#115 ST.offset

Station offset

#104 tleng linear axis stroke length
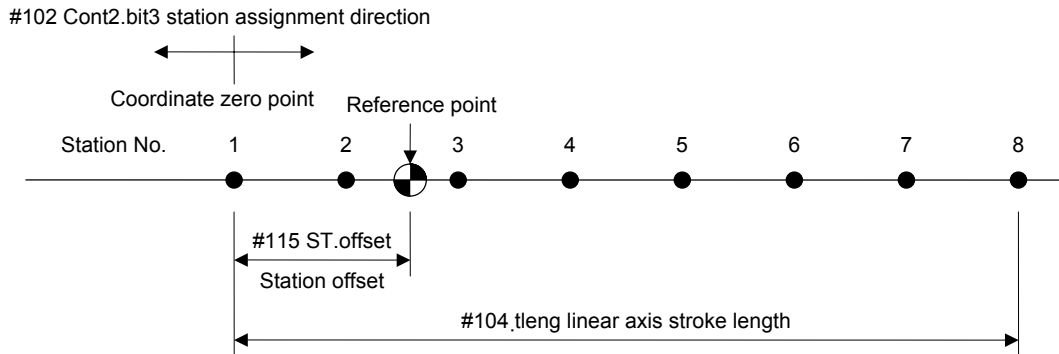
Linear axis when the No. of stations = 8 (No. of divisions is 7)

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #100 | *station | Index No. of stations | 2 | | Set the No. of stations. In linear axes, the No. of divisions = No. of stations − 1. | 2 ~ 360 |
| #102 | *Cont2 | Control parameter 2 | | | This is a HEX setting parameter. Set bits without a description to their default values. | |
| #104 | *tleng | Linear axis stroke length | 100.00 | mm | Set the movement stroke length for linear axes. This is meaningless when setting non-uniform assignments or commanding random positions. | 0.001 ~ 9999.999 |
| #115 | ST.offset | Station offset | 0.000 | ° (mm) | Set the distance (offset) from the reference point to station 1. | −99999.999 ~99999.999 |

| bit | F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Default value | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |

| bit | Meaning when "0" is set. | Meaning when "1" is set. |
|---|---|---|
| 1 | Error not corrected at servo OFF | Error corrected at servo OFF |
| 2 | Linear axis | Rotation axis |
| 3 | Station assignment direction CW | Station assignment direction CCW |
| 4 | Uniform index | Non-uniform index |
| 5 | DO channel standard assignment | DO channel reverse assignment |
| 6 | 2-wire detector communication | 4-wire detector communication |
| 7 | Incremental detection | Absolute position detection |

**POINT**

Set the distance from the reference point (#116 ABS base absolute position zero point) after determining the reference point in the absolute position system, and determine the linear coordinate zero point (station 1).

The reference point is not especially used in the coordinate zero point creation process. However, by setting "0" (default value) in the #115 ST.offset station offset, it is generally used as "reference point = coordinate zero point." In this case, the reference point return operation becomes a positioning operation to the coordinate zero point.

**CAUTION**

When the station offset (#115 ST.offset) is set, the coordinates of all stations move only the setting value.

**(2)  For non-uniform assignment**
When the required positioning coordinates are not uniformly spaced, set the station positions at the respective coordinate positions. Station 1 is assigned to the coordinate zero point (coordinate position = 0). Up to 9 stations including station 1 can be assigned to random coordinates. This can also be used for rotation axes.
Set parameter "#102 cont2 control parameter 2 bit.4" to "1", select non-uniform assignment, and set the coordinate values of stations 2 to 9 in "#190 stops 2 to #197 stops9".
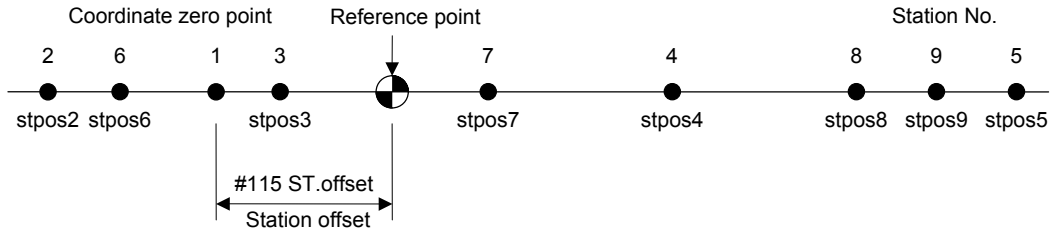


Up to 9 stations can be set (station 1 is fixed at the coordinate zero point)

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #190 | stpos2 | Station 2 coordinate value | 0.000 | ° (mm) | Set the coordinate value of each station when non-uniform assignment is selected. The station 1 coordinate value is fixed at 0.000 (machine coordinate zero point). | −99999.999 ~99999.999 |
| #191 | stpos3 | Station 3 coordinate value | | | | |
| #192 | stpos4 | Station 4 coordinate value | | | | |
| #193 | stpos5 | Station 5 coordinate value | | | | |
| #194 | stpos6 | Station 6 coordinate value | | | | |
| #195 | stpos7 | Station 7 coordinate value | | | | |
| #196 | stpos8 | Station 8 coordinate value | | | | |
| #197 | stpos9 | Station 9 coordinate value | | | | |

**POINT**

1. Setting is also possible for rotation axes.
2. The station Nos. do not have to be arrayed in increasing order.
3. Commands are designated with the station Nos. (1 to 9), in the same manner as normal indexing.
4. Station No. 0 designated special feed commands cannot be used.
5. If the required positioning coordinates exceed 9 locations, carry out positioning with a random point feed command.

**⚠ CAUTION**

1. The coordinates of all stations move only the setting value when the station offset (#115 ST.offset) is set, even if setting non-uniform assignments.

2. If the coordinate setting of two or more stations duplicates, the smallest station number that falls under the duplication is output when axes stop around the station besides the automatic operation. In addition, if the current position is at the same distance from plural stations, the smallest station number that falls under the case is output as the same manner. When coordinates of one station approached the other one very much, the nearer station number is output.

### 6-4-3   Automatic operation

In this operation mode the automatic positioning is carried out to the designated station No. When the station No. is designated and the operation start is input, positioning is carried out to the station of the designated No. When the positioning is completed, each of the following signals are output: Automatic set position reached (JSTA), Set position reached (JST), Near set position (NEAR), and the station No. (STO1 to STO256). Shortcut rotation direction or direction rotation can be selected using the parameters.

**(1)  Setting the automatic operation mode**

Set the following signals before inputting an operation start signal. The settings are validated when the operation start signal (ST) is input.

| Abbrev. | Signal name | Explanation |
|---------|-------------|-------------|
| AUT | Automatic operation mode selection | Select the automatic operation mode. "M01 0101 No operation mode" will occur if the selected mode duplicates another operation mode. Always leave this signal ON during automatic operation. |
| DIR | Rotation direction | Set the station No. assignment direction to "standard". This is meaningless for shortcut rotation setting. |
| PR1, PR2 | Operation parameter selection 1 and 2 | The operation is carried out with the automatic operation speed (Aspeed) and acceleration/deceleration time constant (timeN.1, timeN.2) of the selected operation group. |
| ST1 ~ ST256 | Station selection 1 to 256 | Set the station No. to which the positioning is carried out. Setting to "0" will result in a special command. |

**(2)  Starting the automatic operation mode**

Start the operation by turning ON the operation start (ST) signal. The operation start is held until positioning is completed.

Automatic operation mode selection (AUT)
Value is validated at ST ON.
Rotation direction (DIR)
Operation parameter selection (PR1, 2)
Station selection (ST1 to 256)

Operation start (ST)

Movement command (speed command)

Automatic operation mode selection (AUTO)
"0" is output.    "0" is output.
Station position (STO1 to 256)
Smoothing position (SMZ)

Near set position (NEAR)

Set position reached (JST)

Automatic set position reached (JSTA)
Settling time

Axis selection output (AX1)

Axis moving (+) (MVP)

Axis moving (−) (MVN)

| | |
|---|---|
| **POINT** | 1. A settling time is required from when the movement commands become zero (SMZ=1) until the positioning is completed. The settling time will lengthen if a set position output width narrower than required is set, so set the required positioning accuracy in the set position output width.<br>2. If the start signal is turned OFF during positioning, the positioning will be carried out to the nearest station. In this case, an automatic set position reached (JSTA) signal will not be output. |

| | |
|---|---|
| **⚠ CAUTION** | The control axis rotation direction is determined by a combination of the following: Operation mode, input control signal "rotation direction (DIR)", parameter "#101 cont1 control parameter 1.bit9 rotation direction shortcut", and "#102 cont2 control parameter 2. bit3 station assignment direction CCW". At operation start, pay careful attention to the motor rotation direction. When operating the servomotor for the first time, the motor should be operated as a single unit to confirm the operation, etc. |

**(3)   Designating the shortcut rotation control**
This function automatically judges the direction with the least rotation when positioning to a station in automatic operation.
When the shortcut rotation control function is valid, the axis rotates in the direction with the fewest No. of motor rotations, and positioning is carried out. Thus, the axis does not rotate over 180 degrees.

**(4)   Special station No.**
A special operation for one station feed is carried out when station No. 0 is designated and a start signal is input. At this time, the operation will differ depending upon whether the machine position is inside or outside the "near" range.

| Station No. | Machine position at start | #101 Cont1.bit9 | Positioning operation | Explanation drawing |
|---|---|---|---|---|
| 0 | Inside the "near" range | – | Positioning is carried out to the next station in the designated rotation direction. | Fig. 1 |
| | Outside the "near" range | 1 | Positioning is carried out to the nearest station in the shortcut rotation direction. | Fig. 2 |
| | | 0 | Positioning is carried out to the nearest station in the designated rotation direction. | Fig. 3 |

**(a) For rotary axes**
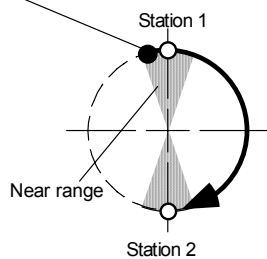


**Fig. 1**       **Fig. 2**       **Fig. 3**

**(b) For linear axes**



Positioning is carried out to the nearest station in the designated direction when starting from the neighborhood outside.

#101 tleng
(Stroke length of linear axis)

Positioning is carried out to the next station in the designated direction when starting from the neighborhood inside.

No travel will be given if the current position is more than one station far from the ends (ST1 or ST6).
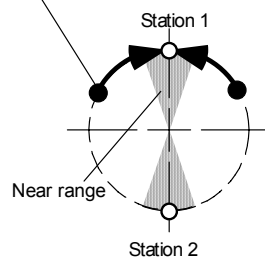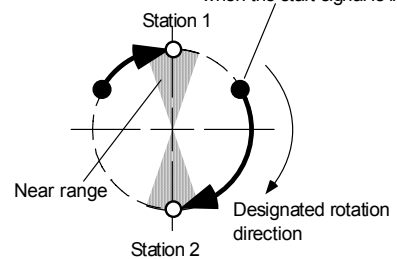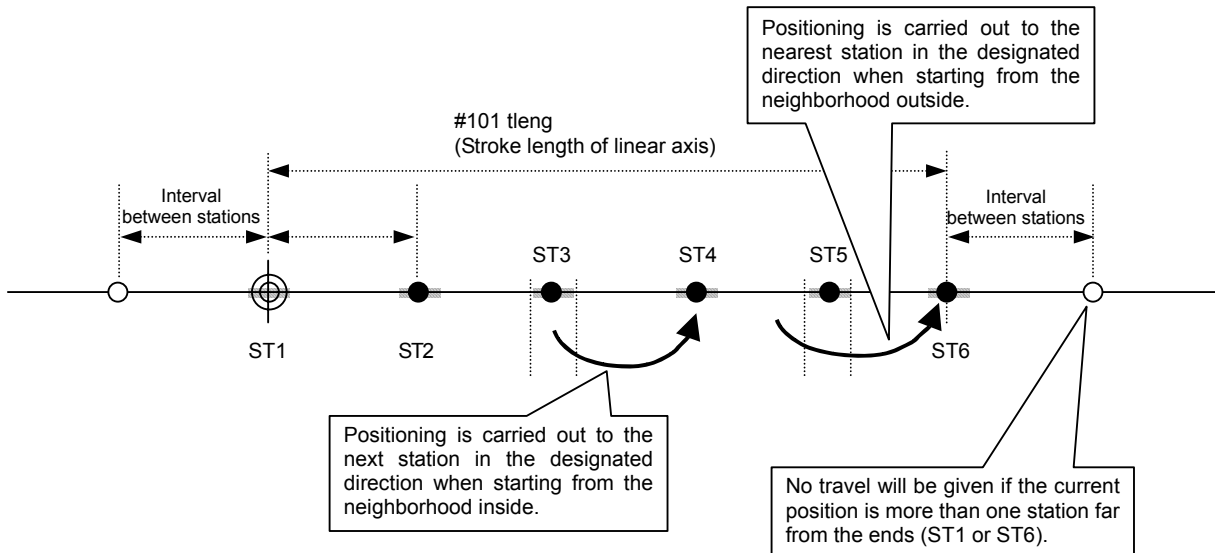
### (5) Random position command operation

In this mode the positioning coordinates are directly commanded from the PLC in 0.001° (mm) units, and positioning is carried out to a random position other than a station. In addition to the settings during normal automatic operation, set the following signals before inputting an operation start signal.

For rotation axes, when #101 Cont1.bitE = 1 is set to "1", the axis rotates in the sign direction of the random position command, and positioning is carried out to coordinates having a plus value separate from the rotation sign. If a command exceeding 360° is issued, the integer expressing "command value/360" becomes the No. of rotations, and the fraction becomes the positioning coordinates.

| Abbrev. | Signal name | Explanation |
|---|---|---|
| STS | Random point feed command valid | The positioning position input from the PLC is validated. Always turn ON during the random position command operation. |

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #101 | ∗Cont1 | Control parameter 1 | | | This is a HEX setting parameter. Set bits without a description to their default values. | |

| bit | F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Default value | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| bit | Meaning when "0" is set. | Meaning when "1" is set. |
|---|---|---|
| 1 | High-speed zero point return after zero point establishment | Dog-type method for each zero point return operation |
| 8 | Reference point return direction (+) | Reference point return direction (−) |
| 9 | Rotation direction determined by DIR | Rotation direction in the shortcut direction |
| A | Machine reference position becomes the reference point | Electrical zero point becomes the reference position |
| D | Coordinate zero point creation valid | Zero point established at power supply ON position |
| E | Rotation direction in DIR or in the shortcut direction | Rotation direction in the random position command sign direction |
| F | Stopper direction is positioning direction | Stopper direction is for the stopper amount in the sign direction |

> **POINT**
>
> 1. When operation start signal (ST) was turned OFF in the middle of positioning by an arbitrary point feed command, the axes decelerate to stop immediately.
> 2. In the case of an arbitrary point feed command, "automatic arrival at rated position (JSTA)" signal, "arrival at rated position (JST)" signal, and "rated position around (NEAR)" signal are output.
> 3. When "arbitrary point feed command effective" signal (STS) was turned OFF in the middle of positioning by an arbitrary point feed command, the positioning will be continued. However, as for the output signals (JSTA,JST,NEAR) that are related to the rated position, they changes to be output by a normal station method. Therefore, keep the "arbitrary point feed command effective" signal (STS) an "ON" state till positioning completion.

### 6-4-4  Manual operation

In this operation mode, for the rotary axis, the axis is moved only while the operation start signal is being input. Positioning is carried out to the nearest station after the operation start signal turns OFF. When the positioning is completed, the following signals are output: Set position reached (JST), Near set position (NEAR), and the station No. (STO1 to STO256).

#### (1)  Setting the manual operation mode

Set the following signals before inputting an operation start signal. The settings are validated when the operation start signal (ST) is input.

| Abbrev. | Signal name | Explanation |
|---|---|---|
| MAN | Manual operation mode selection | Select the manual operation mode. "M01 0101 No operation mode" will occur if the selected mode duplicates another operation mode. Always leave this signal ON during manual operation. |
| DIR | Rotation direction | Set the station No. assignment direction to "standard". |
| PR1, PR2 | Operation parameter selection 1 and 2 | The operation is carried out with the manual operation speed (Mspeed) and acceleration/deceleration time constant (timeN.1, timeN.2) of the selected operation group. |

#### (2)  Starting the manual operation mode

Start the operation by turning ON the operation start (ST) signal. The operation start is held until positioning is completed.



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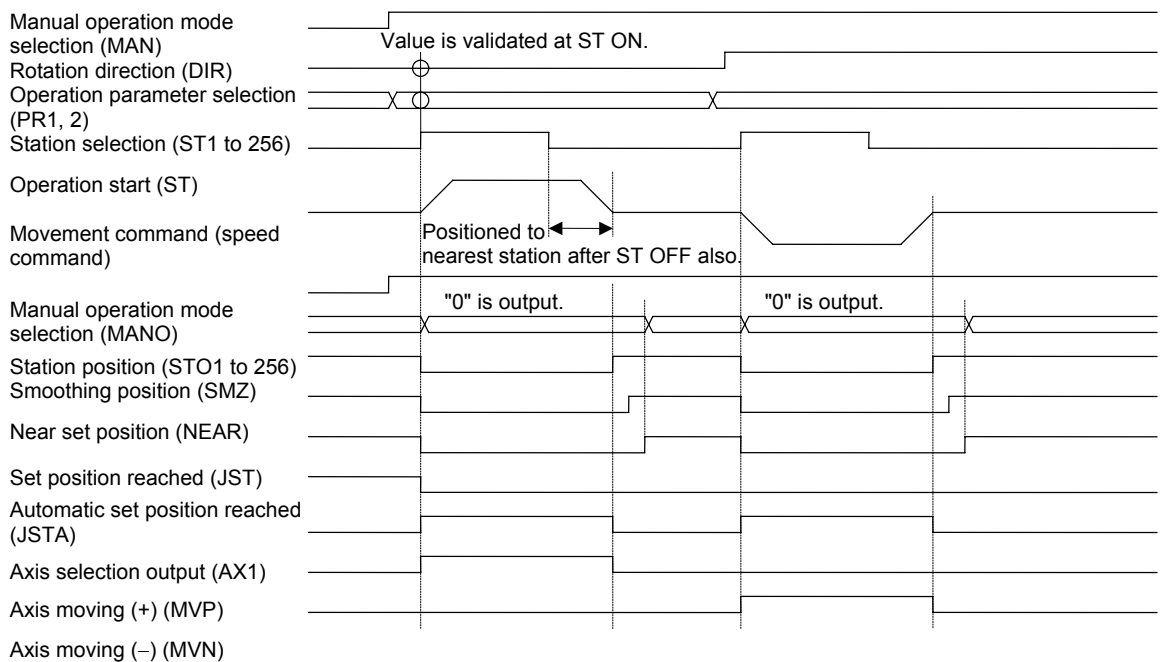
💡 **POINT**  In the manual operation mode, the automatic set position reached (JSTA) signal does not turn ON, even when positioning is carried out to a station.

---

⚠ **CAUTION**  This function is effective for only the rotary axis.
In the case of a linear axis, use a JOG function.

## 6-5    Stopper positioning operation

In this operation mode, positioning is carried out with the axis presses against a stopper, etc.
This operation mode is an expansion function of random position designation automatic operation. Besides normal random point positioning, stopper operation and torque control are automatically carried out.

| | | |
|---|---|---|
| 💡 | **POINT** | The station method is not used in stopper positioning operations. Commands are carried out with random position command operations. |

### 6-5-1    Operation sequence

#### (1)    Setting the stopper positioning operation mode

Set the following signals before the operation start signal. When the stopper positioning command valid (PUS) signal is turned ON, and random position positioning is carried out to the stopper starting coordinates, stopper positioning is carried out after positioning is completed, following the value set in the parameters.

| Abbrev. | Signal name | Explanation |
|---|---|---|
| AUT | Automatic operation mode selection | Select the automatic operation mode. "M01 0101 No operation mode" will occur if the selected mode duplicates another operation mode. |
| PUS | Stopper positioning command valid | Select the stopper positioning mode. When this signal is turned ON and the positioning is started, execute the stopper positioning sequence. |

| | | |
|---|---|---|
| 💡 | **POINT** | 1. The rotation direction (DIR) signal setting is meaningless.<br>2. The operation parameter group to be used is automatically selected in each operation. |

## (2)  Explanation of operation in the stopper positioning operation mode
The stopper positioning operation is as follows.
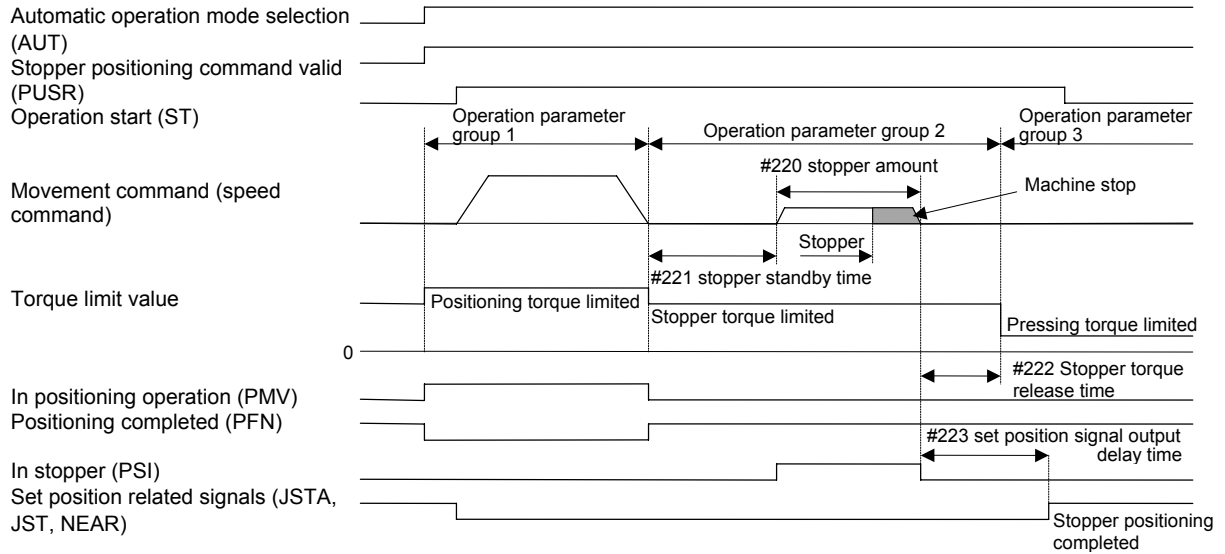


| Operation | Explanation | Related parameter |
|---|---|---|
| ① Stopper starting coordinate positioning | When the operation start (ST) signal is input in the stopper positioning mode, positioning is carried out to the command coordinates (stopper starting coordinates). This operation is carried out with operation parameter group 1.<br>A positioning operation using shortcut control can be carried out by parameter setting.<br>During positioning, the In positioning operation (PMV) signal is output. The positioning completed (PFN) signal turns ON when the positioning is completed. | < Operation group 1 > |
| ② Stopper standby | After the positioning operation deceleration stops, the operation will stop for the time set in the parameter (#221 stopper standby time). If the parameter value is 0, the operation will immediately move to the next stopper operation after deceleration stopping. | < Operation group 2 ><br>#221 pusht1 |
| ③ Stopper | After stopper standby, the stopper operation is executed. The stopper amount is set in the parameters (#220 stopper amount). At this time, the positioning operation is carried out using the speed, time constant, and torque limit value of operation parameter 2. During stopper operation, an in stopper (PSI) signal is output. | < Operation group 2 ><br>#220 push |
| ④ Pressing torque changeover | After the stopper operation finishes and the parameter (#222 stopper torque release time) time has lapsed, the torque changes over to the pressing torque. The pressing torque is the torque limit value of operation parameter group 3. | < Operation group 3 ><br>#222 pusht2 |
| ⑤ Set position related signal output | The automatic set position reached (JSTA) signal and the position reached signal are turned ON after the axis stops within the range set by parameter (#172 just3), the stopper operation is completed and the time set in the parameter (#223 set position signal output delay time) has lapsed. The near set position (NEAR) signal is turned ON after the axis stops within the range set by parameter (#173 near), the stopper operation is completed and the time set in the parameter (#223 set position signal output delay time) has lapsed. This status is held until the rising edge of the next operation start signal. | < Operation group 3 ><br>#172 just3<br>#173 near3<br>#223 pusht3 |

**POINT**

1. Set point related signals (automatic set position, set position, and near set position) are output for pressing positions. At that time, operation parameter group 3 becomes valid.
2. After the pressing is completed, and the pressing torque limit has been switched, this torque limit value (TL3) will be held until the next operation start (ST) startup, or until the pressing positioning command valid (PUSR) is turned OFF.
3. The station position (STO1 to 256) normally outputs as 0.
4. The manual mode cannot be selected in the pressing positioning command mode. When the operation start is turned ON with the manual mode, an operation error "M01 0164" will result. It is possible to select other operation modes.
5. If the start signal is turned OFF before a series of operations finishes, a deceleration stop will occur at that position. At that time, the automatic set position signal will not turn ON. If this happens during positioning, the positioning complete signal also will not turn ON.

### 6-5-2　Setting the parameters

The stopper positioning operation method can be selected using the parameter settings.

**(1)　Method for positioning to the stopper starting coordinates**

The method for positioning for rotation axes can be selected from the following three methods by parameter setting.

| Positioning method | #101 Cont1.bit9 | #101 Cont1.bitE | Explanation |
|---|---|---|---|
| Shortcut invalid | 0 | 0 | The command coordinates are absolute position coordinates, handled within 360°. The positioning direction is that which does not cross 0°. |
| Shortcut valid | 1 | 0 | The command coordinates are absolute position coordinates, short cut rotation is executed and positioning is carried out to those coordinates. Even commands of 360°. or more will result in positioning within 180°. If the movement amount is 180°, positioning is in the (+) direction. |
| Rotation direction designation | Meaningless | 1 | The command sign expresses the rotation direction, and positioning is carried out as an absolute position to a value having a plus value separate from the rotation sign. If the commanded coordinates exceed 360.000, the axis will move one rotation or more. For the movement amount in this case, the integer expressing "command value/360" becomes the No. of rotations, and the fraction becomes the positioning coordinates. For example, a command of $-400.000$ will result in positioning of one rotation in the $(-)$ direction from the current position, to a position of 40.000. Note that only when the command value is $\pm360.000$ is the command handled as $\pm0.000$. |

**(2)　Setting the stopper direction**

The stopper operation is automatically started after the positioning to the stopper starting coordinates is completed. The operation direction can be selected from one of the two following methods by parameter setting.

| Stopper direction | #101 cont1.bitF | Explanation |
|---|---|---|
| Positioning direction | 0 | The stopper is carried out in the same direction as the positioning to the stopper starting coordinates. |
| Parameter direction | 1 | The stopper direction is fixed at the same direction as the stopper amount parameter sign. |

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #101 | ∗Cont1 | Control parameter 1 | | | This is a HEX setting parameter. Set bits without a description to their default values. | |

| bit | F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Default value | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| bit | Meaning when "0" is set. | Meaning when "1" is set. |
|---|---|---|
| 1 | High-speed zero point return after zero point establishment | Dog-type method for each zero point return operation |
| 8 | Reference point return direction (+) | Reference point return direction $(-)$ |
| 9 | Rotation direction determined by DIR | Rotation direction in the shortcut direction |
| A | Machine reference position becomes the reference point | Electrical zero point becomes the reference position |
| D | Coordinate zero point creation valid | Zero point established at power supply ON position |
| E | Rotation direction in DIR or in the shortcut direction | Rotation direction in the random position command sign direction |
| F | Stopper direction is positioning direction | Stopper direction is for the stopper amount in the sign direction |

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #220 | push | Stopper amount | 0.000 | ° (mm) | Set the command stroke during the stopper. | 0.000 ~ 359.999 |
| #221 | pusht1 | Stopper standby time | 0 | ms | Set the standby time from the stopper starting coordinate positioning to the operation start. | 0~9999 |
| #222 | pusht2 | Stopper torque release time | 0 | ms | Set the time from the completion of the stopper operation to the changeover of the pressing torque. | 0~9999 |
| #223 | pusht3 | Set position signal output delay time | 0 | ms | Set the time from the completion of the stopper operation to the output of the automatic set position reached (JSTA), set position reached (JST), and near set position (NEAR) signals. | 0~9999 |

## 6-6    Machine compensation and protection functions

### 6-6-1    Backlash compensation

This function compensates the error (backlash) in the machine system when the movement direction is reversed. When the axis movement direction is reversed, the compensation amount set in the parameter is automatically added. The compensation amount is not added to the machine position coordinates. This function compensates the actual machine position.
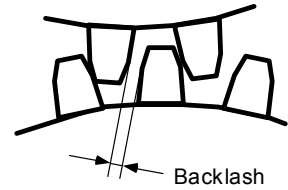
Backlash

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|-----|---------|----------------|---------------|------|-------------|---------------|
| #130 | backlash | Backlash compensation amount | 0 | 1/1000° (μm) | Set the backlash compensation amount. | 0 ~ 9999 |

### 6-6-2    Interlock function

This function interrupts the axis movement with a signal input, and immediately causes the servomotor to deceleration stop. For feed in the plus direction, the axis movement is interrupted and the motor is deceleration stopped when the interlock (+) (IT+) is turned ON. For feed in the plus direction, the same occurs when the interlock (−) (IT−) is turned ON (B contact). The movement will start again when the interlock is turned OFF. The speed and acceleration/deceleration time constant at this time follows the setting of the selected operation parameter group.

Operation start (ST)

Rotation direction (DIR)

Interlock (+) (IT+)

Interlock (−) (IT−)

Axis movement (speed FB)
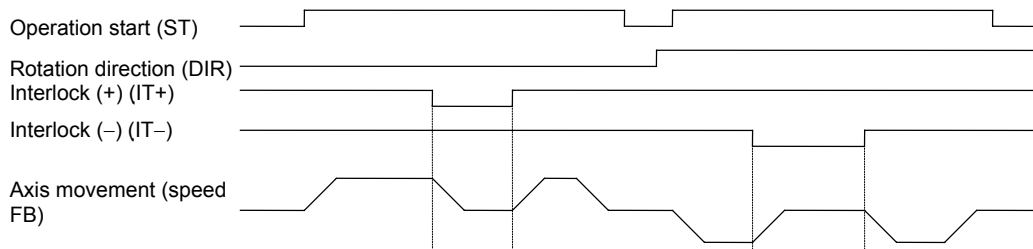
### 6-6-3   Soft limit

For linear axes, this function prevents the machine collision to the machine end by setting the moveable range. Commands exceeding the soft limit points cannot be issued in any operation mode. An operation error (M01 0007) will occur when the machine is stopped by the soft limit function. If the machine position is outside the moveable range, only movement commands in the direction to return to the moveable range will be allowed.

To operate this function, set the plus direction limit position and minus direction limit position in the respective parameters.

The soft limit will not function if the plus and minus direction parameters are set to the same value.



| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|-----|---------|----------------|---------------|------|-------------|---------------|
| #117 | Limit (+) | Soft limit (+) | 1.000 | mm | Commands in the plus direction that exceed this value are not possible. If the machine is in a position exceeding the setting value, commands in the minus direction are possible. The soft limit function will not operate if Limit (+) and Limit (−) are set to the same value. | −99999.999 ~99999.999 |
| #118 | Limit (−) | Soft limit (−) | 1.000 | mm | Commands in the minus direction that exceed this value are not possible. If the machine is in a position exceeding the setting value, commands in the plus direction are possible. | −99999.999 ~99999.999 |

**POINT** The soft limit function is only valid for linear axis settings. In actual operation, the axis stops slightly before the setting position.

### 6-6-4  Servo OFF

This function releases the servo lock. When locking the machine with an external force, such as a mechanical clamp, the servo control is turned OFF, and torque is not output for the deflection that occurs due to the external force. When the servo OFF state is entered, servo READY (RDY) turns OFF. The motor brake braking control (MBR) also turns OFF, and the motor brakes are activated.
By using the vertical axis drop prevention function, READY OFF can be delayed from the servo OFF command input by the time set with the parameters. With this, dropping of the axis is prevented by a delay in the brake operation. Set the time to delay READY OFF in "#013 MBR Vertical axis drop prevention time". Input the servo OFF while confirming the position, and set the minimum delay time at which the axis does not drop. If the servo is turned OFF during machine movement, the speed command will decelerate to a stop. When the in-position is detected, the servo OFF state will be entered. If the operation is still starting, operation will resume after servo OFF is canceled.

Operation start (ST)

Servo OFF (SVF)

Movement command
(speed command)

In-position (INP)

Motor brake control output (MBR)
(CN3 output)
Servo READY (RDY)

Brake release

MBR Vertical axis drop prevention time
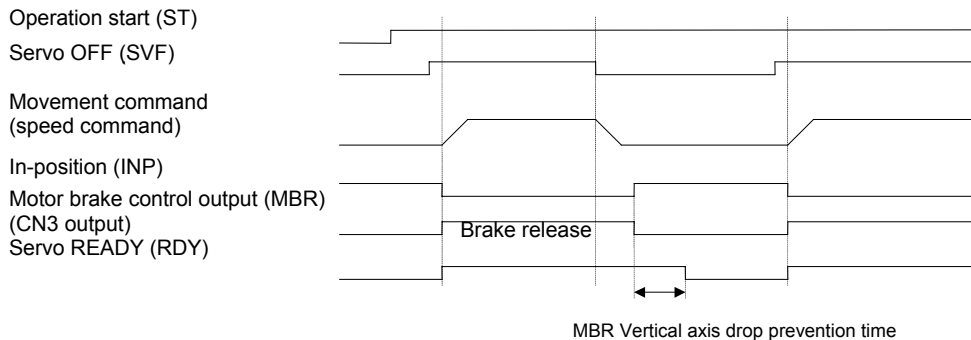
The amount of movement during servo OFF is constantly monitored, so there is no coordinate deviation. The handling for this movement amount can be selected from the following two methods by parameter setting.

| During servo OFF | #102 Cont2.bit1 | Explanation |
|---|---|---|
| Error not corrected | 0 | The movement amount during servo OFF becomes the droop. When the servo is turned ON again, the machine will return to the position where the servo was turned OFF.<br>An alarm will occur if the droop that occurs during servo OFF exceeds the excessive error detection width. |
| Error corrected | 1 | Even if the machine moves during servo OFF, the machine position (command position) is updated without this amount becoming the droop. Thus, at the next servo ON the machine will stop at the position to which it moved. |

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #006 | INP | In-position detection width | 50 | 1/1000° (μm) | The in-position is detected when the position droop becomes equal to or less than this setting value. | 1 ~ 32767 |
| #013 | MBR | Vertical axis drop prevention time | 100 | ms | Input the time to delay servo OFF when the servo OFF command is input. Increment in 100ms units, and set the min. value at which the axis does not drop. | 0 ~ 1000 |
| #102 | *Cont2 | Control parameter 2 | | | This is a HEX setting parameter. Set bits without a description to their default values. | |

| bit | F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Default value | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |

| bit | Meaning when "0" is set. | Meaning when "1" is set. |
|---|---|---|
| 1 | Error not corrected at servo OFF | Error corrected at servo OFF |
| 2 | Linear axis | Rotation axis |
| 3 | Station assignment direction CW | Station assignment direction CCW |
| 4 | Uniform index | Non-uniform index |
| 5 | DO channel standard assignment | DO channel reverse assignment |
| 6 | 2-wire detector communication | 4-wire detector communication |
| 7 | Incremental detection | Absolute position detection |

⚠ **CAUTION**  Do not set a vertical axis drop prevention time longer than required. Doing so could cause the servo control and brakes to collide, the overload alarm to occur and the drive unit to be damaged. There will be no problem if the overlapping time is within 100ms.

### 6-6-5    READY OFF

This is a function to turn OFF the main circuit power to each drive unit. When the drive unit enters a READY OFF state, the servo READY (RDY) and servo READY (SA) signals turn OFF, and the CN3 connector motor brake control output (MBR) and contactor control output (MC) signals turn OFF. When starting the operation again after the READY OFF is canceled, carry out an operation start.
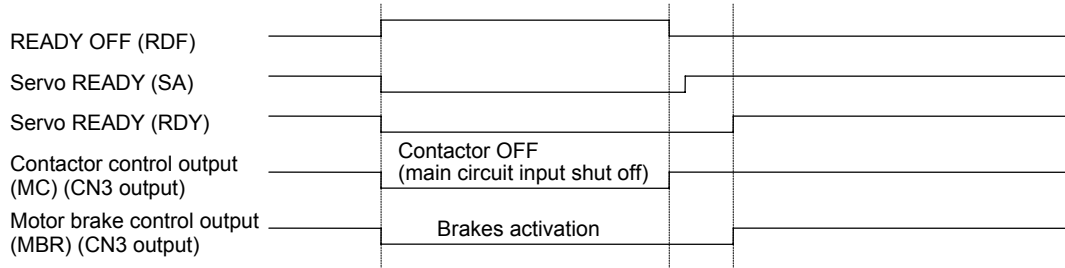
| | |
|---|---|
| READY OFF (RDF) | |
| Servo READY (SA) | |
| Servo READY (RDY) | |
| Contactor control output (MC) (CN3 output) | Contactor OFF (main circuit input shut off) |
| Motor brake control output (MBR) (CN3 output) | Brakes activation |

| ⚠ **CAUTION** | 1. Always install an independent contactor in the servo drive unit in which the READY OFF is commanded, and carry out control with that drive unit's contactor control output. |
|---|---|
| | 2. For safety, issue the READY OFF command after confirming that the motor has stopped. |

### 6-6-6    Data protect

This function protects the parameters stored in the drive unit main unit. When the data protect (PRT1) signal is ON (B contact), the downloading of parameters from the personal computer setup software is prohibited. Parameter downloading from the NC screen is not prohibited.

## 6-7    Miscellaneous functions

### 6-7-1    Feedrate override

The effective feedrate is the speed set in the parameters multiplied by the override (%). The override range is from 0 to 100%, which can be commanded in 1% units. This override is valid for all movement except that in the handle mode. The override is invalidated when the override valid (OVR) signal is turned OFF, and the set speed will become the effective feedrate as is.

The override command is designated by a 7-bit binary (OV1 to OV64). The override is handled as 100% if the command exceeds 100%. If a 0% override is commanded, the axis will deceleration stop, and an operation error "M01 0103 feedrate zero" will occur.

### 6-7-2    Position switches

There are eight types of position switches (PSW1 to PSW8) that indicate that the machine is in the designated region. The region where each position switch outputs ON is set in the parameters. The machine position to be judged can be selected from the machine position of the command system without consideration of the droop, or from the machine FB position (actual machine position) which includes the droop.

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #200 | PSWcheck | PSW detection method | | | This is a HEX setting parameter. Set bits without a description to their default values. | |

| bit | F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Default value | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| bit | position switch | Meaning when "0" is set. | Meaning when "1" is set. |
|---|---|---|---|
| 0 | PSW1 | The position switch output is judged by the machine position of the command system. | The position switch output is judged by the machine FB position (actual position). |
| 1 | PSW2 | | |
| 2 | PSW3 | | |
| 3 | PSW4 | | |
| 4 | PSW5 | | |
| 5 | PSW6 | | |
| 6 | PSW7 | | |
| 7 | PSW8 | | |

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #201 | PSW1dog1 | PSW1 region setting 1 | 0.000 | ° (mm) | When the machine is in the region between region settings 1 and 2, the position switch of each No. will turn ON. The size of the setting value for region setting 1 and 2 does not affect the position switch operation. For rotation axes, the output turns ON at the region not including 0.000°. | −99999.999 ~99999.999 |
| #202 | PSW1dog2 | PSW1 region setting 2 | | | | |
| #203 | PSW2dog1 | PSW2 region setting 1 | | | | |
| #204 | PSW2dog2 | PSW2 region setting 2 | | | | |
| #205 | PSW3dog1 | PSW3 region setting 1 | | | | |
| #206 | PSW3dog2 | PSW3 region setting 2 | | | | |
| #207 | PSW4dog1 | PSW4 region setting 1 | | | | |
| #208 | PSW4dog2 | PSW4 region setting 2 | | | | |
| #209 | PSW5dog1 | PSW5 region setting 1 | | | | |
| #210 | PSW5dog2 | PSW5 region setting 2 | | | | |
| #211 | PSW6dog1 | PSW6 region setting 1 | | | | |
| #212 | PSW6dog2 | PSW6 region setting 2 | | | | |
| #213 | PSW7dog1 | PSW7 region setting 1 | | | | |
| #214 | PSW7dog2 | PSW7 region setting 2 | | | | |
| #215 | PSW8dog1 | PSW8 region setting 1 | | | | |
| #216 | PSW8dog2 | PSW8 region setting 2 | | | | |

# Chapter 7   Absolute Position Detection System

## 7-1   Setting of absolute position detection system

The control unit registers the initially set reference point, and the detector monitors the movement direction and distance that the machine moves even when the power is turned OFF. Thus, when the power is turned ON again, automatic operation can be started automatically without returning to the reference point.

### 7-1-1   Starting the system

Turn the power ON, and set parameter #102 Cont2.bit7 to "1" to validate the absolute position detection. The absolute position detection is selected even after the parameters are initialized (refer to section 6-1-1 Initializing the parameters). When the power is turned ON again after making the setting, the absolute position detection system will be validated.
If the absolute position detection is set for the first time after connecting the motor and drive unit, the ABSOLUTE POSITION LOST (S01 0025) alarm will occur, so turn the drive unit power ON again.
If only the alarm ZERO POINT NOT INITIALIZED (Z70 0001) occurs, the absolute position detection system has started up correctly. This alarm will be reset when the absolute position is established with the following procedures.

### 7-1-2   Initialization methods

The following three types of initialization methods can be selected with the parameter settings.

| Initialization method | #120 ABS Type.bit1 | #120 ABS Type.bit2 | Explanation |
|---|---|---|---|
| Reference point return method | 0 | Meaningless | The reference point is determined using the near-point dog. The operation method is the same as the dog-type reference point return using the incremental system. |
| Machine stopper method | 1 | 0 | The reference point is determined by pushing against a stroke end, etc., with the torque (current) limit set. |
| Reference point setting method | 1 | 1 | The reference point is determined by setting the axis to the machine's reference point. |

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #102 | ∗Cont2 | Control parameter 2 | | | This is a HEX setting parameter. Set bits without a description to their default values. | |
| #120 | ABS Type | Absolute position detector parameter | | | This is a HEX setting parameter. Set bits without a description to their default values. | |

#102 ∗Cont2 Control parameter 2:

| bit | F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Default value | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |

| bit | Meaning when "0" is set. | Meaning when "1" is set. |
|---|---|---|
| 1 | Error not corrected at servo OFF | Error corrected at servo OFF |
| 2 | Linear axis | Rotation axis |
| 3 | Station assignment direction CW | Station assignment direction CCW |
| 4 | Uniform index | Non-uniform index |
| 5 | DO channel standard assignment | DO channel reverse assignment |
| 6 | 2-wire detector communication | 4-wire detector communication |
| 7 | Incremental detection | Absolute position detection |

#120 ABS Type Absolute position detector parameter:

| bit | F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Default value | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

| bit | Meaning when "0" is set. | Meaning when "1" is set. |
|---|---|---|
| 1 | Dog-less type initialization | Dog-type initialization |
| 2 | Machine stopper initialization | Reference point setting initialization |
| 3 | Electrical zero point direction + | Electrical zero point direction − |

**POINT**

1. The battery option is required to use the absolute position system. Refer to the section "4-2 Battery option for absolute position system" for details.
2. After establishing the coordinate zero point with the absolute position detection system, if the parameters are set to the incremental detection, the coordinate data will be set. If the parameter is returned to the absolute position detection, the coordinate zero point will need to be established again.

## 7-2   Setting up the absolute position detection system

Absolute position initialization method
├─ Dog-type ──────── Reference point return method (Determine reference point using near-point dog)
└─ Dog-less type
   ├─ Machine stopper method (Determine reference point by pushing axis against machine)
   └─ Reference point setting method (Determine reference point by setting axis to machine's reference point)
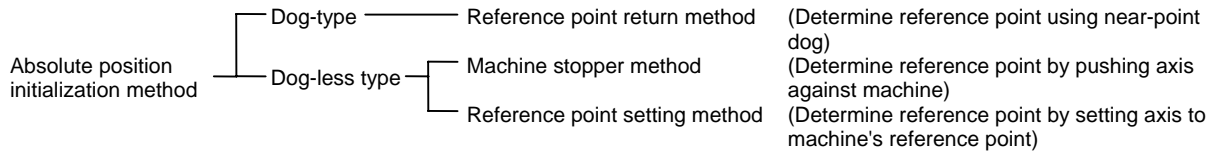
### 7-2-1   Reference point return method

The coordinate zero point is established with the dog-type reference point return operation. The operation method is the same as the dog-type reference point return using the incremental system. Refer to the section "6-3 Setting the coordinate zero point".

### 7-2-2   Machine stopper method

Jog feed is carried out with the torque (current) limit set, and the axis is pushed against the machine, etc., to determine the absolute position reference point.

#### (1)   Initialization

Turn the following signal ON, and change to the absolute position reference point initialization mode. The operation parameter group 4 will be automatically selected during the reference point initialization mode. Set the torque limit value (TL4) and excessive error detection width (OD4) to values appropriate for the pushing operation. (Refer to following table.)

| Abbrev. | Signal name | Explanation |
|---------|-------------|-------------|
| AZS | Reference point initialization mode selection | The absolute position reference point initialization mode is entered. Set the parameter to the machine stopper method, and then initialize the reference zero point. This mode is held until the NC power is turned OFF. |

#### (2)   Explanation of operations

[1] The axis is pushed against the machine stopper with jog or handle feed. When the torque (current) reaches the limit value due to this pushing, the limiting torque (TLQ) is output, and the position is saved as the "absolute position reference point".

[2] The axis is moved in the direction opposite the pushing direction. When the axis moves and reaches the first grid point, the axis automatically stops, and the absolute position coordinates are established.
If parameter "101 Cont1.bitA" is set to "1", the electrical zero point (grid) will be set as the "absolute position reference point" instead of the pushed position.
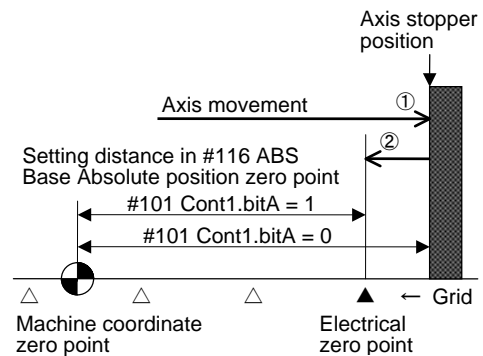
[3] In this state, the absolute position reference point will become the coordinate zero point. To set a point other than the push position or electrical zero point as the absolute position coordinate zero point, move the machine coordinate zero point with parameter #116 ABS Base Absolute position zero point.

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | | | Setting range |
|---|---|---|---|---|---|---|---|---|
| #101 | *Cont1 | Control parameter 1 | | | This is a HEX setting parameter. Set bits without a description to their default values. | | | |

| bit | F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Default value | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| bit | Meaning when "0" is set. | Meaning when "1" is set. |
|---|---|---|
| 1 | High-speed zero point return after zero point establishment | Dog-type method for each zero point return operation |
| 8 | Reference point return direction (+) | Reference point return direction (−) |
| 9 | Rotation direction determined by DIR | Rotation direction in the shortcut direction |
| A | Machine reference position becomes the reference point | Electrical zero point becomes the reference position |
| D | Coordinate zero point creation valid | Zero point established at power supply ON position |
| E | Rotation direction in DIR or in the shortcut direction | Rotation direction in the random position command sign direction |
| F | Stopper direction is positioning direction | Stopper direction is for the stopper amount in the sign direction |

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #178 | TL4 | Operation parameter group 4 Torque limit value | 500 | % | Set so that the torque limit is not reached with the acceleration to the pushing speed, and so that the value is less than 100%. | 1 ~ 500 |
| #179 | OD4 | Operation parameter group 4 Excessive error detection width | 100 | ° (mm) | Set a value that will not cause an excessive error alarm when pushing. | 0 ~ 32767 |

## 7-2-3   Reference point setting method

The absolute position reference point is determined by setting the axis to the machine's reference point.

### (1)   Initialization

Turn the following signal ON, and change to the absolute position reference point initialization mode.
Set the direction from the position to carry out reference point setting to the grid to be used as the electrical zero point in parameter #120 ABS Type Absolute position detection parameter bit3.



| Abbrev. | Signal name | Explanation |
|---|---|---|
| AZS | Reference point initialization mode selection | The absolute position reference point initialization mode is entered. Set the parameter to the reference point setting method, and then initialize the reference zero point. This mode is held until the NC power is turned OFF. |

**(2) Explanation of operation**

① Using jog, handle or incremental feed, set the axis position to the position to become the "absolute position reference point".

② Turn the reference point setting (ZST) signal ON.

③ Using jog, handle or incremental feed, move the axis in the direction of the grid to be the electrical zero point. When the axis reaches the grid to be the electrical zero point, it will automatically stop, and the absolute position coordinates will be established.
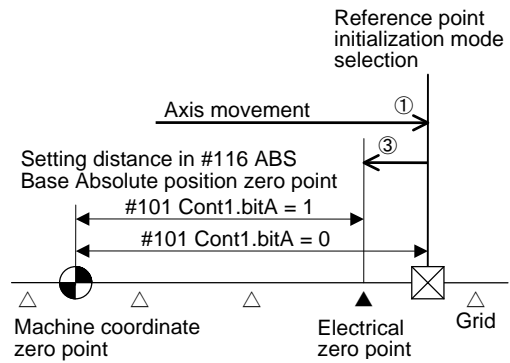
If parameter #101 Cont1.bitA is set to "1", the electrical zero point (grid) will be set as the "absolute position reference point" instead of the position where reference point setting was turned ON.

③ In this state, the absolute position reference point will become the coordinate zero point. To set a point other than the position where reference point setting (ZST) was turned ON or the electrical zero point as the absolute position coordinate zero point, move the machine coordinate zero point with parameter #116 ABS Base Absolute position zero point.

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #101 | *Cont1 | Control parameter 1 | | | This is a HEX setting parameter. Set bits without a description to their default values. | |

| bit | F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Default value | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| bit | Meaning when "0" is set. | Meaning when "1" is set. |
|---|---|---|
| 1 | High-speed zero point return after zero point establishment | Dog-type method for each zero point return operation |
| 8 | Reference point return direction (+) | Reference point return direction (−) |
| 9 | Rotation direction determined by DIR | Rotation direction in the shortcut direction |
| A | Machine reference position becomes the reference point | Electrical zero point becomes the reference position |
| D | Coordinate zero point creation valid | Zero point established at power supply ON position |
| E | Rotation direction in DIR or in the shortcut direction | Rotation direction in the random position command sign direction |
| F | Stopper direction is positioning direction | Stopper direction is for the stopper amount in the sign direction |

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #116 | ABS base | Absolute position zero point | 0.000 | ° (mm) | Set the movement amount when the machine coordinate zero point is to be moved from the reference point during absolute position initialization. | −99999.999 ~99999.999 |
| #120 | ABS Type | Absolute position detector parameter | | | This is a HEX setting parameter. Set bits without a description to their default values. | |

| bit | F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Default value | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

| bit | Meaning when "0" is set. | Meaning when "1" is set. |
|---|---|---|
| 1 | Dog-less type initialization | Dog-type initialization |
| 2 | Machine stopper initialization | Reference point setting initialization |
| 3 | Electrical zero point direction + | Electrical zero point direction − |

# Chapter 8   Servo Adjustment

## 8-1   Measuring the adjustment data

### 8-1-1   D/A output

The MR-J2-CT has a function to D/A output the various control data. To adjust the servo and set the servo parameters matching the machine, the status in the servo must be observed using D/A output. Measure using a hi-corder or synchroscope on hand.

#### (1)   Specifications

| CN3 connector | | | |
|---|---|---|---|
| Pin | Name | Pin | Name |
| 1 | LG | 11 | LG |
| 2 | RxD | 12 | TxD |
| 3 | SG | 13 | MBR |
| 4 | MO1 | 14 | MO2 |
| 5 | COM | 15 | MC |
| 6 | | 16 | |
| 7 | | 17 | |
| 8 | | 18 | |
| 9 | | 19 | DOG |
| 10 | VDD | 20 | EMGX |

| Item | Explanation |
|---|---|
| No. of changes | 2ch |
| Output frequency | 888μs (Minimum value) |
| Output accuracy | 8bit |
| Output voltage range | −10V ~ 0 ~ +10V |
| Output scale setting | Fixed |
| Output pins | CN3 connector<br>  MO1  =  pin 4<br>  MO2  =  pin 14<br>  GND  =  pin 1, 11 |
| Function | Offset amount adjustment function |
| Option | Relay terminal block: MR-J2CN3TM<br>  Lead out the SH21 cable from the CN3<br>  connector, and connect. |
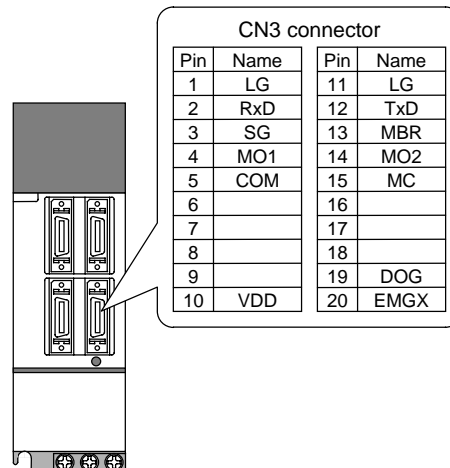
#### (2)   Setting the output data

| No. | Abbrev. | Parameter name | Explanation |
|---|---|---|---|
| #050 | MD1 | D/A output channel 1 data No. | Set the No. of the data to be output to each D/A output channel. |
| #053 | MD2 | D/A output channel 2 data No. | $\boxed{0}\ \boxed{0}\ \boxed{0}\ \boxed{0}$   (Default value) |

| No. | Details | Scale |
|---|---|---|
| 0 | Speed feedback (signed) | Max. speed = 8V |
| 1 | Current feedback (signed) | Max. current (torque) = 8V |
| 2 | Speed feedback (unsigned) | Max. speed = 8V |
| 3 | Current feedback (unsigned) | Max. current (torque) = 8V |
| 4 | Current command | Max. current (torque) = 8V |
| 5 | Command F∠T | 10000   [°/min] = 10V |
| 6 | Droop 1 (1/1) | 2048 [pulse] = 10V |
| 7 | Droop 2 (1/4) | 8192 [pulse] = 10V |
| 8 | Droop 3 (1/16) | 32768 [pulse] = 10V |
| 9 | Droop 4 (1/32) | 65536 [pulse] = 10V |
| A | Droop 5 (1/64) | 131072 [pulse] = 10V |

#### (3)   Setting the offset amount

If the D/A output's zero level does not match (is not set to 0V), adjust the output offset with the following parameters.

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #051 | MO1 | D/A output channel 1 output offset | 0 | mV | Set if the zero level of each D/A output channel does not match. | −999~999 |
| #052 | MO2 | D/A output channel 2 output offset | | | | |

### 8-1-2   Graph display

When the setup software is used, the adjustment data can be displayed on the personal computer screen as a graph. Refer to the "Setup Software Instruction Manual (BNP-B2208)" for details on the handling methods, etc.

## 8-2   Automatic tuning

### 8-2-1   Model adaptive control

The MR-J2-CT servo control has the following type of model scale type control system. It is two free structures having position loop gain and speed loop gain on both the model loop side and actual loop side. If the model load inertia (GD2) is equivalent to the actual load inertia, the actual load can be correctly driven with the torque command (current command) created on the model lop side. If an error is generated between the actual load response and model response, due to disturbance, etc., the actual loop will function to compensate for the error amount.

In this manner, by setting the responsiveness for the command and the responsiveness for disturbance independently, the model adaptive control can realize control capable of relatively high-speed control even with a low actual loop gain.
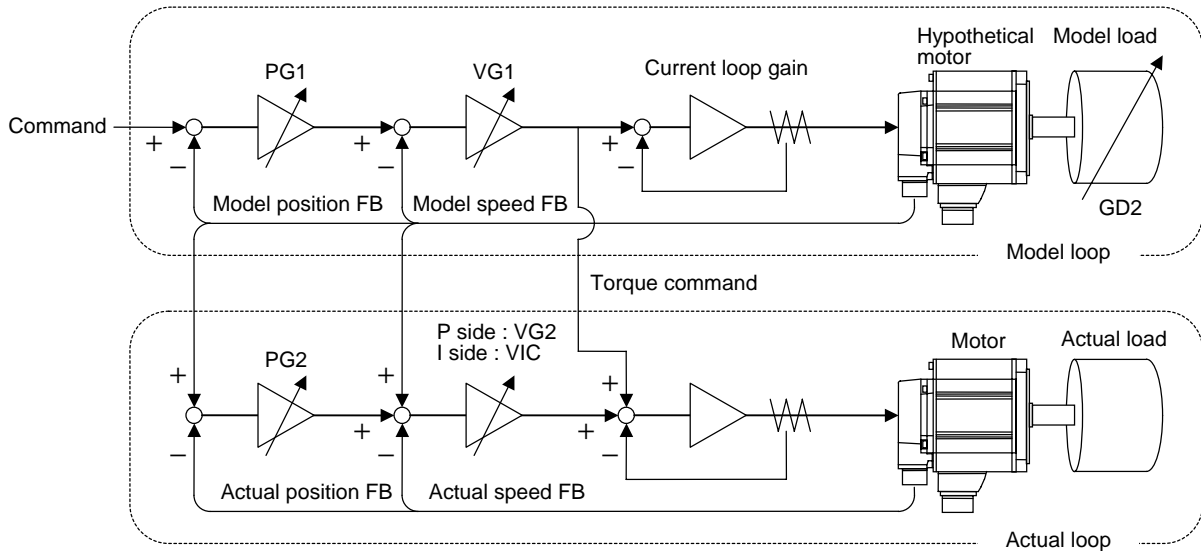


**Model adaptive control**

### 8-2-2   Automatic tuning specifications

The MR-J2-CT has a built-in automatic tuning function, so bothersome servo gain adjustments are carried out by the servo drive unit. With automatic tuning, the size of the motor load inertia is automatically detected, and the optimum servo gain for that inertia is set. The load inertia is detected and the servo gain adjusted while the motor is accelerating and decelerating, so acceleration/deceleration operation is always required for automatic tuning. If the load inertia changes because the No. of tools in the magazine has been changed or the arm is grasping the workpiece, a new gain will be set accordingly.

The adjusted gain is saved in the drive unit's memory, so control will be carried out with the adjusted gain even after the drive unit's power is turned ON again.

**Automatically tuned parameters**

| No. | Abbrev. | Parameter name | Details |
|-----|---------|----------------|---------|
| #008 | PG1 | Position loop gain 1 | This determines the tracking in respect to the position command. |
| #019 | PG2 | Position loop gain 2 | This determines the position responsiveness in respect to the load disturbance. |
| #020 | VG1 | Speed loop gain 1 | This determines the tracking in respect to the speed command. |
| #021 | VG2 | Speed loop gain 2 | This determines the speed responsiveness in respect to the load disturbance. |
| #022 | VIC | Speed integral compensation | This determines the responsiveness of the low-frequency region of speed control. |
| #024 | GD2 | Load inertia ratio | This determines the load inertia ratio in respect to the motor inertia. |

> **POINT**
>
> 1. Automatic tuning detects the load inertia and adjusts the gain while the motor is accelerating or decelerating. Thus, acceleration/deceleration operation is required for tuning. Even if there is a load torque, tuning (gain adjustment) will not be carried out while the motor is stopped or during constant speed feed.
> 2. If the detected load inertia does not change, the gain setting value will also not change.

### 8-2-3　Adjusting the automatic tuning

Automatic tuning detects the load inertia and automatically sets the servo gain. However, whether to set a generally higher gain (high response) or a lower gain (low response) is adjusted with the parameters. Set a low responsiveness if the load vibrates easily, and set a high responsiveness to shorten the settling time and thereby reduce the positioning time. If no problems occur with the standard setting, there is no need to change the parameters.

| Machine operation | Ideal machine operation | Setting method |
|---|---|---|
| Machine resonance occurs<br>The machine gears can be heard | Suppress the machine resonance.<br>Reduce the gear noise. | Decrease the responsiveness setting value. |
| The machine overshoots when stopping | Reduce the overshooting. | Increase the friction characteristic selection.<br>Decrease the responsiveness setting value. |
| The stop settling time is long **(Note)** | Reduce the stop settling time. | Increase the responsiveness setting value. |

　**(Note)**　Stop settling time: Time for servomotor to stop after command changes to zero.

---

💡 **POINT**

1. Automatic tuning sets the various gain to match the load inertia or with the optimum balance. Note that the machine rigidity must be determined and set by the operator.
2. The automatic tuning responsiveness can be increased by using the vibration suppressing function.

---

| No. | Abbrev. | Parameter name | Explanation |
|---|---|---|---|
| #007 | ATU | Automatic tuning | Set the adjustment parameters for automatic tuning. Do not set the values having no explanation.<br><br>`0 1 0 2`　(Default value)<br><br>**Setting value / Details**<br><table><tr><td>1</td><td>Low response (Load with low rigidity, load that easily vibrates)</td></tr><tr><td>2</td><td>Standard setting value</td></tr><tr><td>3</td><td>Standard setting value</td></tr><tr><td>4</td><td>Standard setting value</td></tr><tr><td>5</td><td>High response (Load with high rigidity, load that does not easily vibrate)</td></tr></table><br>**Setting value / Details**<br><table><tr><td>0</td><td>Standard</td></tr><tr><td>1</td><td>Large friction (Set the position loop gain to a low value.)</td></tr></table><br>**Setting value / Details**<br><table><tr><td>0</td><td>Automatically tune only PG2, VG2, VIC, and GD2.</td></tr><tr><td>1</td><td>Automatically tune PG1, PG2, VG1, VG2, VIC and GD2 (all gains).</td></tr><tr><td>2</td><td>Do not automatically tune.</td></tr></table> |

## 8-3   Manual adjustment

With automatic tuning, the model loop load inertia (GD2) is set to the actual load inertia, and the optimum gain is automatically set according to the size of that inertia. The method of manually setting (inputting the parameters) each gain is explained in this section.
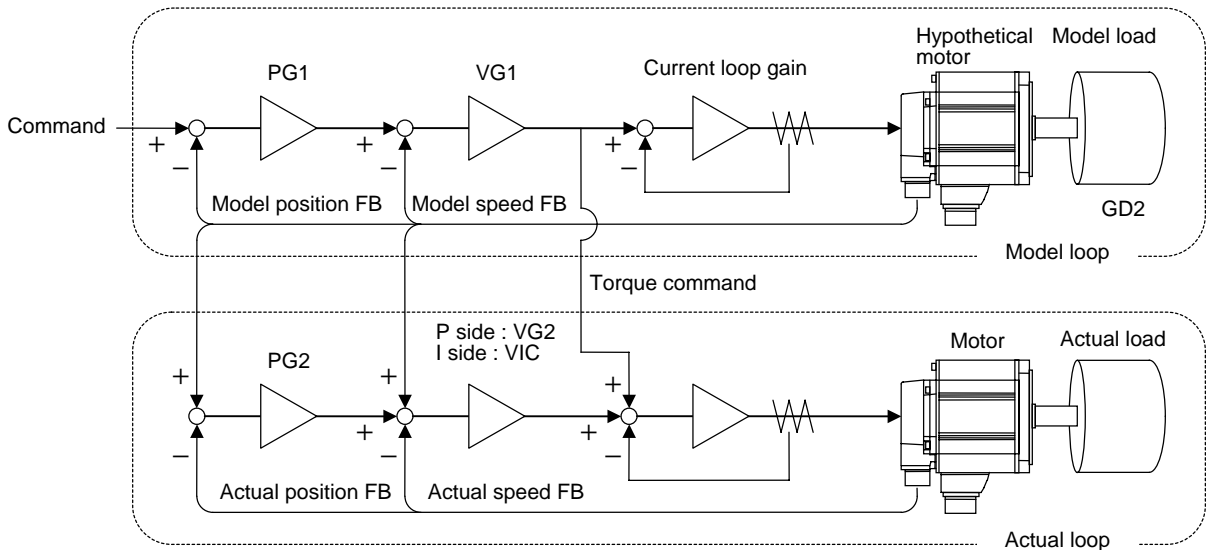


### 8-3-1   Setting the model inertia

Manual adjustment is carried out when sufficient characteristics cannot be obtained with automatic tuning. This often occurs when the load inertia is not correctly detected. If the load inertia ratio on the MONITOR screen greatly differs from the calculated value, or if it is unstable, manually set only the load inertia ratio. Then, set the gain for that load inertia ratio to the optimum value with automatic tuning.

| Machine characteristics | Monitor's load inertia ratio (GD2) phenomenon | Explanation |
|---|---|---|
| The machine friction is large | The difference between the value after acceleration and the value after deceleration is large. | The load inertia is detected while the motor is accelerating or decelerating, so if the friction is large, a large inertia will be detected during acceleration, and a small inertia will be detected during deceleration. The average value obtained from the values after acceleration and deceleration is the true load inertia ratio. |
| Cam drive (The load inertia changes during constant speed operation) | The value is extremely small compared to the calculated value. | The detected load inertia is the load inertia during acceleration/deceleration. Normally, the inertia during the lightest load is detected, so this can be improved by setting the inertia to math the load during actual drive. In this case, the load inertia itself will not change, so improvements can also be made by increasing the automatic tuning responsiveness. (Set a higher gain for the same load inertia.) |

| Step | Operation | Explanation |
|---|---|---|
| 1 | Set parameter "#007 ATU" to 0101. | Start the automatic tuning with a low response. |
| 2 | Set the load inertia ratio in parameter "#024 GD2". | When the load inertia is set, the following parameter will be set to the set load inertia. Do not drive the motor at this time.<br>#008 PG1　:　Position loop gain 1<br>#019 PG2　:　Position loop gain 2<br>#020 VG1　:　Speed loop gain 1<br>#021 VG2　:　Speed loop gain 2<br>#022 VIC　:　Speed integral compensation |
| 3 | Set parameter "#007 ATU" to 0201. | Stop the automatic tuning, and fix the set gain. |
| 4 | Confirm the operation, and if vibration, etc., is not occurring, raise the automatic tuning responsiveness, and repeat (Step 1) to (Step 3). | The optimum value is just before the vibration increases. |

### 8-3-2    Adjusting the gain

If the balance of the various gains set with automatic tuning does not match the machine, the gains must be adjusted individually. Adjust with the following procedure.

**(1)  GD2: Load inertia ratio**

Set the model load inertia to be used in the model loop. If the model load inertia and actual load inertia match, the model section operation will approach the actual operation. Thus, there is no need to raise the actual loop gain PG2 or VG2 more than necessary.

Even when adjusting manually, adjust the following gain using the gain determined in section "8-2-1 Setting the model inertia" as the default value.

$$GD2 = \frac{J_L}{J_M} \quad (J_L: \text{Load inertia}, J_M: \text{Motor inertia})$$

**(2)  VG2: Speed loop gain 2**

The speed lop gain dominates the response dumping. If this gain is extremely low, vibration will occur at the PG2 frequency, and if too high, machine resonance will be induced. To adjust, gradually raise VG2, and set at 70% of the max. value where the machine resonance does not occur.

The VG2 unit is the response frequency, but in actual use, it is the response setting including the load inertia. Thus, the actual response frequency (rad/s) will be the value divided by the load inertia rate (1+JL/Jm).

**(3)  VG2: Position loop gain 2**

PG2 determines the position response in respect to disturbance. Normally it is set with the following equation. Adjust PG1 to shorten the settling time.

$$PG2 = \frac{6 \times VG2}{1 + (J_L/J_M)} \quad (\text{rad/s})$$

**(4)  VIC: Speed integral compensation**

If the load torque fluctuation is large or the machine friction is large, uneven rotation or overshooting during position settling will increase. In this case, the position and speed fluctuation can be reduced by reducing VIC. However, if it is too low, vibration will occur. Adjust with the load inertia ratio while referring to the following table.

| Load inertia ratio | 1 | 3 | 5 | 10 | 20 | 30 or more |
|---|---|---|---|---|---|---|
| Speed integral compensation (ms) | 20 | 30 | 40 | 60 | 100 | 200 |

**(5) VG1: Speed loop gain 1**

**(6) PG1: Position loop gain 1**

These are the model loop side gains that determine the responsiveness in respect to the command. The model side makes an ideal response, so no mater how high these gains are set, the model system will not resonate. However, the impact to the machine during acceleration/deceleration will increase, so the vibration during acceleration/deceleration and the overshooting when stopping will increase. Adjust to the optimum value while actually driving the machine and maintaining the relation given in the following equation.

PG1 is directly related to the target response characteristics, so if this gain is increased, the settling time will be shortened.

$$PG1 = \frac{VG1}{4} \quad (\text{rad/s})$$

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #008 | PG1 | Position loop gain 1 | 70 | rad/s | Set the position loop gain for the model loop. This determines the tracking in respect to the position command. | 4 ~ 1000 |
| #019 | PG2 | Position loop gain 2 | 25 | rad/s | Set the position loop gain for the actual loop. This determines the position responsiveness in respect to disturbance. | 1 ~ 500 |
| #020 | VG1 | Speed loop gain 1 | 1200 | rad/s | Set the speed loop gain for the model loop. This determines the tracking in respect to the speed command. | 20 ~ 5000 |
| #021 | VG2 | Speed loop gain 2 | 600 | rad/s | Set the speed loop gain for the actual loop. This determines the speed responsiveness in respect to disturbance. | 20 ~ 8000 |
| #022 | VIC | Speed integral compensation | 20 | ms | This determines the responsiveness of the low-frequency region of speed control. | 1 ~ 1000 |
| #024 | GD2 | Load inertia ratio | 2.0 | fold | This determines the load inertia ratio in respect to the motor inertia. | 0.0 ~ 50.0 |

## 8-4   Characteristics improvements

### 8-4-1   Vibration suppression measures

#### (1)   Notch filter

The resonance elimination filter operates at the set frequency. Observe the FB torque (current FB) waveform using the monitor output function or setup software graph display function, etc., and measure the resonance frequency. Note that the resonance frequency that can be observed is approx. 0 to 500Hz. Directly observe the phase current using a current probe, etc., for resonance exceeding 500Hz. Note that when the filter is set, other frequency resonance could occur.

| No. | Abbrev. | Parameter name | Explanation |
|---|---|---|---|
| #014 | NCH | Notch filter No. | Set the frequency of the machine resonance suppressing filter. Do not set the values having no explanation. |

| Setting value | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| Frequency (Hz) | Non-starting | 1125 | 563 | 375 | 282 | 225 | 188 | 161 |

#### (2)   Jitter compensation

If the motor position enters the machine's backlash when stopping, the load inertia will be very small. This is because a very large speed loop gain is set in respect to the load inertia, so vibration occurs.

Jitter compensation allows the vibration that occurs while the motor is stopping to be suppressed by ignoring the speed feedback pulses of the backlash amount when the speed feedback polarity changes. Set the value to suppress the vibration by increasing the No. of ignored pulses one pulse at a time. (The position feedback is controlled as normal, so there is no worry of positional deviation.)

Note that if an axis with which vibration does not occur is set, vibration could be induced.

| No. | Abbrev. | Parameter name | Explanation |
|---|---|---|---|
| #016 | JIT | Jitter compensation | Set the No. of pulses ignored for jitter compensation. Do not set the values having no explanation. |

| Setting value | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| No. of ignored pulses | Non-starting | 1 | 2 | 3 |

> **POINT**   Jitter compensation is effective in suppressing vibration only while the motor is stopped.

### 8-4-2   Overshooting measures

#### (1)   Speed differential compensation

With normal PI control, the torque when the position droop reaches zero is held while the motor is stopped. However, with a machine having a large frictional torque, the holding toque will increase, and thus overshooting may occur. By lowering the speed differential compensation from the standard value, overshooting can be compensated.

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #024 | VDC | Speed differential compensation | 1000 | | When the default value 1000 is set, the normal PI control will be applied. Adjust the overshooting amount by reducing this value in units of 20. | 0 ~ 1000 |

## 8-5　Adjusting the acceleration/deceleration operation

### 8-5-1　Setting the operation speed

The operation speed is set to match the motor speed to the machine specifications within a range less than the max. speed. The operation speed is set for each operation group, but the operation group used with each operation mode is determined with the PLC group structure. The operation speed can be set freely for each operation group, but operation at a speed exceeding the operation parameter group 1 automatic operation speed (#150: Aspeed1) is not possible.

| | | |
|---|---|---|
| 💡 **POINT** | | The parameter #150 (Aspeed1) operation parameter group 1 automatic operation speed will be the clamp value (max. limit speed) for the automatic operation speed and manual operation speed in all operation groups. |

### 8-5-2　Setting the acceleration/deceleration time constant

For the acceleration/deceleration time constant, the linear acceleration/deceleration time in respect to the operation parameter group 1 automatic operation speed is set with an ms unit. Even if the operation group is not 1, the acceleration/deceleration inclination will be set with the time to accelerate to #150:Aspeed1.

The acceleration/deceleration time constant for rapid traverse (speed used for positioning at the highest speed) is set so that the max. current during rapid traverse acceleration/deceleration is within the range given below (this applies to only when the operation speed is less than the rated speed). The max. current can be confirmed with the MAX CURRENT 2 display on the NC auxiliary axis monitor or the peak load rate display in the setup software. With the setup software, the command torque can be displayed in a graph and confirmed. Set the acceleration/deceleration time constants for the operation modes to a value higher than the acceleration/deceleration time constant for rapid traverse.

When using deceleration control to control the stopping of the motor during an emergency stop, set the same value as the rapid traverse acceleration/deceleration time constant in the deceleration control time constant (#010: EMGt).

If the operation speed exceeds the motor's rated speed, adjust the acceleration/deceleration time constant so that the output torque at the high speed region is within the motor's specification range. The output torque is especially limited if the servomotor is at a speed higher than the rated speed. An insufficient torque will occur easily if the drive unit input voltage is low (170 to 190V), and can cause an excessive error to occur during acceleration or deceleration. The S-character acceleration/deceleration function is effective for reducing the acceleration/deceleration torque in high speed regions.

Max. current for acceleration/deceleration

| HC-SF series | | HC-RF series | | HA-FF series | |
|---|---|---|---|---|---|
| **Motor type** | **Max. current** | **Motor type** | **Max. current** | **Motor type** | **Max. current** |
| HC-SF52 | 240 ~ 270% | HC-RF103 | 200 ~ 225% | HA-FF053 | 240 ~ 270% |
| HC-SF102 | 240 ~ 270% | HC-RF153 | 200 ~ 225% | HA-FF13 | 240 ~ 270% |
| HC-SF152 | 240 ~ 270% | HC-RF203 | 200 ~ 225% | HA-FF23 | 240 ~ 270% |
| HC-SF202 | 240 ~ 270% | **HC-MF series** | | HA-FF33 | 240 ~ 270% |
| HC-SF352 | 240 ~ 270% | **Motor type** | **Max. current** | HA-FF43 | 240 ~ 270% |
| HC-SF53 | 240 ~ 270% | HC-MF053 | 260 ~ 290% | HA-FF63 | 240 ~ 270% |
| HC-SF103 | 240 ~ 270% | HC-MF13 | 260 ~ 290% | | |
| HC-SF153 | 240 ~ 270% | HC-MF23 | 280 ~ 290% | | |
| HC-SF203 | 240 ~ 270% | HC-MF43 | 275 ~ 290% | | |
| HC-SF353 | 240 ~ 270% | HC-MF73 | 280 ~ 290% | | |

| | | |
|---|---|---|
| 💡 **POINT** | | The acceleration deceleration time constants of all operation groups will be set to the acceleration/deceleration time constant in respect to the speed set in parameter #150 (Aspeed1). |

| | | |
|---|---|---|
| ⚠ **CAUTION** | | When using at a region higher than the rated speed, take special care to the acceleration/deceleration torque. If the drive unit's input voltage is low (170 to 190V), an excessive error could occur easily during acceleration/deceleration. When adjusting, determine the acceleration/deceleration time constant from the motor's speed - torque characteristics so that the acceleration/deceleration torque is within the specifications. The output torque at high speed regions can be reduced by using the S-character acceleration/deceleration function. |

# Chapter 9   Inspections

| ⚠ **DANGER** | 1. Wait at least 10 minutes after turning the power OFF and check that the input/output and voltage are zero with a tester, etc., before starting wiring or inspections. Failure to observe this could lead to electric shocks.<br>2. Only qualified persons must carry out the inspections. Failure to observe this could lead to electric shocks. Contact your dealer for repairs or part replacements. |
|---|---|
| ⚠ **CAUTION** | 3. Do not perform a megger test (insulation resistance measurement) on the servo drive unit. Failure to observe this could lead to faults.<br>4. Never disassemble or modify the unit. |

## 9-1    Inspections

Periodically inspecting the following points is recommended.

① Are any screws on the terminal block loose? Tighten if loose.

② Is there any abnormal noise from the servomotor bearings or the brakes?

③ Are any of the cables damaged or cracked? If the cable moves with the machine, carry out a periodic inspection according to the usage conditions.

④ Is the axis at the load coupling section misaligned?

## 9-2    Life parts

The guidelines for the part replacement interval are as shown below. These will differ according to the usage methods and environmental conditions, of if an abnormality is found, the part must be replaced. Contact your dealer for repairs and part replacements.

| Part name | | Standard replacement time | Remarks |
|---|---|---|---|
| Servo drive unit | Smoothing capacity | 10 years | The standard replacement time is a reference time. If an abnormality is found before the standard replacement time is reached, the part must be replaced. |
| | Relay | – | |
| | Cooling fan | 10,000 to 30,000 hours (2 to 3 years) | |
| | Battery | 10,000 hours | |
| Servomotor | Bearings | 20,000 to 30,000 hours | |
| | Detector | 20,000 to 30,000 hours | |
| | Oil seal, V-ring | 5,000 hours | |

①Smoothing capacitor       : The smoothing capacitor characteristics will deteriorate due to the effect of the ripple current, etc. The capacitor life will be greatly affected by the ambient temperature and usage conditions, but when run continuously in a normal air-conditioned environment, the life will be reached in 10 years.

②Relays       : Contact defects will occur due to contact wear caused by the switching current. This will differ according to the power capacity, but the life will be reached at a No. of cumulative switches (switching life) of 100,000 times.

③ Servomotor bearings       : When used at the rated speed and rated load, replace the bearings after about 20,000 to 30,000 hours. This will differ according to the operation state, but if abnormal noise or vibration is found during the inspection, the bearings must be replaced.

④ Servomotor oil seal, V-ring: These parts must be replaced after about 5,000 hours of operation at the rated speed. This will differ according to the operation state, but these parts must be replaced if oil leaks, etc., are found during the inspection.

# Chapter 10   Troubleshooting

## 10-1   Troubleshooting at start up

| ⚠ **CAUTION** | Excessive adjustment and changes of the parameters will cause unstable operation, so do not carry out. The fault items that might occur when starting up, and countermeasures for these faults are shown below. Remedy according to each item. |
|---|---|

| No. | Start up flow | Fault item | Investigation item | Assumed cause |
|---|---|---|---|---|
| 1 | Power ON | The LED does not light. | Does not improve even when connectors CN1A, CN1B, CN2 and CN3 are disconnected. | ① Power voltage defect<br>② Servo drive unit fault |
| | | | Improved when connectors CN1A, CN1B and CN3 are disconnected. | The power supply of the CN1A, CN1B or CN3 cable wiring is short circuited. |
| | | | Improved when connector CN2 is disconnected. | ① The power supply of the detector cable is short circuited.<br>② Detector fault |
| | | An alarm occurs. | Refer to section 10-3 and remove the cause. | |
| 2 | Servo ON | An alarm occurs. | Refer to section 10-3 and remove the cause. | |
| | | The servo does not lock. (The motor shaft is free.) | ① Confirm whether the NC is outputting a servo ON signal.<br>② Confirm whether the servo drive unit is receiving the servo ON signal. (A personal computer and setup software are required.) | NC side sequence program defect. |
| 3 | Servo adjustment | The speed is inconsistent at low speeds. | Adjust the gain with the following procedure.<br>① Increase the automatic tuning responsiveness.<br>② Carry out acceleration/ deceleration to complete automatic tuning. | Incorrect gain adjustment. |

## 10-2   Displays and countermeasures for various alarms

### 10-2-1   Drive unit LED display during alarm

The MR-J2-□CT has various self diagnosis functions built in. If these self diagnosis functions detect an error, the alarm classification code and alarm No. will be displayed on the 7-segment LED on the upper front of the drive unit. The 7-segment LED displays in the following order.
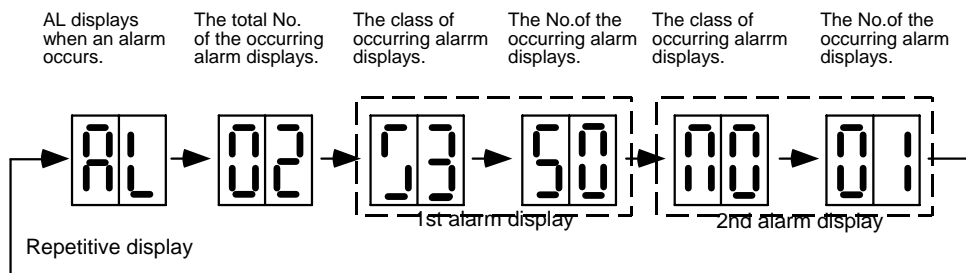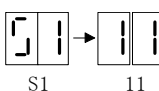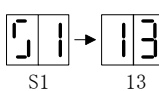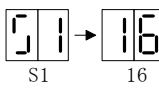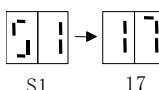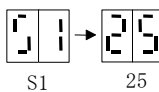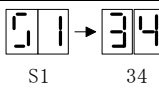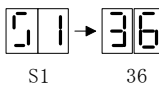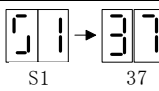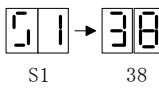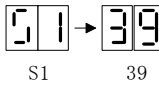
## 10-2-2   Alarm/warning list
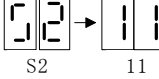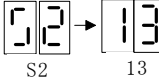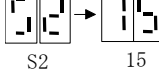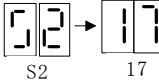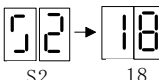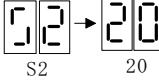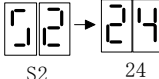
| Class | Alarm No. (displayed on personal computer) | | Main unit LED display | | Details |
|---|---|---|---|---|---|
| Servo alarm | S01 | 0011 | S1 | 11 | PCB error (control circuit error) |
| | S01 | 0013 | S1 | 13 | Software processing timeout |
| | S01 | 0016 | S1 | 16 | Motor type error, detector initial communication error, detector CPU error |
| | S01 | 0017 | S1 | 17 | PCB error (A/D conversion initial error) |
| | S01 | 0025 | S1 | 25 | Absolute position lost |
| | S01 | 0034 | S1 | 34 | CRC error |
| | S01 | 0036 | S1 | 36 | Timeout, NC power down |
| | S01 | 0037 | S1 | 37 | Parameter error (regenerative resistor type error) |
| | S01 | 0038 | S1 | 38 | Communication frame error |
| | S01 | 0039 | S1 | 39 | Communication INFO error |
| | S02 | 0011 | S2 | 11 | PCB error (drive circuit error) |
| | S02 | 0013 | S2 | 13 | Software processing timeout, clock error |
| | S02 | 0015 | S2 | 15 | EEROM error |
| | S02 | 0017 | S2 | 17 | PCB error (A/D conversion error) |
| | S02 | 0018 | S2 | 18 | PCB error (LSI error) |
| | S02 | 0020 | S2 | 20 | Detector error (detector data alarm, detector communication error) |
| | S02 | 0024 | S2 | 24 | Ground fault detection at power ON |
| | S03 | 0010 | S3 | 10 | Undervoltage |
| | S03 | 0030 | S3 | 30 | Regeneration error (regeneration transistor error, over-regeneration) |
| | S03 | 0031 | S3 | 31 | Overspeed |
| | S03 | 0032 | S3 | 32 | Overcurrent (hardware overcurrent, software overcurrent) |
| | S03 | 0033 | S3 | 33 | Overvoltage |
| | S03 | 0046 | S3 | 46 | Motor overheating, detector heating |
| | S03 | 0050 | S3 | 50 | Overload 1 (drive unit overload, motor overload) |
| | S03 | 0051 | S3 | 51 | Overload 2 (collision detection) |
| | S03 | 0052 | S3 | 52 | Excessive error |
| Servo warning | S52 | 0092 | S- | 92 | Battery voltage drop |
| | S52 | 00E0 | S- | E0 | Over-regeneration warning |
| | S52 | 00E1 | S- | E1 | Drive unit overload warning, motor overload warning |
| | S52 | 00E3 | S- | E3 | Absolute position counter warning |
| | S52 | 00E9 | S- | E9 | Main circuit OFF warning |
| System alarms | Z70 | 0001 | Z0 | 01 | Zero point initialization incomplete |
| | Z70 | 0002 | Z0 | 02 | Absolute position reference data lost |
| | Z70 | 0003 | Z0 | 03 | Absolute position parameter changed or lost |
| | Z71 | 0001 | Z1 | 01 | Absolute position detector data lost |
| | Z73 | 0001 | Z3 | 01 | Battery voltage drop warning |
| | Z73 | 0003 | Z3 | 03 | Absolute position counter warning |
| | | | 88 display | | Watch dog |
| | Q01 | #### | q1 | ## | Emergency stop |
| Operation alarm | M01 | 0001 | M0 | 01 | Near-point dog length insufficient |
| | M01 | 0003 | M0 | 03 | Zero point return direction illegal |
| | M01 | 0004 | M0 | 04 | External interlock |
| | M01 | 0005 | M0 | 05 | Internal interlock |
| | M01 | 0007 | M0 | 07 | Soft limit |
| | M01 | 0024 | M0 | 24 | In absolute position alarm. Zero point return not possible. |
| | M01 | 0025 | M0 | 25 | In initializing absolute position. Zero point return not possible. |
| | M01 | 0101 | M1 | 01 | No operation mode |
| | M01 | 0103 | M1 | 03 | Feedrate 0 |
| | M01 | 0160 | M1 | 60 | Station No. designation illegal. Starting not possible. |
| | M01 | 0161 | M1 | 61 | Zero point return incomplete. Starting not possible. |
| | M01 | 0162 | M1 | 62 | In initializing zero point. Starting not possible. |
| | M01 | 0163 | M1 | 63 | In absolute position alarm. Starting not possible. |
| | M01 | 0164 | M1 | 64 | In random positioning mode. Manual operation not possible. |
| | M01 | 0165 | M1 | 65 | Uneven indexing station No. illegal. Starting not possible. |

## 10-3 Detailed explanations and countermeasures of alarms
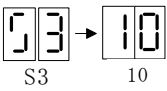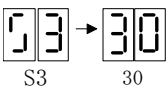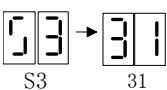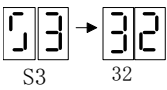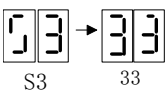
### 10-3-1 Detailed explanations and countermeasures for servo alarms
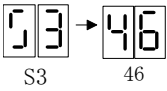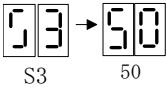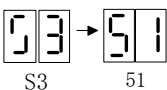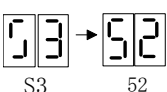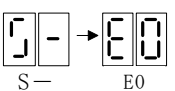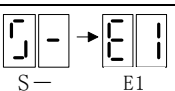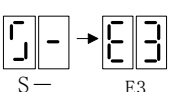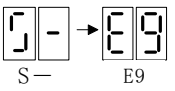
These alarms indicate that an error has occurred in the servo control circuit.

| Personal computer display | Main unit LED display | Name | Details | Cause | Remedy |
|---|---|---|---|---|---|
| S01 0011 | S1 → 11 | PCB error 1 | An error occurred in the drive unit's internal PCB. | Servo drive unit internal part fault <Investigation method> • Alarm (AL11) occurs even when all connectors are disconnected and power is turned ON. | Replace servo drive unit. |
| S01 0013 | S1 → 13 | Software processing timeout, clock error | An error occurred in the drive unit's internal reference clock. | | Replace servo drive unit. |
| S01 0016 | S1 → 16 | Motor type, detector type error | Motor type error | A type or capacity motor that cannot be driven is connected. | Use a correct drive unit and motor combination. |
| | | | Detector initial communication error. | The detector cable connector is disconnected. | Connect correctly. |
| | | | | Detector fault. | Replace the motor. |
| | | | | Detector cable defect (broken wire or short circuit) | Replace or repair cable. |
| | | | Detector CPU error | Detector fault. | Replace the motor (detector). |
| S01 0017 | S1 → 17 | PCB error (A/D conversion initial error) | An error occurred in the drive unit's internal A/D converter. | Servo drive unit internal part fault <Investigation method> • Alarm (AL10) occurs even when all connectors are disconnected and power is turned ON. | Replace servo drive unit. |
| S01 0025 | S1 → 25 | Absolute position lost | An error occurred in the detector's internal absolute position data. | The voltage of the super capacitor in the detector has dropped. (During setup or when unit was left with detector cable disconnected for one hour or more.) | Turn the power ON for 2 to 3 minutes while the alarm is occurring, and then turn the power ON again. |
| | | | | Battery voltage drop | Replace the battery, and initialize the absolute position again. |
| S01 0034 | S1 → 34 | CRC error | An error occurred in the communication with the NC. | An error occurred in the communication data due to disturbance such as noise. | Take countermeasures against noise. |
| S01 0036 | S1 → 36 | Communication timeout, NC down | Communication with the NC was cut off. | The bus cable (SH21) connection was disconnected. | Connect correctly. |
| | | | | The NC power was turned OFF. | Turn the NC power ON. |
| | | | | The drive unit or NC is faulty. | Replace the drive unit or NC. |
| S01 0037 | S1 → 37 | Parameter error | The parameter setting value is incorrect. | An external regenerative resistor that is not combined was designated with parameter #002. | Set the parameter correctly. |
| S01 0038 | S1 → 38 | Frame error | An error occurred in the communication with the NC. | An error occurred in the communication data due to disturbance such as noise. | Take countermeasures against noise. |
| S01 0039 | S1 → 39 | INFO error | Undefined data was transferred from the NC. | An incompatible NC is connected to. | Change the NC software version to a compatible version. |

| | | | | | |
|---|---|---|---|---|---|
| These alarms indicate that an error has occurred in the servo control circuit. | | | | | |
| **Personal computer display** | **Main unit LED display** | **Name** | **Details** | **Cause** | **Remedy** |
| S02   0011 | S2 → 11 | PCB error 1 (drive circuit error) | An error occurred in the drive unit's internal PCB. | Servo drive unit internal part fault <Investigation method> • Alarm (AL11) occurs even when all connectors are disconnected and power is turned ON. | Replace servo drive unit. |
| S02   0013 | S2 → 13 | Software processing timeout, clock error | An error occurred in the drive unit's internal reference clock. | | Replace servo drive unit. |
| S02   0015 | S2 → 15 | EEROM error | A write error occurred to the EEROM in the drive unit. | EEROM defect | Replace servo drive unit. |
| S02   0017 | S2 → 17 | PCB error (A/D conversion error) | An error occurred in the drive unit's internal A/D converter. | Servo drive unit internal part fault <Investigation method> • Alarm (AL17) occurs even when all connectors are disconnected and power is turned ON. | Replace servo drive unit. |
| S02   0018 | S2 → 18 | PCB error (LSI error) | An error occurred in the drive unit's internal LSI. | Servo drive unit internal part fault <Investigation method> • Alarm (AL18) occurs even when all connectors are disconnected and power is turned ON. | Replace servo drive unit. |
| S02   0020 | S2 → 20 | Detector error | An error occurred in the communication between the servo drive unit and detector. | • The detector cable connection is disconnected. | Connect correctly. |
| | | | | • Detector cable defect (broken wire or short circuit) | Replace or repair cable. |
| S02   0024 | S2 → 24 | Ground fault detection | A ground fault of the output was detected when the power was turned ON. | • There is a ground fault in the output wire or the in the motor. | Repair the ground fault section. Replace the cable or motor. |

| These alarms indicate that an error has occurred in the servo control circuit. | | | | | |
|---|---|---|---|---|---|
| **Personal computer display** | **Main unit LED display** | **Name** | **Details** | **Cause** | **Remedy** |
| S03　0010 | S3 → 10 | Undervoltage | The power voltage is 160V or less. | The power voltage is low. | Review the power supply. |
| | | | | A momentary power failure lasting 15ms or longer occurred. | |
| | | | | The power capacity is insufficient causing a power voltage drop when starting. | |
| | | | | The power was turned ON immediately after turning the power OFF. | |
| | | | | Servo drive unit internal part fault <Investigation method> • Alarm (AL10) occurs even when all connectors are disconnected and power is turned ON. | Replace the servo drive unit. |
| S03　0030 | S3 → 30 | Regeneration error | The tolerable regeneration power of the internal regenerative resistor or external regenerative option was exceeded. | Parameter #002 setting is incorrect. | Set correctly. |
| | | | | The external regenerative option is not connected, or the TE2 short cable is not connected. | Connect correctly. |
| | | | | The tolerable regeneration power was exceeded due to high frequency operation or continuous regeneration operation. | Lower the positioning frequency. Change the regenerative option to a larger capacity. Lower the load. |
| | | | | The power voltage was 260V or more. | Review the power supply. |
| | | Regenerative transistor error | | The regenerative transistor in the servo drive unit is faulty. <Investigation method> The alarm occurs even when the external regenerative option and TE2 short cable is disconnected. | Replace the servo drive unit. |
| S03　0031 | S3 → 31 | Overspeed | The motor's speed exceeded the tolerable momentary speed. | The acceleration/deceleration time constant is small casing a large overshoot. | Increase the acceleration/deceleration time constant. |
| | | | | The electronic gear ratio is large. | Review the gear ratio. |
| | | | | Detector fault. | Replace the detector. |
| S03　0032 | S3 → 32 | Overcurrent | A current exceeding the servo drive unit's tolerable current flowed. | The servo drive unit's output U, V and W phases are short circuited. | Repair the wiring. |
| | | | | The servo drive unit's output U, V and W phases ground faulted during operation. | Replace the servo drive unit. |
| | | | | | Correct the wiring. |
| | | | | The overcurrent detection circuit malfunctioned due to external noise. The servo drive unit's power module is faulty. <Investigation method> Alarm 32 occurs even when the servo drive unit output (terminal block TE1's U, V, W) is disconnected. | Take countermeasures against noise. |
| S03　0033 | S3 → 33 | Overvoltage | The voltage of the converter in the servo drive unit was 400V or more. | The TE2 short cable or external regenerative resistor lead wire is broken or disconnected. | Wire correctly. |
| | | | | The regenerative resistance transistor is faulty. | Replace the servo drive unit. |
| | | | | The internal regenerative resistor or external regenerative option has a broken wire. | For the internal regenerative resistor, replace the drive unit. For the external regenerative option, replace the regenerative option. |

| These alarms indicate that an error has occurred in the servo control circuit. | | | | | |
|---|---|---|---|---|---|
| Personal computer display | Main unit LED display | Name | Details | Cause | Remedy |
| S03　0046 | `S3 → 46` | Motor overheating | An operation state causing the motor to overheat continued. | The servomotor is in the overload state. | Reduce the motor load. Review the operation pattern. |
| | | | | The thermal protector in the detector is faulty. | Replace the detector. |
| S03　0050 | `S3 → 50` | Overload 1 | The servo drive unit or servo overload protection function activated. (Refer to the graph in 11-1 Overload protection characteristics.) | The servomotor's continuous output exceeded the rated output. | Reduce the motor load. Review the operation pattern. Change to a motor or drive unit with large output. |
| | | | | The servo drive unit output exceeded the tolerable instantaneous output. | |
| | | | | The servo system is unstable, and hunting is occurring. | Change the setting of the automatic tuning response characteristics. |
| | | | | The motor connection is incorrect. | Correct the connection. |
| | | | | The detector is faulty. | Replace the servomotor. |
| S03　0051 | `S3 → 51` | Overload 2 | The max. output current flowed for several seconds due to a machine collision or overload. | The machine stopper or others was collided against. | Review the operation pattern. |
| | | | | The motor connection is incorrect. | Correct the connection. |
| | | | | The servo system is unstable, and hunting is occurring. | Change the setting of the automatic tuning response characteristics. |
| | | | | The detector is faulty. | Replace the servomotor. |
| S03　0052 | `S3 → 52` | Excessive error | A position deflection exceeding the excessive error detection setting value occurred. | The acceleration/deceleration time constant is too low. | Increase the acceleration/ deceleration time constant. |
| | | | | The torque limit value is too low. | Increase the torque limit value. |
| | | | | Starting is not possible due to low torque caused by power voltage drop. | Review the power facility capacity. Use a motor with a large output. |
| | | | | The machine stopper or others was collided against. | Review the operation pattern. |
| | | | | The detector is faulty. | Replace the servomotor. |
| | | | | The motor connection is incorrect. | Connect correctly. |
| | | | | Communication cable defect (broken wire or short circuit) | Repair or replace the cable. |

| | | | | | |
|---|---|---|---|---|---|
| These alarms indicate that an error has occurred in the servo control circuit. | | | | | |
| **Personal computer display** | **Main unit LED display** | **Name** | **Details** | **Cause** | **Remedy** |
| S52   0092 | S - → 92 | Battery voltage drop | The absolute position detection battery voltage dropped. | The battery is not mounted. | Mount a battery. |
| | | | | Battery life | Replace the battery and initialize the absolute position. |
| S52   00E0 | S - → E0 | Over-regeneration warning | The regeneration power may have exceeded the tolerable range of the built-in regenerative resistor or external regenerative option. | A level 85% or more of the built-in regenerative resistor or external regenerative option's tolerable regeneration power was reached. | 1. Lower the positioning frequency. 2. Change the regenerative option to a larger one. 3. Lower the load. |
| S52   00E1 | S - → E1 | Overload warning | The overload 1 alarm could occur. | 85% or more of the overload 1 alarm occurrence level was reached. | Refer to the items for S03 0050. |
| S52   00E3 | S - → E3 | Absolute position counter warning | There is an error in the absolute position detector internal data. | 1. Noise entered the detector. | Take countermeasures against noise. |
| | | | | 2. Detector fault. | Replace the servomotor. |
| S52   00E9 | S - → E9 | Main circuit OFF warning | | The servo ON signal was input while the main circuit power was OFF. The contactor operation is faulty. | Turn ON the main circuit power. |

## 10-3-2    Detailed explanations and countermeasures for system alarms
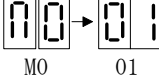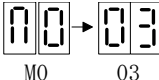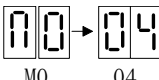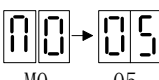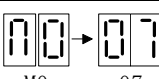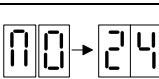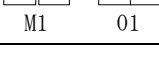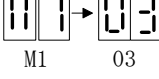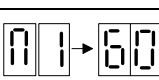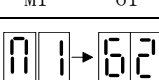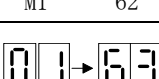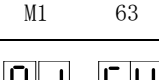
| Personal computer display | Main unit LED display | Name | Cause | Remedy |
|---|---|---|---|---|
| Z70  0001 | Z0 → 01 | Zero point initialization incomplete | The zero point (reference point) has not been initialized in the absolute position system. | Initialize the zero point (reference point). |
| Z70  0002 | Z0 → 02 | Absolute position reference data lost | The absolute position reference coordinate data in the drive unit has been lost. | Initialize the zero point (reference point). |
| Z70  0003 | Z0 → 03 | Absolute position system related parameter error | The absolute position system related parameters have been changed or lost. | Correctly set the parameters and then initialize the zero point (reference point). |
| Z71  0001 | Z1 → 01 | Absolute position detector data lost | The data in the detector has been lost due to a battery voltage drop.<br>Battery voltage drop<br>Detector cable wire breakage or looseness | Check the battery and detector cable and then initialize the zero point (reference point). |
| Z73  0001 | Z3 → 01 | Absolute position memory battery voltage warning | Battery voltage drop<br>Detector cable wire breakage or looseness | Check the battery and detector cable. The zero point does not need to be initialized. |
| Z73  0003 | Z3 → 03 | Absolute position counter warning | An error occurred in the detector's absolute position counter. | Replace the detector. |
|  | 88 | Watch dog | An error occurred in the drive unit's control circuit. | Replace the drive unit. |
| Q01  #### | Q1 → ## | Emergency stop | An emergency stop occurred due to a cause other than bus emergency stop input or external emergency stop input. | The emergency stop cause is displayed with bit correspondence in ##, so check the cause. |
|  | E7 | Emergency stop | A bus emergency stop or external emergency stop was input. | Check the NC emergency stop and external emergency stop. |

**<Details of emergency stop causes>**
Each bit data is displayed as a hexadecimal.

| bit 0 | Servo alarm |
|---|---|
| bit 1 | Absolute position lost |
| bit 2 | Bus emergency stop high-order input |
| bit 3 | Bus emergency stop low-order input |

| bit 4 | External emergency stop |
|---|---|
| bit 5 |  |
| bit 6 | PLC emergency stop |
| bit 7 | Other cause |
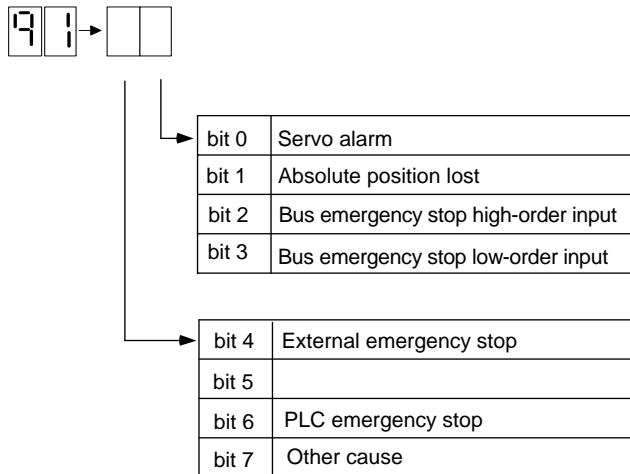
## 10-3-3   Detailed explanations and countermeasures for operation alarms

These alarms indicate that there is a mistake in the operation or in the operation command.

| Personal computer display | Main unit LED display | Name | Cause | Remedy |
|---|---|---|---|---|
| M01  0001 | M0 → 01 | Near-point dog length insufficient | When executing dog-type reference point, the zero point return speed is too fast or the dog length is too short. | Lower the zero point return speed or increase the dog length. |
| M01  0003 | M0 → 03 | Reference point return direction illegal | When executing reference point return, the axis was moved in the opposite of the designated direction. | Move the axis in the correct direction. |
| M01  0004 | M0 → 04 | External interlock | The axis interlock function is valid. | Cancel the interlock signal |
| M01  0005 | M0 → 05 | Internal interlock | An interlock was established by the servo OFF function. | Cancel the servo OFF. |
| M01  0007 | M0 → 07 | Soft limit | The soft limit was reached. | Check the soft limit setting and machine position |
| M01  0024 | M0 → 24 | In absolute position alarm. Reference point return not possible. | Reference point return was executed during an absolute position alarm. | Initialize the absolute position reference point and then fix the absolute position coordinates. |
| M01  0025 | M0 → 25 | In initializing absolute position. Reference point return not possible. | Reference point return was executing while initializing the absolute position. | Initialize the absolute position reference point and then fix the absolute position coordinates. |
| M01  0101 | M1 → 01 | No operation mode | The operation mode is not designated, or the operation mode was changed during axis movement. | Correctly designate the operation mode. |
| M01  0103 | M1 → 03 | Feedrate 0 | The operation parameter's feedrate setting is zero. The operation parameter feedrate setting is zero. Or, the override is valid, and the override value is zero. | Set a value other than zero in the feedrate setting or over-ride value. |
| M01  0160 | M1 → 60 | Station No. designation illegal. Starting not possible. | A station No. exceeding the No. of indexed divisions was designated. | Correctly designate the station No. |
| M01  0161 | M1 → 61 | Reference point return incomplete. Starting not possible. | Automatic/manual operation was started before reference point return was executed with the incremental system. | Execute the reference point return. |
| M01  0162 | M1 → 62 | In initializing reference point. Starting not possible. | The start signal was input while initializing the absolute position reference point. | Complete the absolute position reference point initialization. |
| M01  0163 | M1 → 63 | In absolute position alarm. Starting not possible. | The start signal was input during an absolute position alarm. | Initialize the absolute position reference point and then fix the absolute position coordinates. |
| M01  0164 | M1 → 64 | In random positioning mode. Manual operation not possible. | The manual operation mode was started during the random positioning mode. | Turn the random positioning mode OFF before switching to the manual operation mode. |
| M01  0165 | M1 → 65 | Uneven indexing station No. illegal. Starting not possible. | During uneven indexing, the commanded station No. exceeded the number of indexing stations or 9. | Check the commanded station No. and #100 No. of indexing stations. |

# Chapter 11    Characteristics

## 11-1   Overload protection characteristics

The servo drive unit has an electronic thermal relay to protect the servomotor and servo drive unit from overloads. The operation characteristics of the electronic thermal relay are shown below.

If overload operation over the electronic thermal relay protection curve shown below is carried out, overload 1 alarm will occur. If the maximum current flows continuously for several seconds due to a machine collision, etc., overload 2 alarm will occur. Use within the region to the left of the solid or dotted line in the graph.

When applying a load while stopped (during servo lock), make sure that 70% or the rated torque is not exceeded.

a : HC-MF Series
    HA-FF Series
    (300W or more)
    HC-SF Series
    HC-RF Series
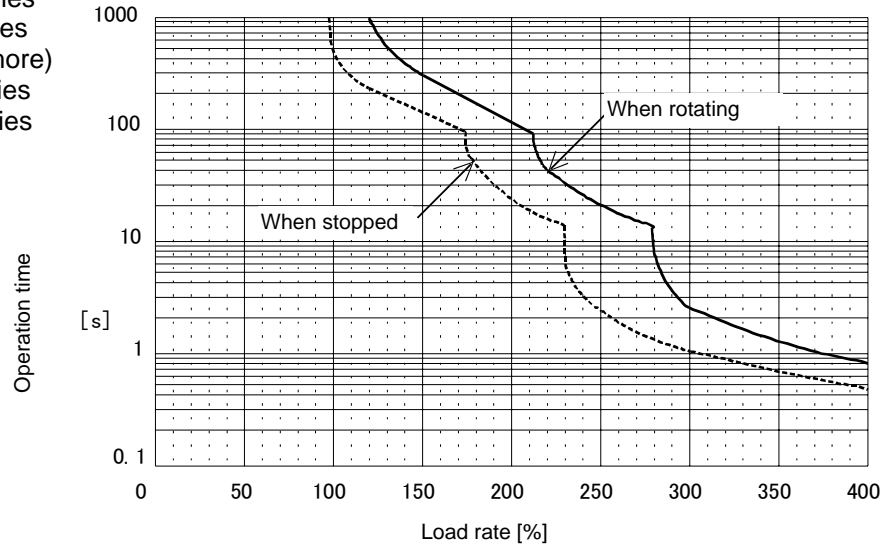
b : HA-FF Series
    (200W or less)
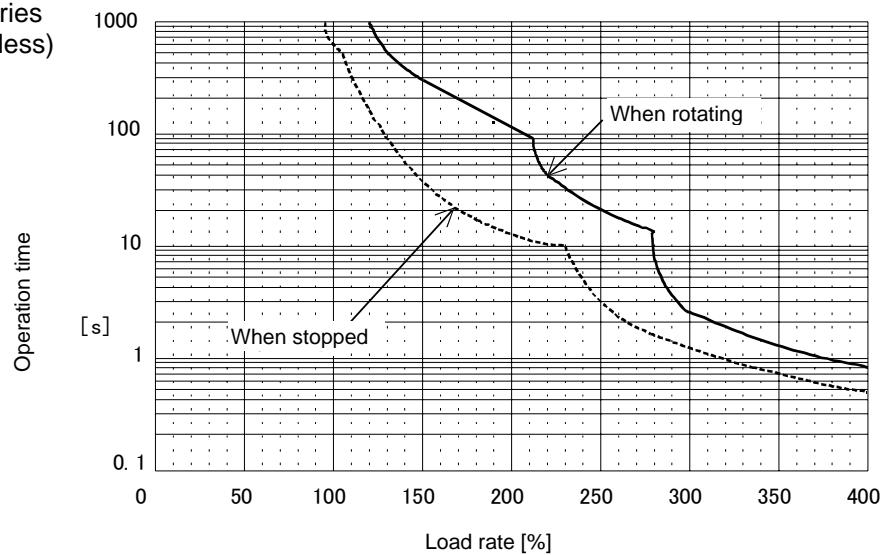
**Fig. 11-1   Overload protection characteristics of MR-J2-CT**

## 11-2   Servo drive unit generation loss

### 11-2-1   Servo drive unit calorific value

The servo drive unit calorific value is determined from the following table by the motor with which the servo drive unit is combined. The calorific value for the actual machine will be a value between the calorific values at the stall torque (at the rated torque) and the zero torque according to the frequency during operation. Consider the worst usage conditions for the thermal design of the fully closed type control panel, and use the values given below. Even when the servomotor is run below the maximum speed, the servo drive unit calorific value will not change if the generated torque is the same.

**Table 11-1   Servo drive unit calorific values**

| Motor type | Calorific value (W) | | Area required for heat radiation (m$^2$) | Motor type | Calorific value (W) | | Area required for heat radiation (m$^2$) |
|---|---|---|---|---|---|---|---|
| | At rated torque | At zero torque | | | At rated torque | At zero torque | |
| HC-SF52 | 40 | 15 | 0.8 | HC-FF053 | 25 | 15 | 0.5 |
| HC-SF102 | 50 | 15 | 1.0 | HC-FF13 | 25 | 15 | 0.5 |
| HC-SF152 | 60 | 20 | 1.2 | HC-FF23 | 25 | 15 | 0.5 |
| HC-SF202 | 85 | 20 | 1.7 | HC-FF33 | 30 | 15 | 0.6 |
| HC-SF352 | 140 | 20 | 2.8 | HC-FF43 | 35 | 15 | 0.7 |
| HC-SF53 | 40 | 15 | 0.8 | HC-FF63 | 40 | 15 | 0.8 |
| HC-SF103 | 50 | 15 | 1.0 | | | | |
| HC-SF153 | 60 | 20 | 1.2 | HC-MF053 | 25 | 15 | 0.5 |
| HC-SF203 | 85 | 20 | 1.7 | HC-MF13 | 25 | 15 | 0.5 |
| HC-SF353 | 140 | 20 | 2.8 | HC-MF23 | 25 | 15 | 0.5 |
| | | | | HC-MF43 | 35 | 15 | 0.7 |
| HC-RF103 | 45 | 15 | 0.9 | HC-MF73 | 50 | 15 | 1.0 |
| HC-RF153 | 60 | 20 | 1.2 | | | | |
| HC-RF203 | 120 | 20 | 2.4 | | | | |

| | |
|---|---|
| 💡 **POINT** | 1. The heat generated by the regeneration resistor is not included in the servo drive unit calorific value. Refer to section "13-4 Selection of regenerative resistor" and calculate the calorific value of the regenerative resistor using the regeneration load and positioning frequency.<br>2. The area required for heat radiation is the heat radiation area (guideline) of the fully closed type control panel storing the servo drive unit when using the unit at an ambient temperature of 40°C and stall (rated) load. |

## 11-2-2   Heat radiation area of fully closed type control panel

Set the temperature in the fully closed type control panel (hereafter control panel) in which the servo drive unit is stored so that the ambient temperature is 40°C +10°C or less. (Provide a 5°C allowance in respect to the maximum working environmental conditions temperature of 55°C.) The control panel heat radiation area is usually calculated with the following expression.

$$A = \frac{P}{K \cdot \triangle T} \quad \text{.............. (11-1)}$$

A : Heat radiation area [m²]
P : Loss generated in control panel
$\triangle T$ : Temperature difference between control panel and outside air [°C]
K : Heat radiation coefficient (5 ~ 6)
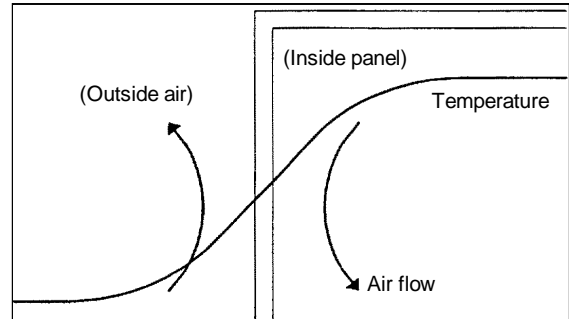
**Fig. 11-2   Fully closed type control panel temperature gradient**

When calculating the heat radiation area with the above expression (11-1), use P as the total loss generated in the control panel. Refer to the table in section "11-2-1 Servo drive unit calorific value" for the servo drive unit calorific values. A indicates the area effective for heat radiation, so if the control panel is directly installed on a heat insulating wall, etc., provide the control panel's surface area as an allowance.

When air flows along the outside of the panel, the temperature slope will become sudden, and an effective heat exchange will be possible both inside and outside of the fully closed control type panel.

The required heat radiation area will also differ according to the conditions in the control panel. If the convection in the control panel is poor, effective heat radiation will not be possible. In this case, when designing the control panel, consider the placement of devices in the control panel, and mixing the air with a fan, etc.

## 11-3  Magnetic brake characteristics

<table>
<tr>
<td rowspan="2" style="text-align:center; vertical-align:middle;">⚠ **CAUTION**</td>
<td>

1. The axis will not be mechanically held even when the dynamic brakes are used. If the machine could drop when the power fails, use a servomotor with magnetic brakes or provide an external brake mechanism as holding means to prevent dropping.
2. The magnetic brakes are used for holding, and must not be used for normal braking. There may be cases when holding is not possible due to the life or machine structure (when ball screw and servomotor are coupled with a timing belt, etc.). Provide a stop device on the machine side to ensure safety. When releasing the brakes, always confirm that the servo is ON first.
3. When operating the brakes, always turn the servo OFF (or ready OFF). When releasing the brakes, always confirm that the servo is ON first. Sequence control considering this condition is possible if the drive unit motor brake control signal (MBR) is used.
4. When the vertical axis drop prevention function is used, the drop of the vertical axis at the servo OFF command input can be suppressed to a minimum.

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

### 11-3-1  Motor with magnetic brakes

**(1) Types**

The motor with magnetic brakes is set for each motor. The "B" following the standard motor type indicates the motor with brakes.

**(2) Applications**

When this type of motor is used for the vertical feed axis in a machining center, etc., slipping and dropping of the spindle head can be prevented even when the hydraulic balancer's hydraulic pressure reaches zero when the power turns OFF. When used with a robot, deviation of the posture when the power is turned OFF can be prevented.
When used for the feed axis of a grinding machine, a double safety measures is formed with the deceleration stop (dynamic brake stop), and the risks of colliding with the grinding stone and scattering can be prevented.
This motor cannot be used for purposes other than holding and braking during a power failure (emergency stop). (This cannot be used for normal deceleration, etc.)

**(3) Features**

① The magnetic brakes use a DC excitation method, thus:
   • The brake mechanism is simple and the reliability is high.
   • There is no need to change the brake tap between 50 Hz and 60 Hz.
   • There is no rush current when the excitation occurs, and shock does not occur.
   • The brake section is not larger than the motor section.
② The magnetic brakes are built into the motor, and the installation dimensions (flange size) are the same as the motor without brakes.

## 11-3-2 Magnetic brake characteristics

### Table 11-2 (1) Magnetic brake characteristics 1

| Item / Motor type | | | HC-SF Series | | HC-RF Series |
|---|---|---|---|---|---|
| | | | **52B, 102B, 152B**<br>**53B, 103B, 153B** | **202B, 352B**<br>**203B, 353B** | **103B, 153B, 203B** |
| Type (Note 1) | | | Spring braking type safety brakes | | |
| Rated voltage | | | 24 VDC | | |
| Rated current at 20°C | (A) | | 0.8 | 1.4 | 0.8 |
| Excitation coil resistance at 20°C | (Ω) | | 29 | 16.8 | 30 |
| Capacity | (W) | | 19 | 34 | 19 |
| Attraction current | (A) | | 0.2 | 0.4 | 0.25 |
| Dropping current | (A) | | 0.08 | 0.2 | 0.085 |
| Static friction torque | (N·m) | | 8.3 | 43.1 | 6.8 |
| Inertia (Note 2) | (kg·cm$^2$) | | 2.0 | 10 | 0.35 |
| Release delay time (s) (Note 3) | | | 0.04 | 0.1 | 0.03 |
| Braking delay time (Note 3) | AC OFF (s) | | 0.12 | 0.12 | 0.12 |
| | DC OFF (s) | | 0.03 | 0.03 | 0.03 |
| Tolerable braking work amount | Per braking | (J) | 400 | 4,500 | 400 |
| | Per hour | (J) | 4,000 | 45,000 | 4,000 |
| Brake play at motor axis (°) | | | 0.2 ~ 0.6 | 0.2 ~ 0.6 | 0.2 ~ 0.6 |
| Brake life (Note 4) | No. of braking operations (times) | | 20,000 | 20,000 | 20,000 |
| | Braking amount per braking | (J) | 200 | 1,000 | 200 |

**Table 11-2 (2)   Magnetic brake characteristics 2**

| Item | Motor type | | HA-FF Series | | | HC-MF Series | | |
|---|---|---|---|---|---|---|---|---|
| | | | 053B, 13B | 23B, 33B | 43B, 63B | 053B, 13B | 23B, 43B | 73B |
| Type (Note 1) | | | Spring braking type safety brakes | | | | | |
| Rated voltage | | | 24 VDC | | | | | |
| Rated current at 20°C | | (A) | 0.22 | 0.31 | 0.46 | 0.26 | 0.33 | 0.42 |
| Excitation coil resistance at 20°C | | (Ω) | 111 | 78 | 52 | 91 | 73 | 57 |
| Capacity | | (W) | 7 | 7.4 | 11 | 6.3 | 7.9 | 10 |
| Attraction current | | (A) | 0.15 | 0.2 | 0.3 | 0.18 | 0.18 | 0.2 |
| Dropping current | | (A) | 0.06 | 0.06 | 0.1 | 0.06 | 0.11 | 0.12 |
| Static friction torque | | (N·m) | 0.39 | 1.18 | 2.3 | 0.32 | 1.3 | 2.4 |
| Inertia (Note 2) | | (kg·cm$^2$) | 0.02 | 0.13 | 0.34 | 0.0031 | 0.04 | 0.13 |
| Release delay time (Note 3) | | (s) | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| Braking delay time (sec) (Note 3) | AC OFF | (s) | 0.08 | 0.1 | 0.12 | 0.08 | 0.1 | 0.12 |
| | DC OFF | (s) | 0.01 | 0.03 | 0.03 | 0.01 | 0.02 | 0.03 |
| Tolerable braking work amount | Per braking | (J) | 3.9 | 18.0 | 46.0 | 5.6 | 22.0 | 64.0 |
| | Per hour | (J) | 39 | 180 | 460 | 56 | 220 | 640 |
| Brake play at motor axis | | (°) | 0.3 ~ 3.5 | 0.2 ~ 2.0 | 0.2 ~ 1.3 | 0.19 ~ 2.5 | 0.12 ~ 1.2 | 0.1 ~ 0.9 |
| Brake life (Note 4) | No. of braking operations | (times) | 30,000 | 30,000 | 30,000 | 20,000 | 20,000 | 20,000 |
| | Braking amount per braking | (J) | 4 | 18 | 47 | 4 | 15 | 32 |

**Notes:**
1. There is no manual release mechanism. If handling is required such as during the machine core alignment work, prepare a separate 24 VDC power supply, and electrically release the brakes.
2. These are the values added to the servomotor without brakes.
3. This is the value for 20°C at the initial attraction gap.
4. The brake gap will widen through brake lining wear caused by braking. However, the gap cannot be adjusted. Thus, the brake life is reached when adjustments are required.
5. The internal power output (VDD) 24 VDC for digital output cannot be used. Always prepare a separate power supply.
6. A leakage flux will be generated at the shaft end of the servomotor with magnetic brakes.
7. When operating in low speed regions, the sound of loose brake lining may be heard. However, this is not a problem in terms of function.

### 11-3-3    Magnetic brake power supply

| ⚠ **CAUTION** | 1. The internal power supply output (VDD) 24 VDC as digital output cannot be used for the magnetic brake release power supply. Always prepare an external release power supply dedicated for the magnetic brakes.<br>2. Always install a surge absorber on the brake terminal when using DC OFF.<br>3. Do not connector or disconnect the cannon plug while the brake power is ON. The cannon plug pins could be damaged by sparks. |
|---|---|

#### (1)  Brake excitation power supply

① Prepare a brake excitation power supply that can accurately ensure the attraction current in consideration of the voltage fluctuation and excitation coil temperature.

② The brake terminal polarity is random. Make sure not to mistake the terminals with other circuits.

#### (2)  Brake excitation circuit

(a) AC OFF and (b) DC OFF can be used to turn OFF the brake excitation power supply (to apply the brakes).

#### (a) AC OFF

The braking delay time will be longer, but the excitation circuit will be simple, and the relay cut off capacity will be smaller.

#### (b) DC OFF

The braking delay time can be shortened, but a surge absorber will be required and the relay cut off capacity will increase.

##### <Cautions>

• Provide sufficient DC cut off capacity at the contact.

• Always use a serge absorber.

• When using the cannon plug type, the surge absorber will be further away, so use shielded wires between the motor and surge absorber.



**(a) Example of AC OFF**          **(b) Example of DC OFF**
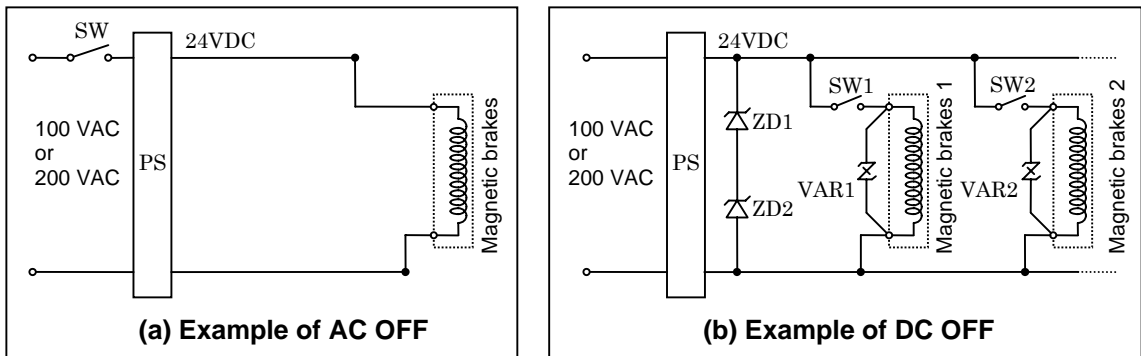
PS          : 25 VDC stabilized power supply
ZD1, ZD2    : Zener diode for power supply
                protection (1W, 24V)
VAR1, VAR2: Surge absorber (220V)

**Fig. 11-3    Magnetic brake circuits**

## 11-4    Dynamic brake characteristics

When an emergency stop occurs due to an alarm occurrence, the dynamic brakes will activate and the motor will stop. (A deceleration control stop can also be selected with the parameter setting.)

### 11-4-1    Deceleration torque

The dynamic brakes use the motor as a generator, and obtains the deceleration torque by consuming that energy with the dynamic brake resistance. The characteristics of this deceleration torque have a maximum deceleration torque (Tdp) regarding the motor speed as shown in the following drawing. The torque for each motor is shown in the following table.
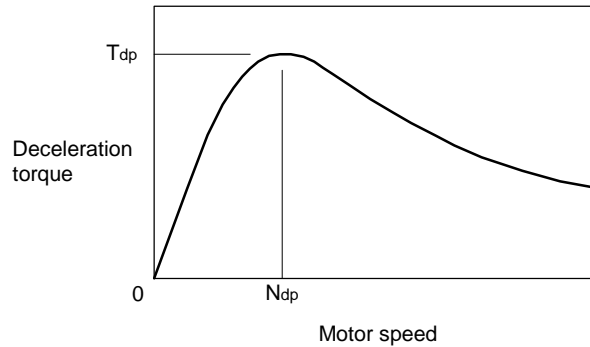


**Fig. 11-4    Deceleration torque characteristics of a dynamic brake stop**

**Table 11-3    Max. deceleration torque of a dynamic brake stop**

| Motor type | Rated torque (N·m) | $T_{dp}$ (N·m) | $N_{dp}$ (r/min) | Motor type | Rated torque (N·m) | $T_{dp}$ (N·m) | $N_{dp}$ (r/min) |
|---|---|---|---|---|---|---|---|
| HA-SF52 | 2.39 | 2.40 | 496 | HA-FF053 | 0.16 | 0.12 | 3509 |
| HA-SF102 | 4.78 | 5.59 | 473 | HA-FF13 | 0.32 | 0.17 | 2646 |
| HA-SF152 | 7.16 | 18.49 | 1062 | HA-FF23 | 0.64 | 0.38 | 1163 |
| HA-SF202 | 9.55 | 10.56 | 457 | HA-FF33 | 0.95 | 0.56 | 1064 |
| HA-SF352 | 16.70 | 32.57 | 945 | HA-FF43 | 1.30 | 0.75 | 668 |
| HA-SF53 | 1.59 | 2.54 | 472 | HA-FF63 | 1.90 | 0.96 | 624 |
| HA-SF103 | 3.18 | 5.36 | 417 | | | | |
| HA-SF153 | 4.78 | 18.88 | 1676 | HC-MF053 | 0.16 | 0.11 | 1445 |
| HA-SF203 | 6.37 | 10.63 | 771 | HC-MF13 | 0.32 | 0.34 | 1642 |
| HA-SF353 | 11.1 | 22.94 | 1338 | HC-MF23 | 0.64 | 0.40 | 465 |
| | | | | HC-MF43 | 1.30 | 0.76 | 426 |
| HC-RF103 | 3.18 | 3.67 | 582 | HC-MF73 | 2.40 | 1.59 | 260 |
| HC-RF153 | 4.78 | 5.44 | 668 | | | | |
| HC-RF203 | 6.37 | 7.16 | 973 | | | | |

## 11-4-2  Coasting amount

The motor coasting amount when stopped by a dynamic brake can be approximated using the following expression.

$$C_{MAX} = \frac{No}{60} \bullet te + \left( 1 + \frac{J_L}{J_M} \right) \bullet (A \bullet No^3 + B \bullet No)$$

$C_{MAX}$  :  Maximum motor coasting amount        (turn)
No    :  Initial motor speed                          (r/min)
$J_M$    :  Motor inertia                              (kg·cm$^2$)
$J_L$    :  Motor shaft conversion load inertia        (kg·cm$^2$)
te    :  Brake drive relay delay time              (s)    (Normally, 0.03s)
A     :  Coefficient A (Refer to the table below)
B     :  Coefficient B (Refer to the table below)
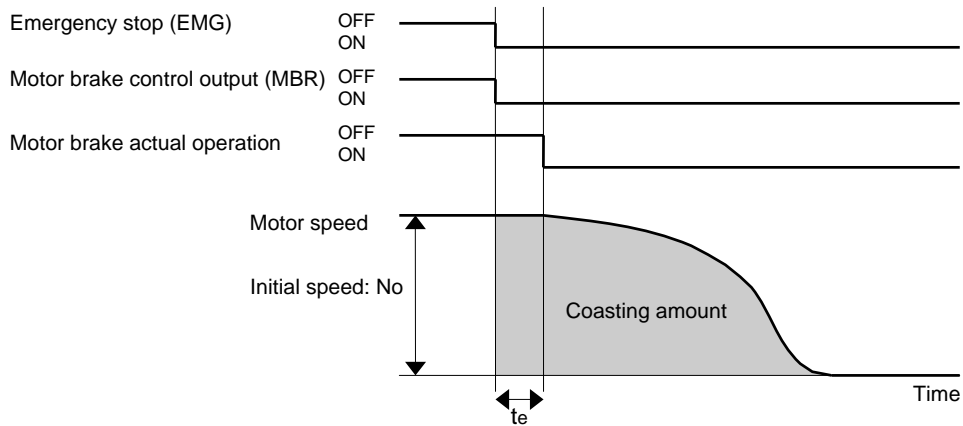


**Fig. 11-5    Dynamic brake braking diagram**

**Table 11-4    Coasting amount calculation coefficients**

| Motor type | $J_M$ (kg·cm$^2$) | A | B | Motor type | $J_M$ (kg·cm$^2$) | A | B |
|---|---|---|---|---|---|---|---|
| HA-SF52 | 6.5 | $16.13 \times 10^{-11}$ | $11.93 \times 10^{-5}$ | HA-FF053 | 0.063 | $0.11 \times 10^{-11}$ | $16.21 \times 10^{-5}$ |
| HA-SF102 | 13.6 | $14.97 \times 10^{-11}$ | $10.03 \times 10^{-5}$ | HA-FF13 | 0.095 | $0.15 \times 10^{-11}$ | $12.72 \times 10^{-5}$ |
| HA-SF152 | 20.0 | $2.96 \times 10^{-11}$ | $10.03 \times 10^{-5}$ | HA-FF23 | 0.35 | $0.58 \times 10^{-11}$ | $9.35 \times 10^{-5}$ |
| HA-SF202 | 42.5 | $25.60 \times 10^{-11}$ | $16.07 \times 10^{-5}$ | HA-FF33 | 0.5 | $0.61 \times 10^{-11}$ | $8.23 \times 10^{-5}$ |
| HA-SF352 | 82.0 | $7.75 \times 10^{-11}$ | $20.76 \times 10^{-5}$ | HA-FF43 | 0.98 | $1.42 \times 10^{-11}$ | $7.60 \times 10^{-5}$ |
| HA-SF53 | 6.6 | $15.99 \times 10^{-11}$ | $10.71 \times 10^{-5}$ | HA-FF63 | 1.2 | $1.46 \times 10^{-11}$ | $6.83 \times 10^{-5}$ |
| HA-SF103 | 13.6 | $17.70 \times 10^{-11}$ | $9.24 \times 10^{-5}$ | | | | |
| HA-SF153 | 20.0 | $1.84 \times 10^{-11}$ | $15.49 \times 10^{-5}$ | HC-MF053 | 0.019 | $0.35 \times 10^{-11}$ | $2.17 \times 10^{-5}$ |
| HA-SF203 | 42.5 | $15.08 \times 10^{-11}$ | $26.92 \times 10^{-5}$ | HC-MF13 | 0.03 | $0.16 \times 10^{-11}$ | $1.27 \times 10^{-5}$ |
| HA-SF353 | 82.0 | $7.77 \times 10^{-11}$ | $41.74 \times 10^{-5}$ | HC-MF23 | 0.088 | $1.38 \times 10^{-11}$ | $0.90 \times 10^{-5}$ |
| | | | | HC-MF43 | 0.143 | $1.29 \times 10^{-11}$ | $0.70 \times 10^{-5}$ |
| HC-RF103 | 1.5 | $2.04 \times 10^{-11}$ | $2.07 \times 10^{-5}$ | HC-MF73 | 0.6 | $4.29 \times 10^{-11}$ | $0.87 \times 10^{-5}$ |
| HC-RF153 | 1.9 | $1.52 \times 10^{-11}$ | $2.04 \times 10^{-5}$ | | | | |
| HC-RF203 | 2.3 | $0.96 \times 10^{-11}$ | $2.73 \times 10^{-5}$ | | | | |

## 11-5    Vibration class

The vibration class of the servomotor is V-10 at the rated speed. The servomotor installation posture and measurement position to be used when measuring the vibration are shown below.
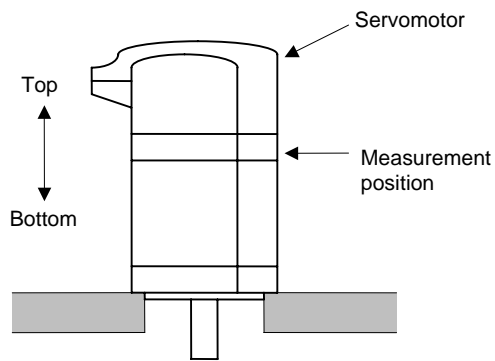


**Fig. 11-6    Servomotor vibration measurement conditions**

# Chapter 12    Specifications

## 12-1 Servo drive units

### 12-1-1 List of specifications

| Servo drive unit type (MR-J2-) | | 10CT | 20CT | 40CT | 60CT | 70CT | 100CT | 200CT | 350CT |
|---|---|---|---|---|---|---|---|---|---|
| Power supply | Voltage, frequency | 3-phase 200 to 230 VAC/ 50, 60 Hz | | | | | | | |
| | Tolerable voltage fluctuation | 3-phase 170 to 253 VAC/ 50, 60 Hz | | | | | | | |
| | Tolerable frequency fluctuation | Within ±5% | | | | | | | |
| Method | | Sine wave PWM control, current control method | | | | | | | |
| Dynamic brakes | | Built-in | | | | | | | |
| Regenerative resistor | | External only | Built-in or external option | | | | | | |
| External digital input | | External emergency stop input | | | | | | | |
| External digital output | | Contactor control output, motor brake control output | | | | | | | |
| External analog output | | ±10V, 2ch | | | | | | | |
| Protective functions | | Overcurrent cut off, over voltage cut off, overload cut off (electronic thermal relay), servomotor overheating protection, detector error protection, regeneration error protection, undervoltage, instantaneous power failure protection, overspeed protection, excessive error protection | | | | | | | |
| Structure | | Protection type (protection method: IP20) | | | | | | | |
| Environment conditions | | To follow section 3-1-1 Environmental conditions | | | | | | | |
| Weight [kg] | | 0.7 | 0.7 | 0.7 | 1.1 | 1.5 | 1.5 | 2.0 | 2.0 |

## 12-1-2 Outline dimension drawings

● **MR-J2-10CT, -20CT**

[Unit: mm]



50
6
ø6 installation
6
168
156
6
6
6
3 - M4 × 0.7 screw

Wiring allowance 70 or more
Heat radiation allowance 100 or more
135
Wiring allowance 40 or more
6 - M4 × 0.7 screw
4

● **MR-J2-40CT, -60CT**

Wiring allowance 70 or more
[Unit: mm]



70
22
ø6 installation
6
168
156
6
6
3 - M4 × 0.7 screw
22

Heat radiation allowance 100 or more
135
Wiring allowance 40 or more
6 - M4 × 0.7 screw
4

● **MR-J2-70CT, -100CT**

Wiring allowance
70 or more

[Unit: mm]

70

22

ø6 installation

190

6

168

156

6

Heat radiation
allowance
100 or more

22

6

6

6

6

Wiring
allowance
40 or more

3 - M4 × 0.7 screw

6 - M4 × 0.7 screw

6

● **MR-J2-200CT, -350CT**

[Unit: mm]

Wiring allowance
75 or more

90

6

6

2-ø6
installation hole

195

6

168

156

6

Heat radiation
allowance
100 or more

6

6

6

6

Wiring
allowance
40 or more

12- M4 × 0.7 screws    3- M4 × 0.7 screws

6

## 12-2   Servomotor

### 12-2-1   List of specifications

| Servomotor type | | HC-SF Series (2000r/min rating) | | | | |
|---|---|---|---|---|---|---|
| | | Absolute position standard | | | | |
| | | HC-SF52 | HC-SF102 | HC-SF152 | HC-SF202 | HC-SF352 |
| Corresponding servo drive unit type        MR-J2- | | 60CT | 100CT | 200CT | | 350CT |
| Continuous characteristics | Rated output   [kW] | 0.5 | 1.0 | 1.5 | 2.0 | 3.5 |
| | Rated current    [A] | 3.2 | 6.0 | 9.0 | 10.7 | 16.6 |
| | Rated torque  [N·m] | 2.39 | 4.78 | 7.16 | 9.55 | 16.7 |
| Rated speed                 [r/min] | | 2000 | | | | |
| Max. speed                 [r/min] | | 3000 | | | 2500 | |
| Max. current                   [A] | | 9.6 | 18 | 27 | 33 | 51 |
| Max. torque                [N·m] | | 7.16 | 14.4 | 21.6 | 28.5 | 50.1 |
| Motor inertia          [kg·cm$^2$] | | 6.6 | 13.7 | 20.0 | 42.5 | 82.0 |
| Motor inertia with brakes    [kg·cm$^2$] | | 8.6 | 15.7 | 22.0 | 52.5 | 92.0 |
| Recommended motor shaft conversion load inertia rate | | 10-times or less of motor inertia | | | | |
| Power facility capacity      [kVA] | | 1.0 | 1.7 | 2.5 | 3.5 | 5.5 |
| Speed/position detector | | Resolution per motor rotation 16384 (pulse/rev) | | | | |
| Structure | | Fully closed, self-cooling (protection method: IP65) | | | | |
| Environment conditions | | To follow section 3-2-1 Environment conditions | | | | |
| Weight   With/without brakes     [kg] | | 5.0 / 7.5 | 7.0 / 9.0 | 9.0 / 11 | 12 / 18 | 19 / 25 |
| Armature insulation class | | Class F | | | | |

**(Note)**  The above characteristic values are the central values. The maximum current and maximum torque are the values when combined with the drive unit.

| Servomotor type | | HC-SF Series (3000r/min rating) | | | | |
|---|---|---|---|---|---|---|
| | | Absolute position standard | | | | |
| | | HC-SF53 | HC-SF103 | HC-SF153 | HC-SF203 | HC-SF353 |
| Corresponding servo drive unit type        MR-J2- | | 60CT | 100CT | 200CT | | 350CT |
| Continuous characteristics | Rated output    [kW] | 0.5 | 1.0 | 1.5 | 2.0 | 3.5 |
| | Rated current     [A] | 3.2 | 5.4 | 8.6 | 10.2 | 16.8 |
| | Rated torque  [N·m] | 1.59 | 3.18 | 4.78 | 6.37 | 11.1 |
| Rated speed                 [r/min] | | 3000 | | | | |
| Max. speed                 [r/min] | | 3000 | | | | |
| Max. current                   [A] | | 9.6 | 16 | 26 | 31 | 49 |
| Max. torque                [N·m] | | 4.77 | 9.55 | 14.3 | 19.1 | 33.4 |
| Motor inertia          [kg·cm$^2$] | | 6.6 | 13.7 | 20.0 | 42.5 | 82.0 |
| Motor inertia with brakes    [kg·cm$^2$] | | 8.6 | 15.7 | 22.0 | 52.5 | 92.0 |
| Recommended motor shaft conversion load inertia rate | | 10-times or less of motor inertia | | | | |
| Power facility capacity      [kVA] | | 1.0 | 1.7 | 2.5 | 3.5 | 5.5 |
| Speed/position detector | | Resolution per motor rotation 16384 (pulse/rev) | | | | |
| Structure | | Fully closed, self-cooling (protection method: IP65) | | | | |
| Environment conditions | | To follow section 3-2-1 Environment conditions | | | | |
| Weight   With/without brakes     [kg] | | 5.0 / 7.5 | 7.0 / 9.0 | 9.0 / 11 | 12 / 18 | 19 / 25 |
| Armature insulation class | | Class F | | | | |

**(Note)**  The above characteristic values are the central values. The maximum current and maximum torque are the values when combined with the drive unit.

| Servomotor type | | HC-RF Series | | |
|---|---|---|---|---|
| | | Absolute position standard | | |
| | | HC-RF103 | HC-RF153 | HC-RF203 |
| Corresponding servo drive unit type  MR-J2- | | 200CT | | 350CT |
| Continuous characteristics | Rated output  [kW] | 1.0 | 1.5 | 2.0 |
| | Rated current  [A] | 6.1 | 8.8 | 14 |
| | Rated torque  [N·m] | 3.18 | 4.77 | 6.37 |
| Rated speed  [r/min] | | 3000 | | |
| Max. speed  [r/min] | | 4500 | | |
| Max. current  [A] | | 18.4 | 23.4 | 37 |
| Max. torque  [N·m] | | 7.95 | 11.9 | 15.9 |
| Motor inertia  [kg·cm²] | | 1.5 | 1.9 | 2.3 |
| Motor inertia with brakes  [kg·cm²] | | 1.9 | 2.3 | 2.7 |
| Recommended motor shaft conversion load inertia rate | | 5-times or less of motor inertia | | |
| Power facility capacity  [kVA] | | 1.7 | 2.5 | 3.5 |
| Speed/position detector | | Resolution per motor rotation 16384 (pulse/rev) | | |
| Structure | | Fully closed, self-cooling (protection method: IP65) | | |
| Environment conditions | | To follow section 3-2-1 Environment conditions | | |
| Weight  With/without brakes  [kg] | | 3.9 / 6.0 | 5.0 / 7.0 | 6.2 / 8.3 |
| Armature insulation class | | Class F | | |

**(Note)** The above characteristic values are the central values. The maximum current and maximum torque are the values when combined with the drive unit.

| Servomotor type | | HA-FF Series | | | | | |
|---|---|---|---|---|---|---|---|
| | | Absolute position standard | | | | | |
| | | HA-FF053 | HA-FF13 | HA-FF23 | HA-FF33 | HA-FF43 | HA-FF63 |
| Corresponding servo drive unit type  MR-J2- | | 10CT | | 20CT | 40CT | | 60CT |
| Continuous characteristics | Rated output  [kW] | 0.05 | 0.1 | 0.2 | 0.3 | 0.4 | 0.6 |
| | Rated current  [A] | 0.6 | 1.1 | 1.3 | 1.9 | 2.5 | 3.6 |
| | Rated torque  [N·m] | 0.16 | 0.32 | 0.64 | 0.95 | 1.3 | 1.9 |
| Rated speed  [r/min] | | 3000 | | | | | |
| Max. speed  [r/min] | | 4000 | | | | | |
| Max. current  [A] | | 1.8 | 3.3 | 3.9 | 5.7 | 7.5 | 10.8 |
| Max. torque  [N·m] | | 0.48 | 0.95 | 1.9 | 2.9 | 3.8 | 5.7 |
| Motor inertia  [kg·cm²] | | 0.063 | 0.095 | 0.35 | 0.5 | 0.98 | 1.2 |
| Motor inertia with brakes  [kg·cm²] | | 0.08 | 0.113 | 0.483 | 0.633 | 1.325 | 1.55 |
| Recommended motor shaft conversion load inertia rate | | 10-times or less of motor inertia | | | | | |
| Power facility capacity  [kVA] | | 0.3 | 0.3 | 0.5 | 0.7 | 0.9 | 1.1 |
| Speed/position detector | | Resolution per motor rotation  8192 (pulse/rev) | | | | | |
| Structure | | Fully closed, self-cooling (protection method: IP44, excluding connector section. IP54 for HA-FF∗∗C-UE Series.) | | | | | |
| Environment conditions | | To follow section 3-2-1 Environment conditions | | | | | |
| Weight  With/without brakes  [kg] | | 1.3 / 1.6 | 1.5 / 1.8 | 2.3 / 2.9 | 2.6 / 3.2 | 4.2 / 5.0 | 4.8 / 5.6 |
| Armature insulation class | | Class B | | | | | |

**(Note)** The above characteristic values are the central values. The maximum current and maximum torque are the values when combined with the drive unit.

| Servomotor type | | HC-MF Series | | | | |
|---|---|---|---|---|---|---|
| | | Absolute position standard | | | | |
| | | HC-MF053 | HC-MF13 | HC-MF23 | HC-MF43 | HC-MF73 |
| Corresponding servo drive unit type       MR-J2- | | 10CT | | 20CT | 40CT | 70CT |
| Continuous characteristics | Rated output    [kW] | 0.05 | 0.1 | 0.2 | 0.4 | 0.75 |
| | Rated current    [A] | 0.85 | 0.85 | 1.5 | 2.8 | 5.2 |
| | Rated torque   [N·m] | 0.16 | 0.32 | 0.64 | 1.3 | 2.4 |
| Rated speed             [r/min] | | 3000 | | | | |
| Max. speed             [r/min] | | 4500 | | | | |
| Max. current             [A] | | 2.6 | 2.6 | 5.0 | 9.0 | 18 |
| Max. torque             [N·m] | | 0.48 | 0.95 | 1.9 | 3.8 | 7.2 |
| Motor inertia        [kg·cm$^2$] | | 0.019 | 0.03 | 0.088 | 0.143 | 0.6 |
| Motor inertia with brakes    [kg·cm$^2$] | | 0.022 | 0.033 | 0.13 | 0.19 | 0.8 |
| Recommended motor shaft conversion load inertia rate | | 30-times or less of motor inertia | | | | |
| Power facility capacity       [kVA] | | 0.3 | 0.3 | 0.5 | 0.9 | 1.3 |
| Speed/position detector | | Resolution per motor rotation    8192 (pulse/rev) | | | | |
| Structure | | Fully closed, self-cooling (protection method: IP44 excluding the shaft penetration section and connectors) | | | | |
| Environment conditions | | To follow section 3-2-1 Environment conditions | | | | |
| Weight    With/without brakes      [kg] | | 0.40 / 0.75 | 0.53 / 0.89 | 0.99 / 1.6 | 1.45 / 2.1 | 3.0 / 4.0 |
| Armature insulation class | | Class B | | | | |

**(Note)**  The above characteristic values are the central values. The maximum current and maximum torque are the values when combined with the drive unit.

## 12-2-2   Torque characteristic drawings

### (1)   HC-SF Series
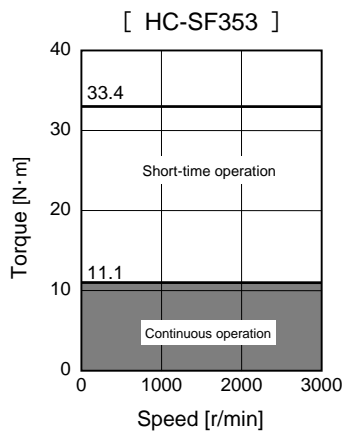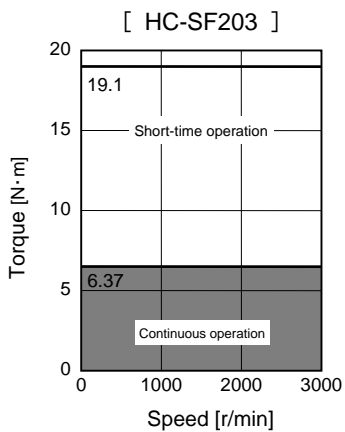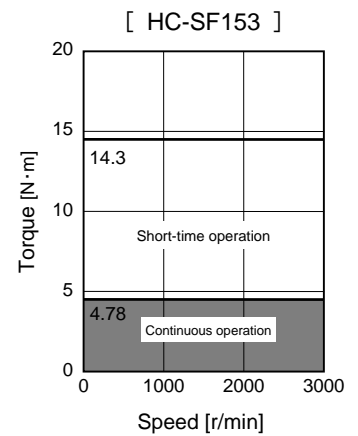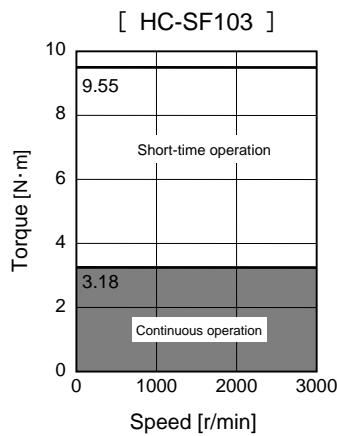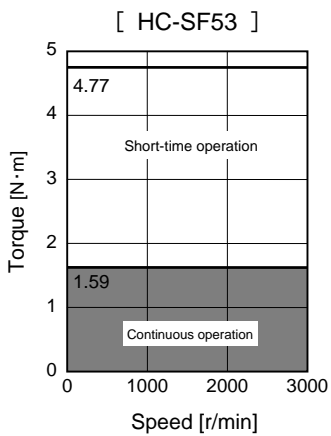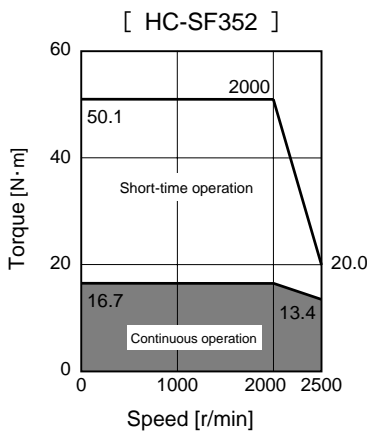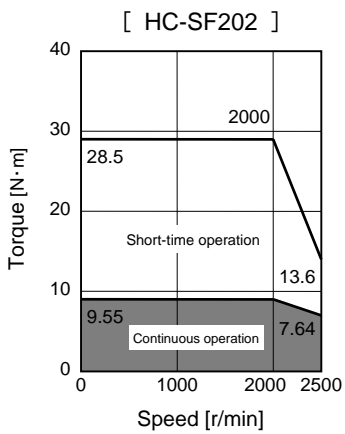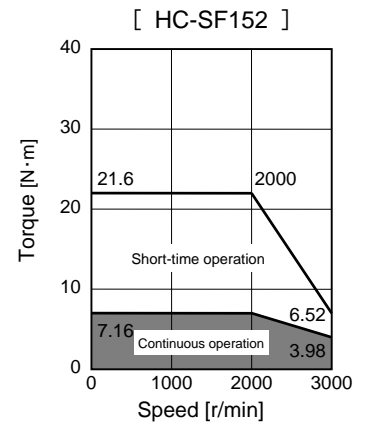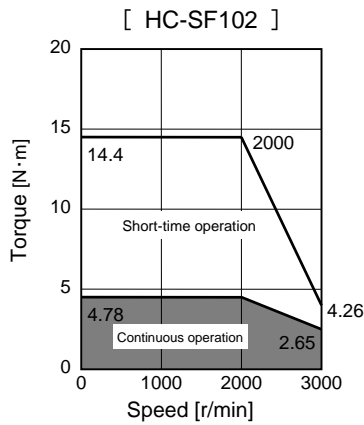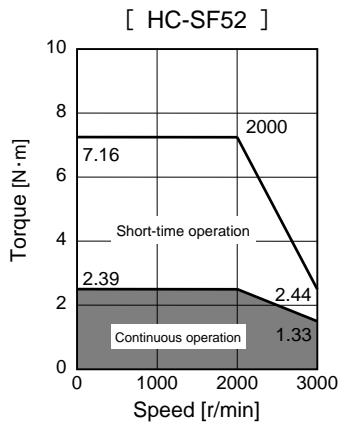
[ HC-SF52 ]

[ HC-SF102 ]

[ HC-SF152 ]

[ HC-SF202 ]

[ HC-SF352 ]

[ HC-SF53 ]

[ HC-SF103 ]

[ HC-SF153 ]

[ HC-SF203 ]

[ HC-SF353 ]

**(Caution)** The data in these characteristics is for an input voltage of 200VAC.

12 - 8

**(2)  HC-RF Series**

[ HC-RF103 ]　　　　　　　　[ HC-RF153 ]　　　　　　　　[ HC-RF203 ]
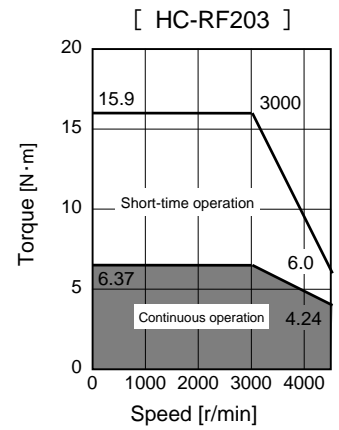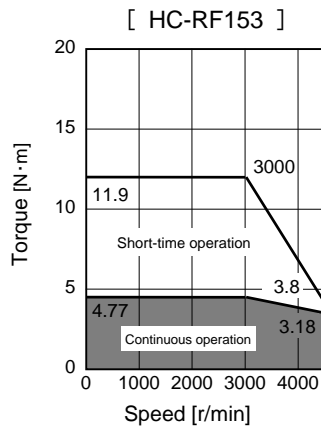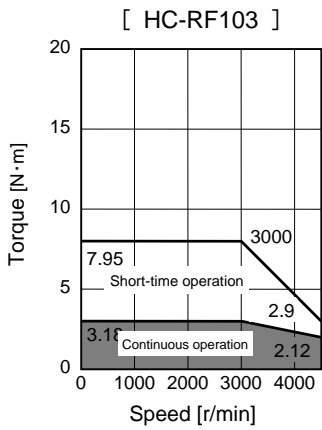


**(Caution)**　The data in these characteristics is for an input voltage of 200VAC.

**(3)  HA-FF Series**
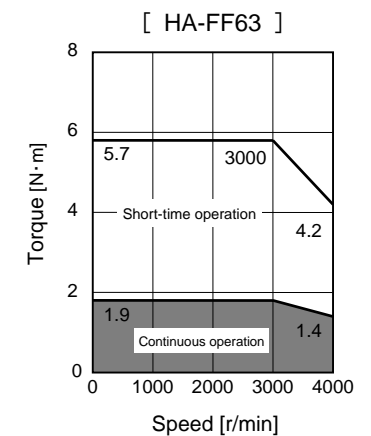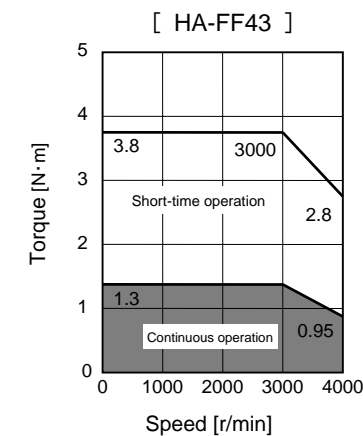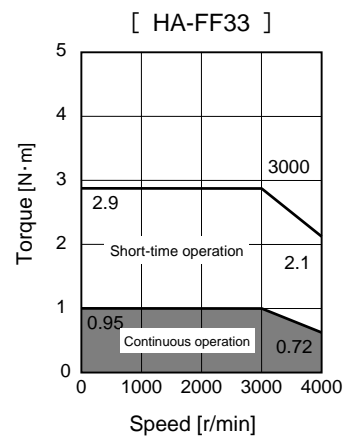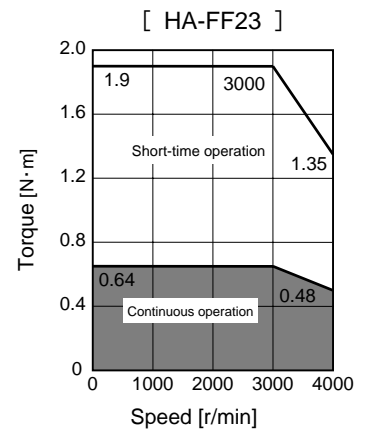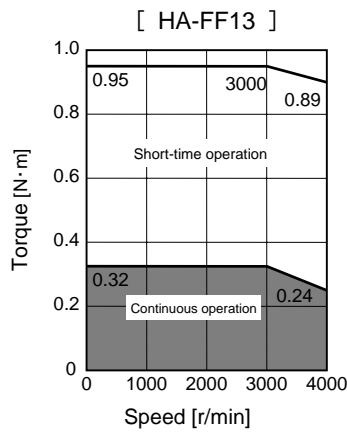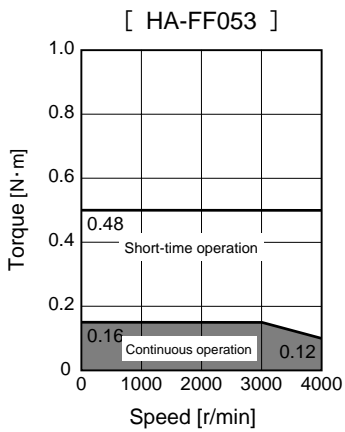
[ HA-FF053 ]　　　　　　　　[ HA-FF13 ]　　　　　　　　[ HA-FF23 ]



[ HA-FF33 ]　　　　　　　　[ HA-FF43 ]　　　　　　　　[ HA-FF63 ]



**(Caution)**　The data in these characteristics is for an input voltage of 200VAC.

12 - 9

**(4)  HC-MF Series**

［ HC-MF053 ］



Torque [N·m] vs Speed [r/min]
0.48
Short-time operation
0.16
Continuous operation    0.11

［ HC-MF13 ］



Torque [N·m] vs Speed [r/min]
0.95    4000
0.83
Short-time operation
0.32
Continuous operation    0.21

［ HC-MF23 ］



Torque [N·m] vs Speed [r/min]
1.9    3000
Short-time operation
0.9
0.64
Continuous operation    0.42

［ HC-MF43 ］



Torque [N·m] vs Speed [r/min]
3.8    3000
Short-time operation
1.7
1.3
Continuous operation    0.85

［ HC-MF73 ］



Torque [N·m] vs Speed [r/min]
7.2    3000
Short-time operation
2.4    2.9
Continuous operation    1.6
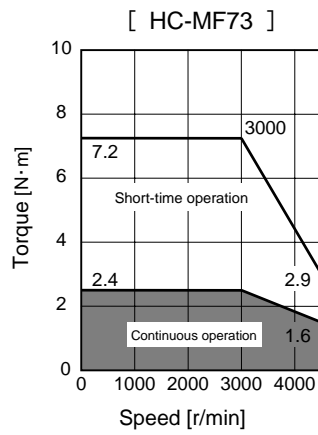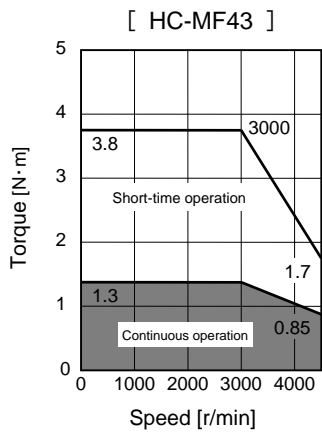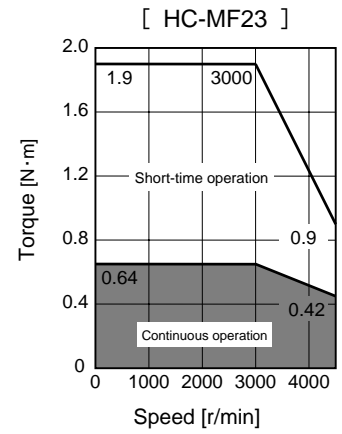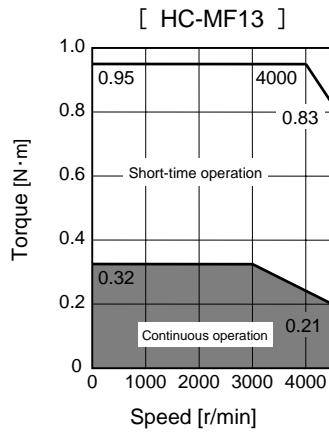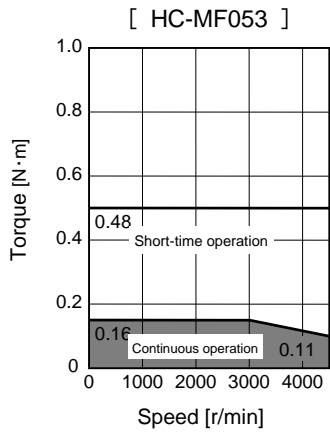
**(Caution)**    The data in these characteristics is for an input voltage of 200VAC.

## 12-2-3   Outline dimension drawings

- HC-SF52(B)(K)
- HC-SF53(B)(K)
- HC-SF102(B)(K)
- HC-SF103(B)(K)
- HC-SF152(B)(K)
- HC-SF153(B)(K)

- HC-SF53(B)T
- HC-SF53(B)T
- HC-SF103(B)T
- HC-SF103(B)T
- HC-SF153(B)T
- HC-SF153(B)T

[Unit:mm]



Detector connector MS3102A20-29P

Power supply connector CE05-2A22-23P

Oil seal S30457B

4-φ9 installation hole
Use a hexagon socket head bolt.



Tightening torque 23 to 30 N·m
U nut M10 × 1.25
Plain washer 10
Taper 1/10
Oil seal S30457B

Cross-section A-A

4-φ9 installation hole
Use a hexagon socket head bolt.
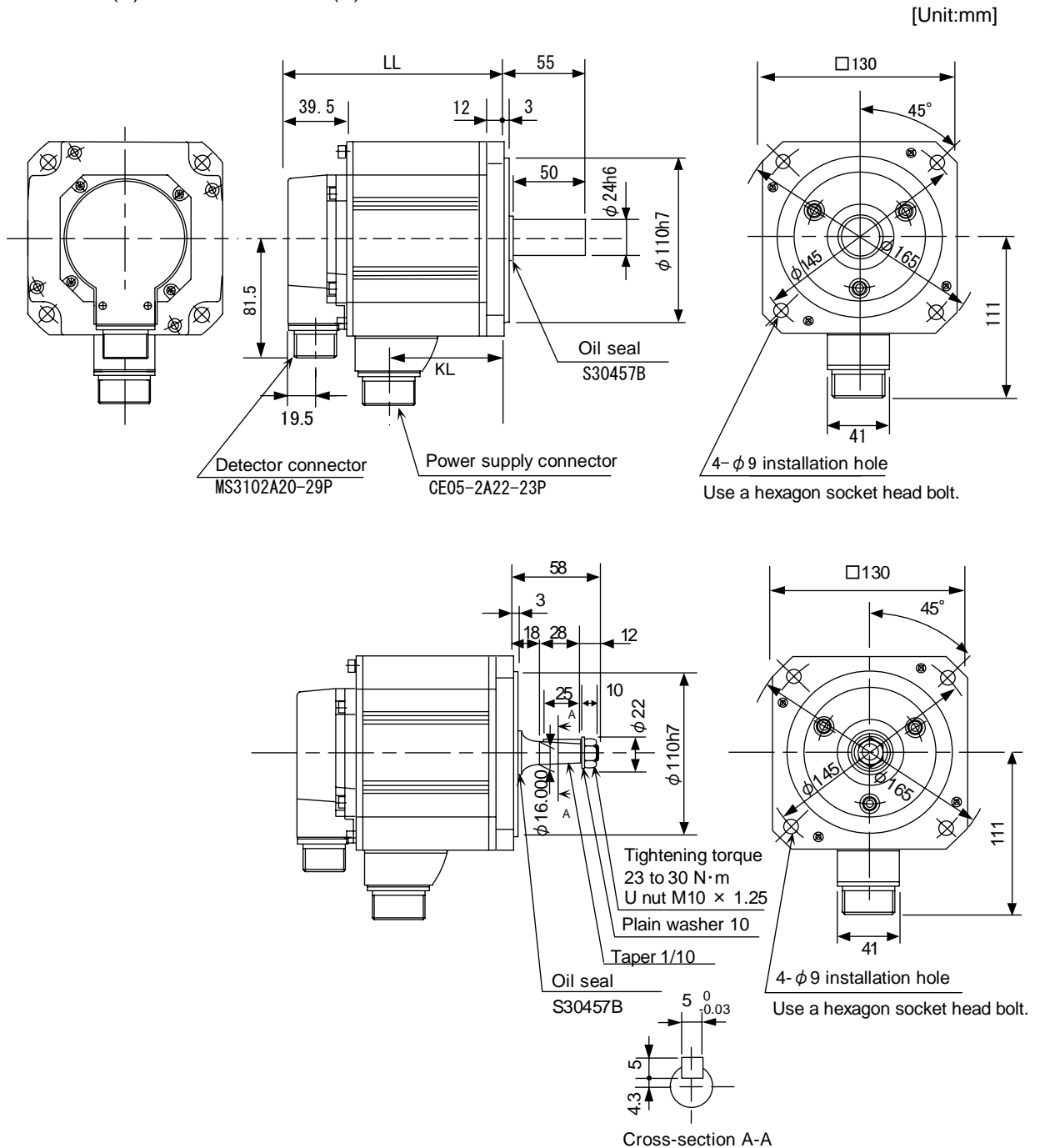
| Servomotor type | | L (Note 1) | KL |
|---|---|---|---|
| 2000r/min | 3000r/min | | |
| HC-SF52(B) | HC-SF53(B) | 120(153) | 51.5 |
| HC-SF102(B) | HC-SF103(B) | 145(178) | 76.5 |
| HC-SF152(B) | HC-SF153(B) | 170(203) | 101.5 |

**Note 1.** The dimensions given in parentheses are for when magnetic brakes are provided.
**Note 2.** Refer to section 12-2-4 for the dimensions of K (keyway).

- HC-SF202(K)
- HC-SF203(K)
- HC-SF352(K)
- HC-SF353(K)

[Unit:mm]
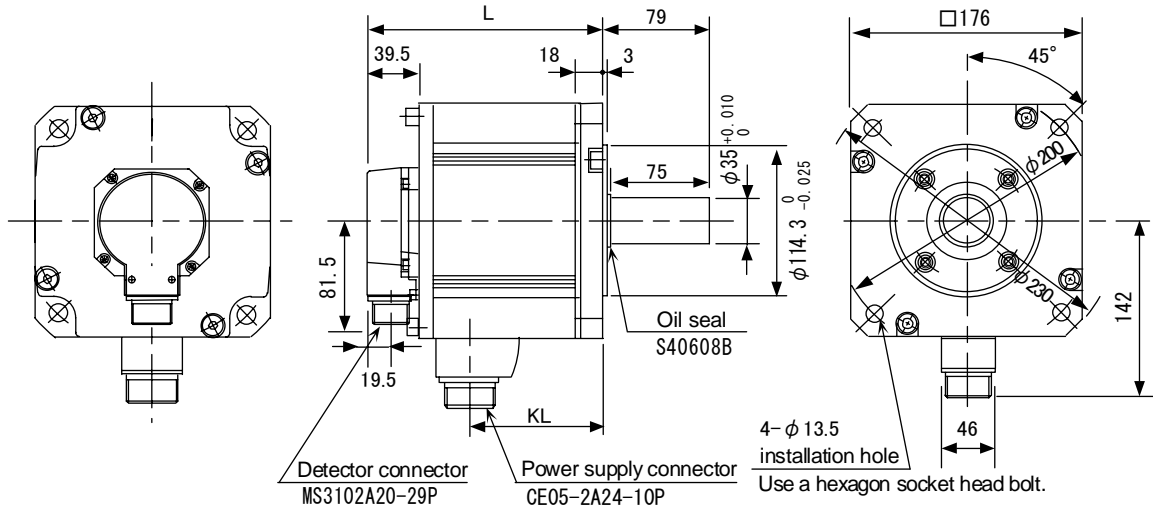


| Servomotor type | | L | KL |
|---|---|---|---|
| 2000r/min | 3000r/min | | |
| HC-SF202 | HC-SF203 | 145 | 68.5 |
| HC-SF352 | HC-SF353 | 187 | 110.5 |

**Note 1.** Refer to section 12-2-4 for the dimensions of K (keyway).

- HC-SF202B(K)
- HC-SF203B(K)
- HC-SF352B(K)
- HC-SF353B(K)

[Unit:mm]
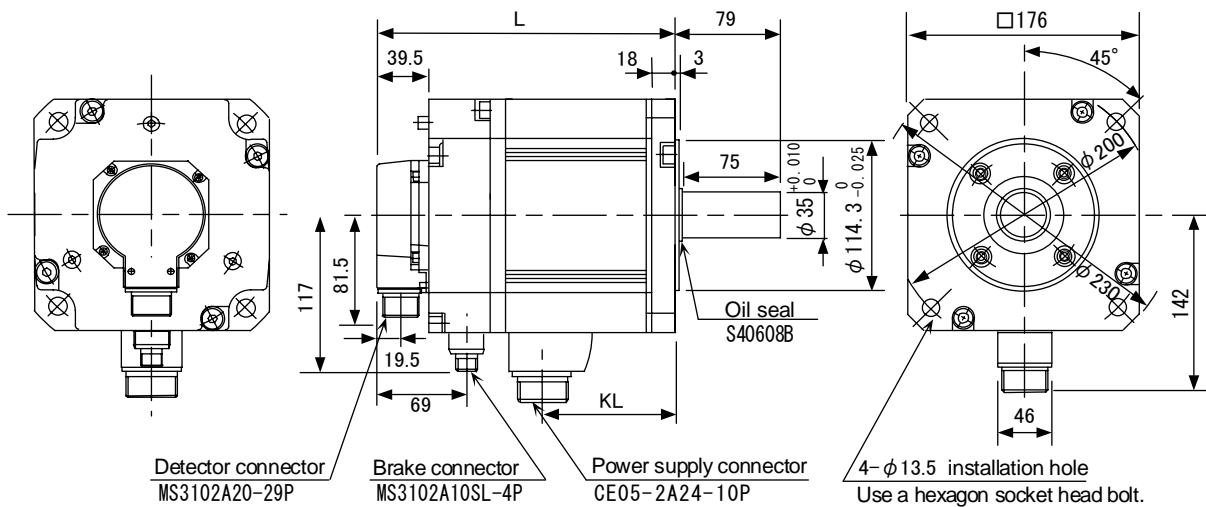


| Servomotor type | | L | KL |
|---|---|---|---|
| 2000r/min | 3000r/min | | |
| HC-SF202B | HC-SF203B | 193 | 68.5 |
| HC-SF352B | HC-SF353B | 235 | 110.5 |

**Note 1.** Refer to section 12-2-4 for the dimensions of K (keyway).

- HC-RF103(B)(K)
- HC-RF153(B)(K)
- HC-RF203(B)(K)

- HC-RF103(B)T
- HC-RF153(B)T
- HC-RF203(B)T

[Unit:mm]



Detector connector
MS3102A20-29P

Power supply connector
CE05-2A22-23P

Oil seal S30457B

4-φ9 installation hole
Use a hexagon socket head bolt.

Plain washer 10

Taper 1/10

Oil seal S30457B

Cross-section A-A

Tightening torque  23 to 30 N·m
U nut M10 × 1.25

4-φ9 installation hole
Use a hexagon socket head bolt.
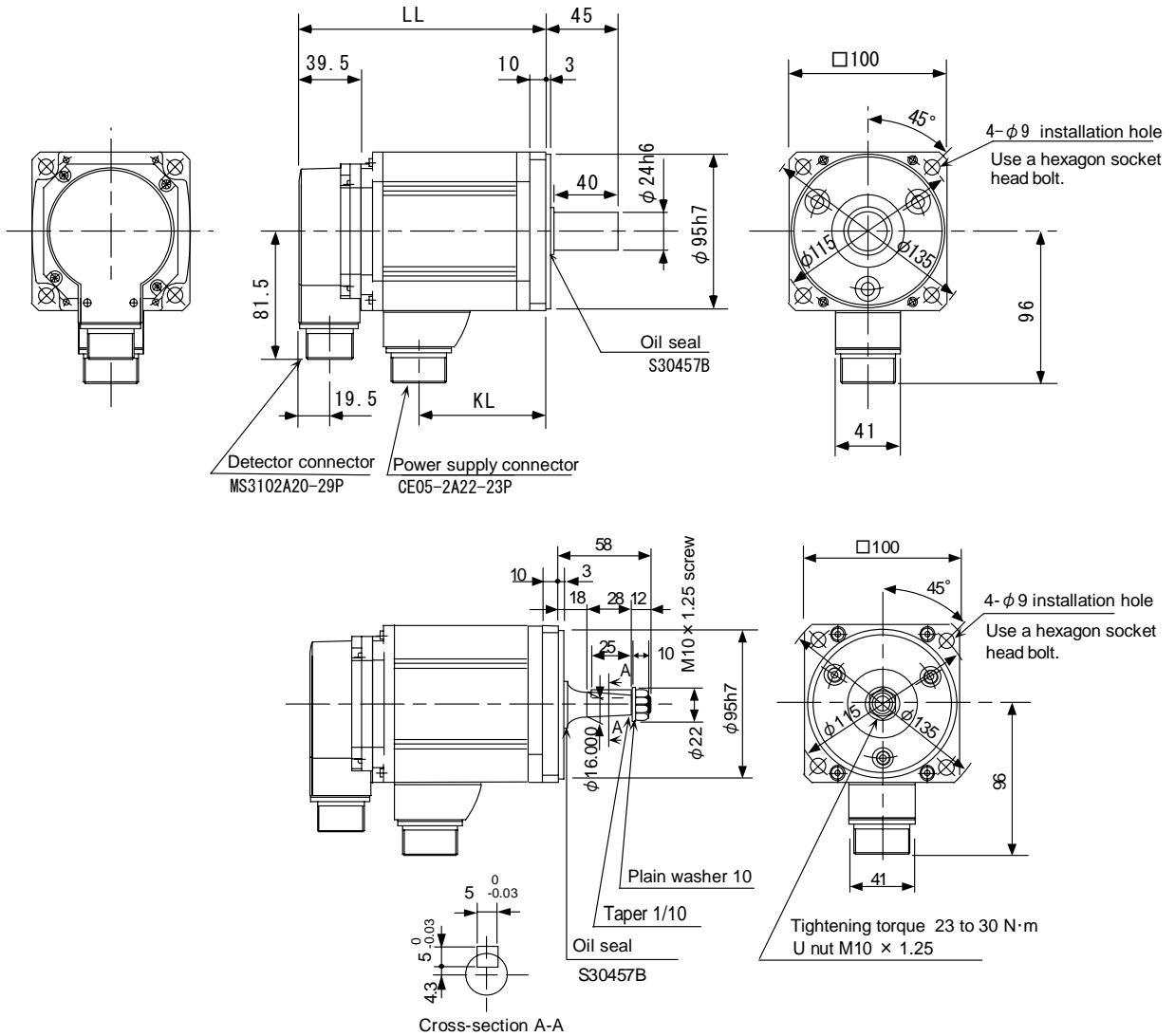
| Servomotor type | L (Note 1) | KL |
|---|---|---|
| HC-RF103(B) | 147(185) | 71 |
| HC-RF153(B) | 172(210) | 96 |
| HC-RF203(B) | 197(235) | 121 |

**Note 1.** The dimensions given in parentheses are for when magnetic brakes are provided.
**Note 2.** Refer to section 12-2-4 for the dimensions of K (keyway).

- HA-FF053(D)
- HA-FF13(D)

[Unit:mm]



Ground terminal M3 screw

L

30

□54

39

Ground terminal
(opposite side)

6

2.5

45°

V-ring

φ47

φ50h7

φ8h6

φ60

φ68

39

4-φ4.5

39

Detector cable wire outlet

Power supply lead wire outlet

0.3m detector cable
With end connector 172169-9
(AMP)

Power supply lead
VCTF 3-1.25² 0.5m
(With round crimp terminals
with end insulation tube 1.25-4)
Red : U phase, White : V phase, Black : W phase
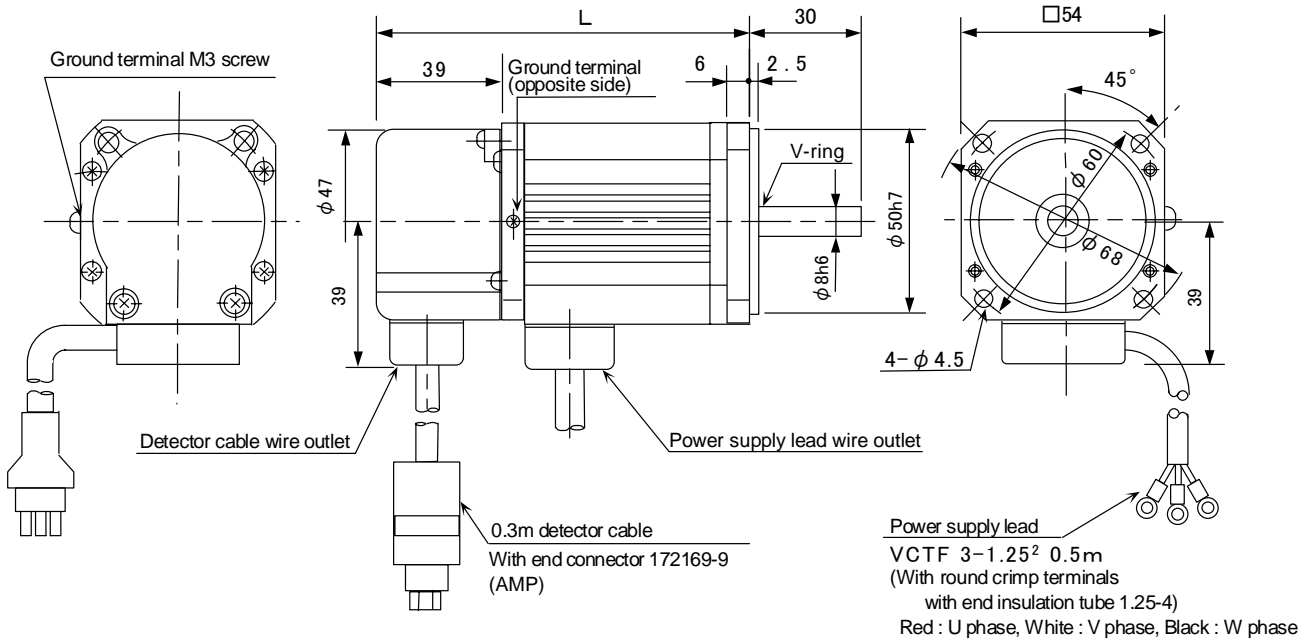
| Servomotor type | L |
|---|---|
| HA-FF053 | 106 |
| HA-FF13 | 123 |

**Note 1.** Use a friction coupling (Spun ring, etc.) to connect with the load.
**Note 2.** Refer to section 12-2-4 for the dimensions of D (D cut).

- HA-FF053B(D)
- HA-FF13B(D)

[Unit:mm]



Ground terminal M3 screw

L

30

□54

39

Ground terminal
(opposite side)

6

2.5

45°

V-ring

φ47

φ50h7

φ8h6

φ60

φ68

39

4-φ4.5

39

Detector cable wire outlet

Power supply lead
wire outlet

Brake lead
VCTF 2-0.5² 0.5m
(With round crimp terminals
with end insulation tube 1.25-4)

0.3m detector cable
With end connector 172169-9 (AMP)

Power supply lead
VCTF 3-1.25² 0.5m
(With round crimp terminals
with end insulation tube 1.25-4)
Red : U phase, White : V phase,
Black : W phase

| Servomotor type | L |
|---|---|
| HA-FF053B | 141 |
| HA-FF13B | 158 |

**Note 1.** Use a friction coupling (Spun ring, etc.) to connect with the load.
**Note 2.** Refer to section 12-2-4 for the dimensions of D (D cut).

- HA-FF23
- HA-FF33

[Unit:mm]

Ground terminal M3 screw

φ47

39

Detector cable wire outlet

0.3m detector cable
With end connector 172169-9
(AMP)

L

39

30

8 3

25

16 4

A

φ70h7

A

V-ring

Power supply lead
wire outlet

4

4 2.5

M4 × 0.7 screw  Depth15

φ11h6

Cross-section
A-A

□76

45°

φ90

φ100

50

4−φ5.5

Power supply lead
VCTF 3−1.25² 0.5m
(With round crimp terminals
with end insulation tube 1.25-4)
Red : U phase, White : V phase,
Black : W phase

| Servomotor type | L |
|---|---|
| HA-FF23 | 130.5 |
| HA-FF33 | 148 |

- HA-FF23B
- HA-FF33B

[Unit:mm]

Ground terminal M3 screw

φ47

39

Detector cable wire outlet

0.3m detector cable
With end connector
172169-9 (AMP)

L

39

30

8 3

25

16 4

A

φ70h7

A

V-ring

Power supply lead
wire outlet

Brake lead
VCTF 2−0.5² 0.5m
(With round crimp terminals
with end insulation tube 1.25-4))

4

4 2.5

M4 × 0.7 screw  Depth15

φ11h6

Cross-section
A-A

□76

45°

φ90

φ100

50

4−φ5.5

Power supply lead
VCTF 3−1.25² 0.5m
(With round crimp terminals
with end insulation tube 1.25-4)
Red : U phase, White : V phase,
Black : W phase

| Servomotor type | L |
|---|---|
| HA-FF23B | 168 |
| HA-FF33B | 185.5 |

- HA-FF43
- HA-FF63

[Unit:mm]



| Servomotor type | L |
|---|---|
| HA-FF43 | 154.5 |
| HA-FF63 | 169.5 |

- HA-FF43B
- HA-FF63B

[Unit:mm]
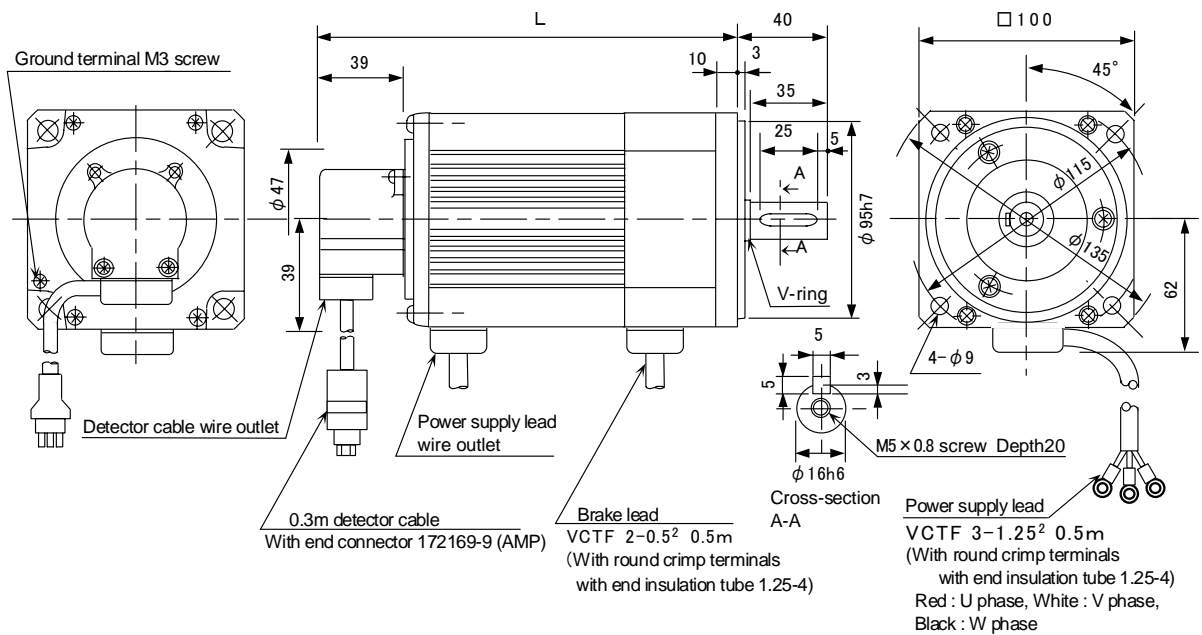


| Servomotor type | L |
|---|---|
| HA-FF43B | 191.5 |
| HA-FF63B | 206.5 |

12 - 16

- HA-FF053C(D)-UE
- HA-FF13C(D)-UE

[Unit:mm]



Oil seal
HA-FF053C-UE
: GM10204B
HA-FF13C-UE
: S10207B

Detector connector
MS3102A20-29P

Power supply connector
CE05-2A14S-2PD-B (D17)
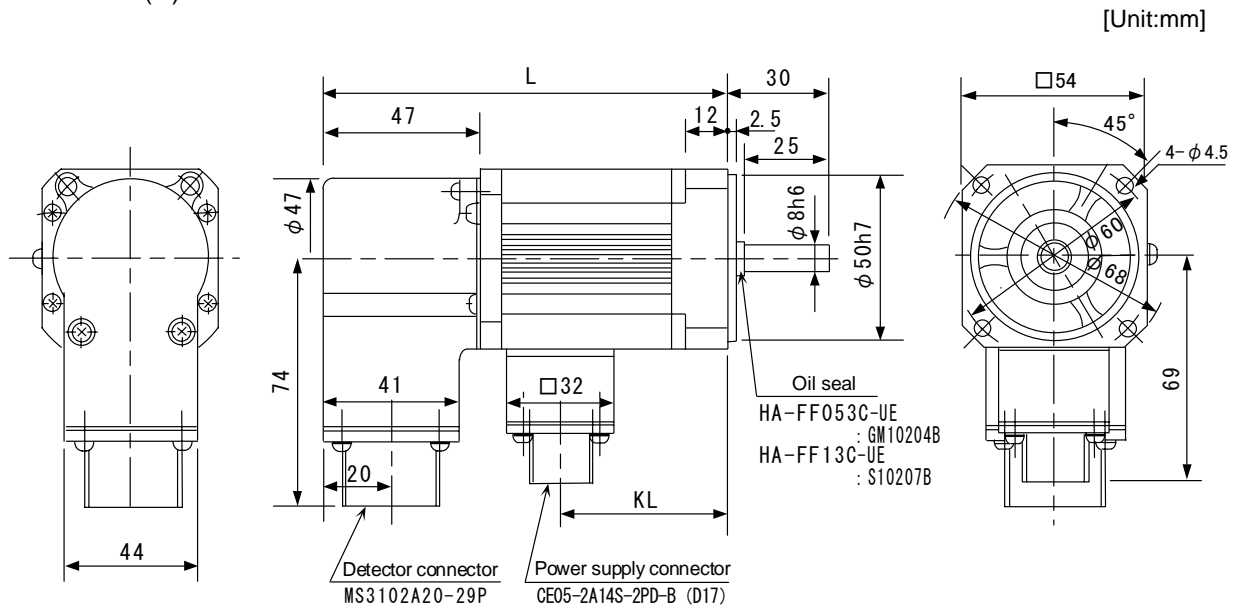
| Servomotor type | L | KL |
|---|---|---|
| HA-FF053C-UE | 120 | 49.5 |
| HA-FF13C-UE | 137 | 66.5 |

**Note 1.** Use a friction coupling (Spun ring, etc.) to connect with the load.
**Note 2.** Refer to section 12-2-4 for the dimensions of D (D cut).

- HA-FF053CB(D)-UE
- HA-FF13CB(D)-UE

[Unit:mm]



Oil seal
HA-FF053CB-UE
: GM10204B
HA-FF13CB-UE
: S10207B

Detector connector
MS3102A20-29P

Power supply connector
CE05-2A14S-2PD-B (D17)

Brake connector
MS3102E10SL-4P
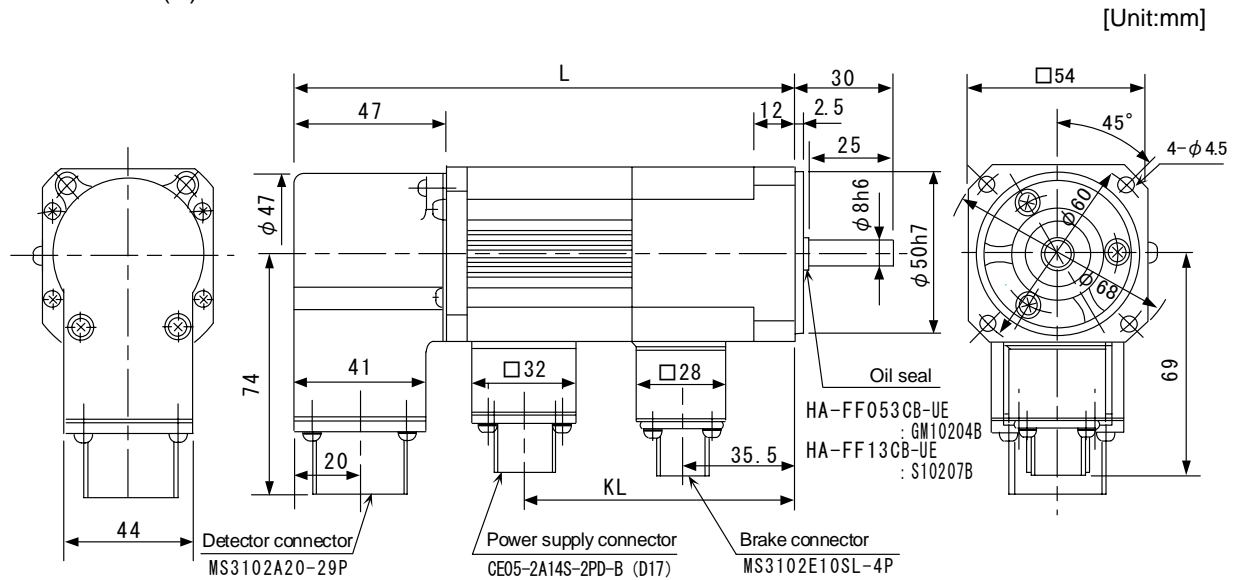
| Servomotor type | L | KL |
|---|---|---|
| HA-FF053CB-UE | 155 | 84 |
| HA-FF13CB-UE | 172 | 101 |

**Note 1.** Use a friction coupling (Spun ring, etc.) to connect with the load.
**Note 2.** Refer to section 12-2-4 for the dimensions of D (D cut).

- HA-FF23C-UE
- HA-FF33C-UE

[Unit:mm]
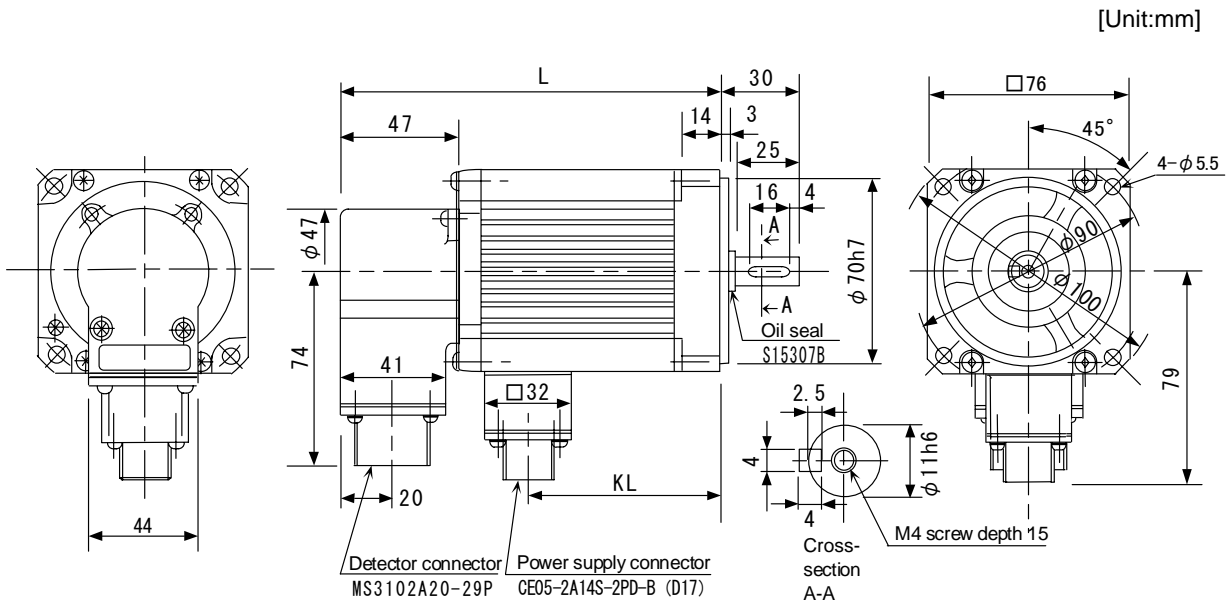


| Servomotor type | L | KL |
|---|---|---|
| HA-FF23C -UE | 145 | 71.5 |
| HA-FF33C -UE | 162 | 89 |

- HA-FF23CB-UE
- HA-FF33CB-UE

[Unit:mm]
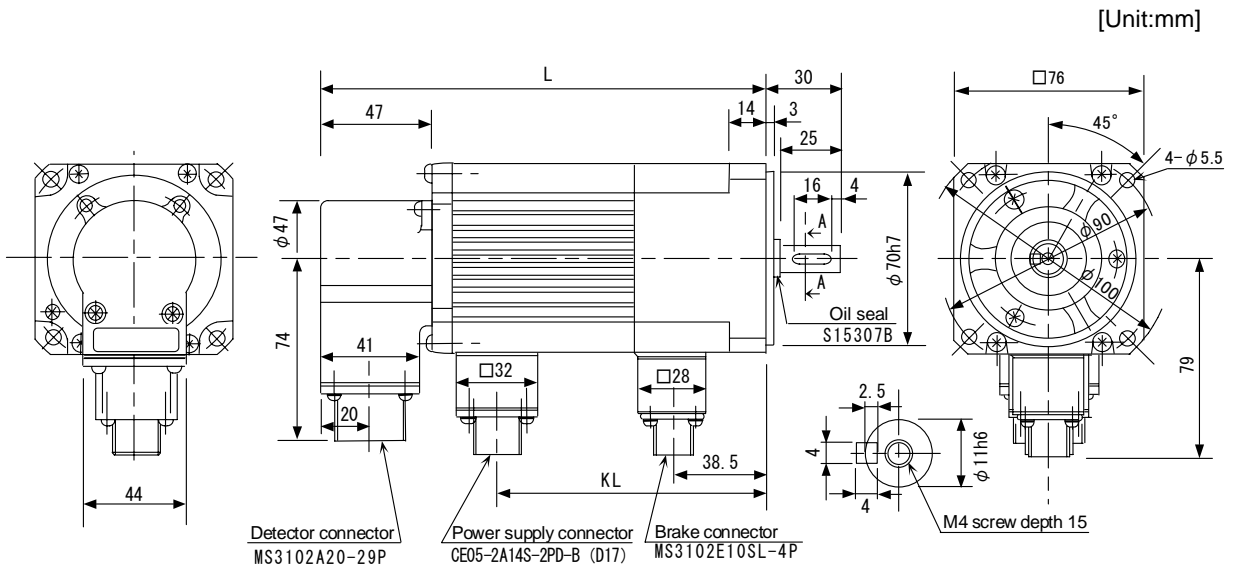


| Servomotor type | L | KL |
|---|---|---|
| HA-FF23CB-UE | 182 | 109 |
| HA-FF33CB-UE | 200 | 127 |

- HA-FF43C-UE
- HA-FF63C-UE

[Unit:mm]



Detector connector
MS3102A20-29P

Power supply connector
CE05-2A14S-2PD-B(D17)

Oil seal
S17308B

M5 screw depth 20

Cross-section A-A
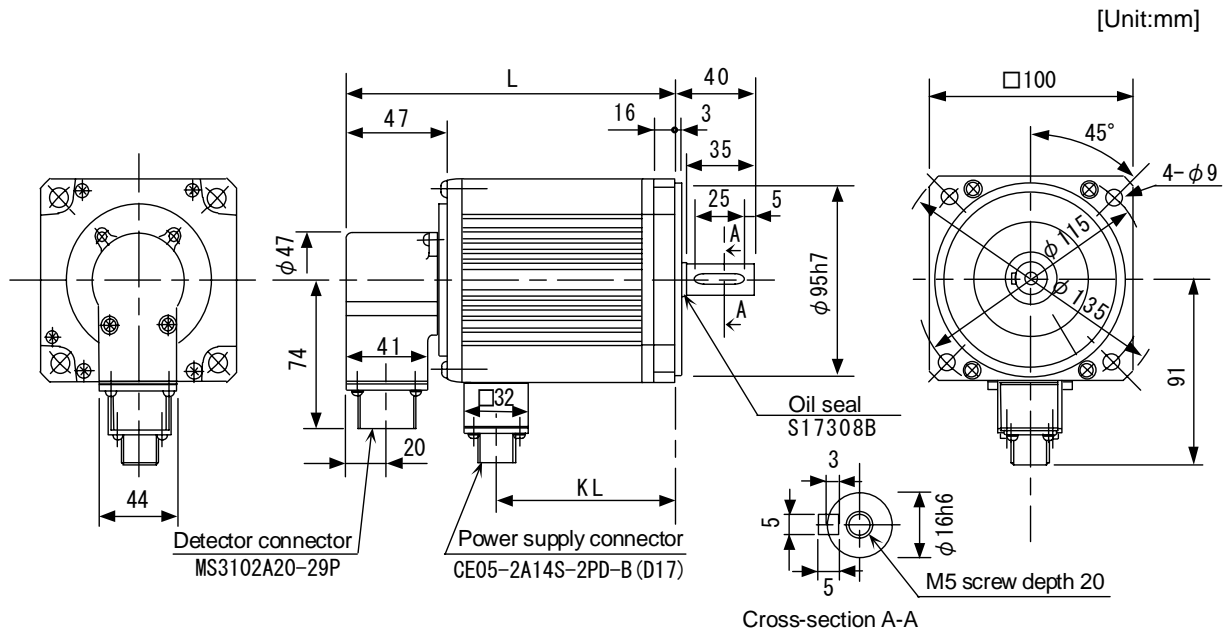
| Servomotor type | L | KL |
|---|---|---|
| HA-FF43C-UE | 169 | 93 |
| HA-FF63C-UE | 184 | 108 |

- HA-FF43CB-UE
- HA-FF63CB-UE

[Unit:mm]



Detector connector
MS3102A20-29P

Power supply connector
CE05-2A14S-2PD-B(D17)

Brake connector
MS3102E10SL-4P

Oil seal
S17308B

M5 screw depth 20

Cross-section A-A
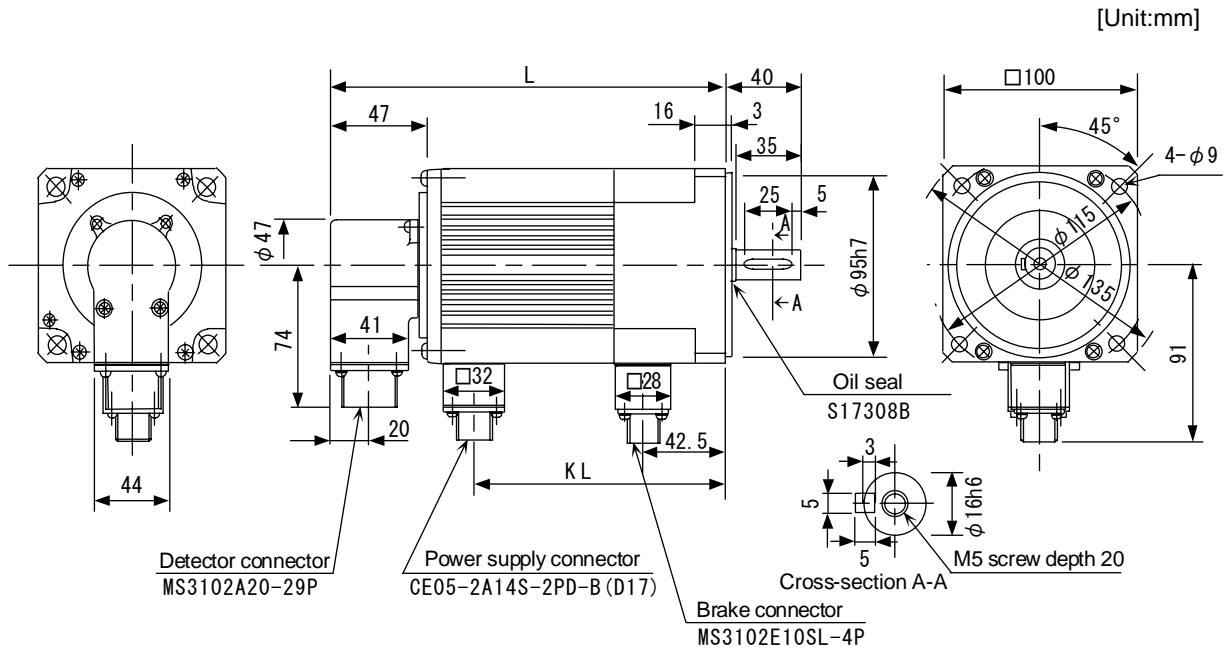
| Servomotor type | L | KL |
|---|---|---|
| HA-FF43CB-UE | 206 | 130 |
| HA-FF63CB-UE | 221 | 145 |

- HC-MF053 (D) (-UE)
- HC-MF13 (D) (-UE)

[Unit:mm]
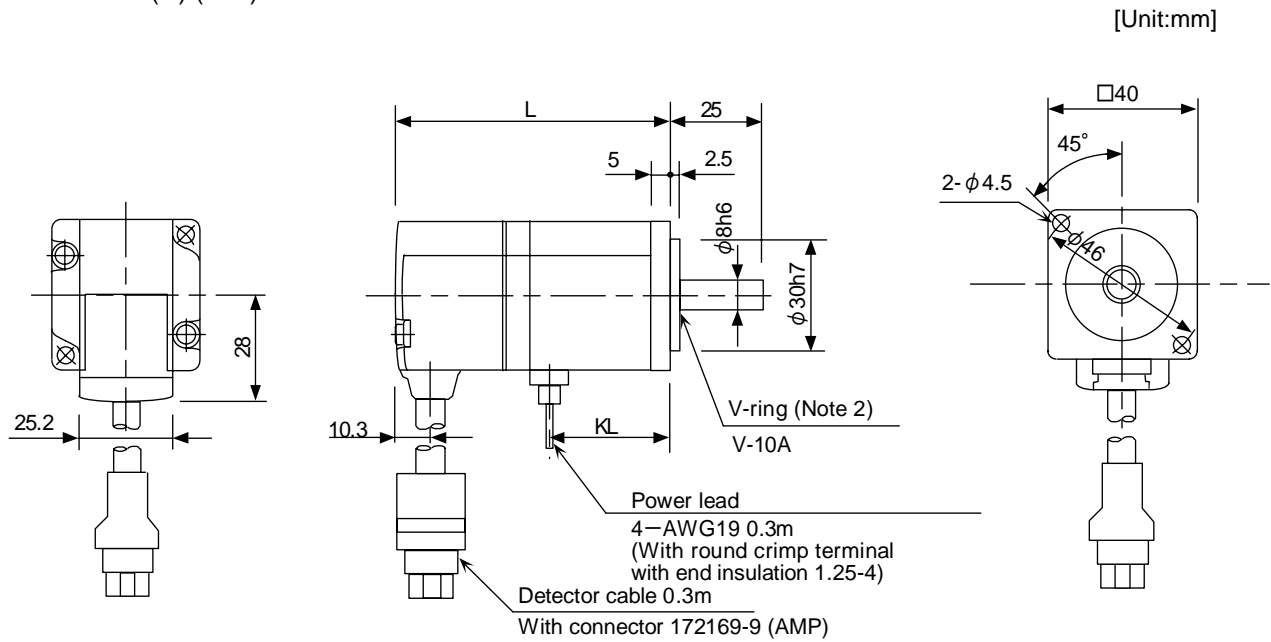


| Servomotor type | L | KL |
|---|---|---|
| HC-MF053(-UE) | 81.5(89.5) | 30.5(38.5) |
| HC-MF13(-UE) | 96.5(104.5) | 45.5(53.5) |

**Note 1.** Use a frictional coupler (Shupan ring, etc.) when connecting to the load.
**Note 2.** The EN Standards compliant part (HC-MF053-UE, HC-MF13-UE) has a V-ring.
**Note 3.** Refer to section 12-2-4 for the dimensions of D (D cut).

- HC-MF053B (D) (-UE)
- HC-MF13B (D) (-UE)

[Unit:mm]
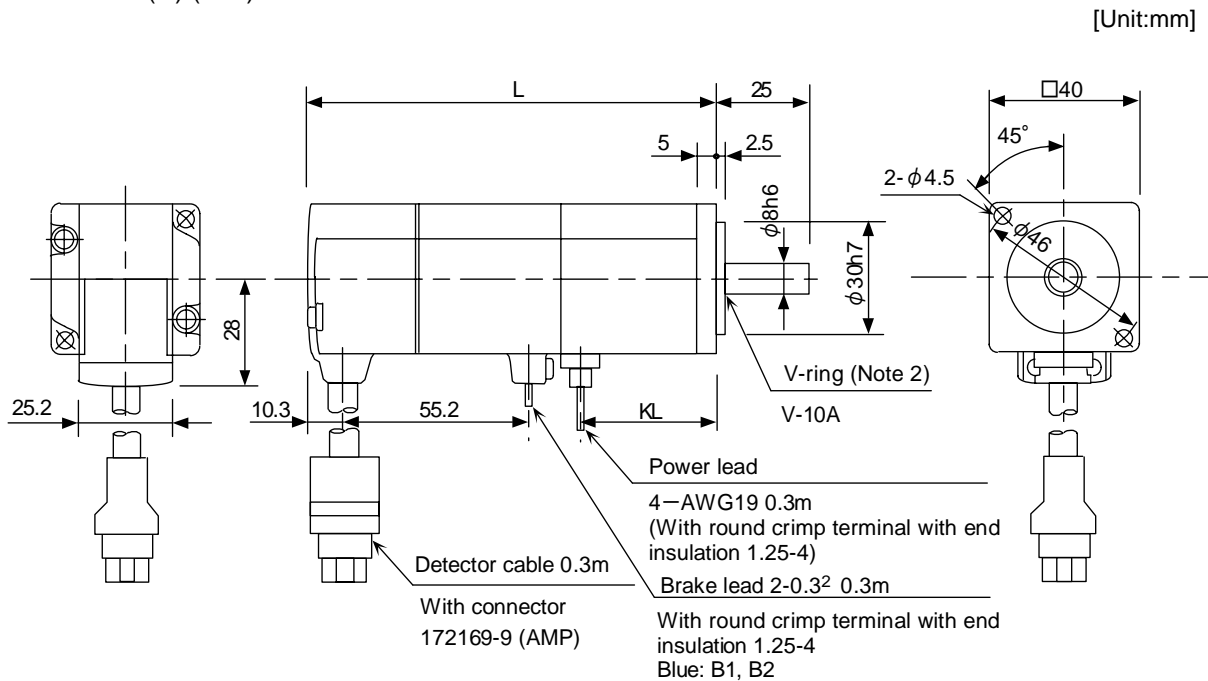


| Servomotor type | L | KL |
|---|---|---|
| HC-MF053B(-UE) | 109.5(117.5) | 30.5(38.5) |
| HC-MF13B(-UE) | 124.5(132.5) | 45.5(53.5) |

**Note 1.** Use a frictional coupler (Shupan ring, etc.) when connecting to the load.
**Note 2.** The EN Standards compliant part (HC-MF053B-UE, HC-MF13B-UE) has a V-ring.
**Note 3.** Refer to section 12-2-4 for the dimensions of D (D cut).

- HC-MF23 (K) (-UE)
- HC-MF43 (K) (-UE)

[Unit:mm]



V-ring (Note 2)
V-16A

Power lead
4－AWG19 0.3m
(With round crimp terminal with end insulation 1.25-4)

Detector cable 0.3m

With connector
172169-9 (AMP)
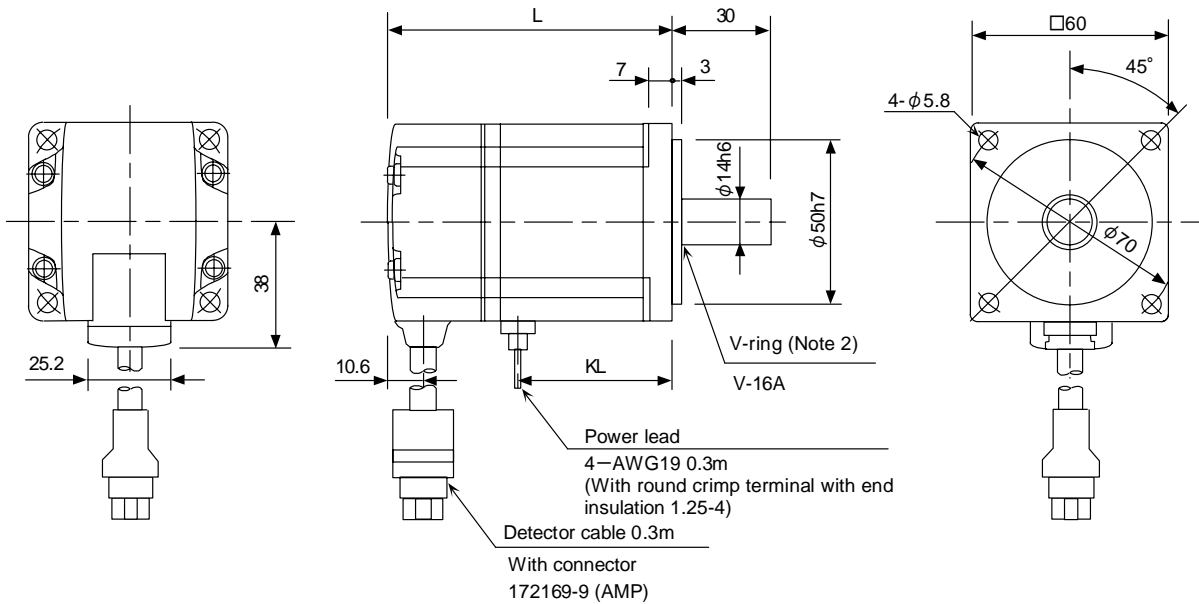
| Servomotor type | L | KL |
|---|---|---|
| HC-MF23(-UE) | 99.5(108.5) | 50(59) |
| HC-MF43(-UE) | 124.5(133.5) | 75(84) |

Note 1. Use a frictional coupler (Shupan ring, etc.) when connecting to the load.
Note 2. The EN Standards compliant part (HC-MF23-UE, HC-MF43-UE) has a V-ring.
Note 3. Refer to section 12-2-4 for the dimensions of K (keyway).

- HC-MF23B (K) (-UE)
- HC-MF43B (K) (-UE)

[Unit:mm]



V-ring (Note 2)
V-16A

Power lead
4－AWG19 0.3m
(With round crimp terminal with end insulation 1.25-4)

Brake lead 2-0.3² 0.3m

With round crimp terminal with end insulation 1.25-4
Blue: B1, B2

Detector cable 0.3m

With connector
172169-9 (AMP)
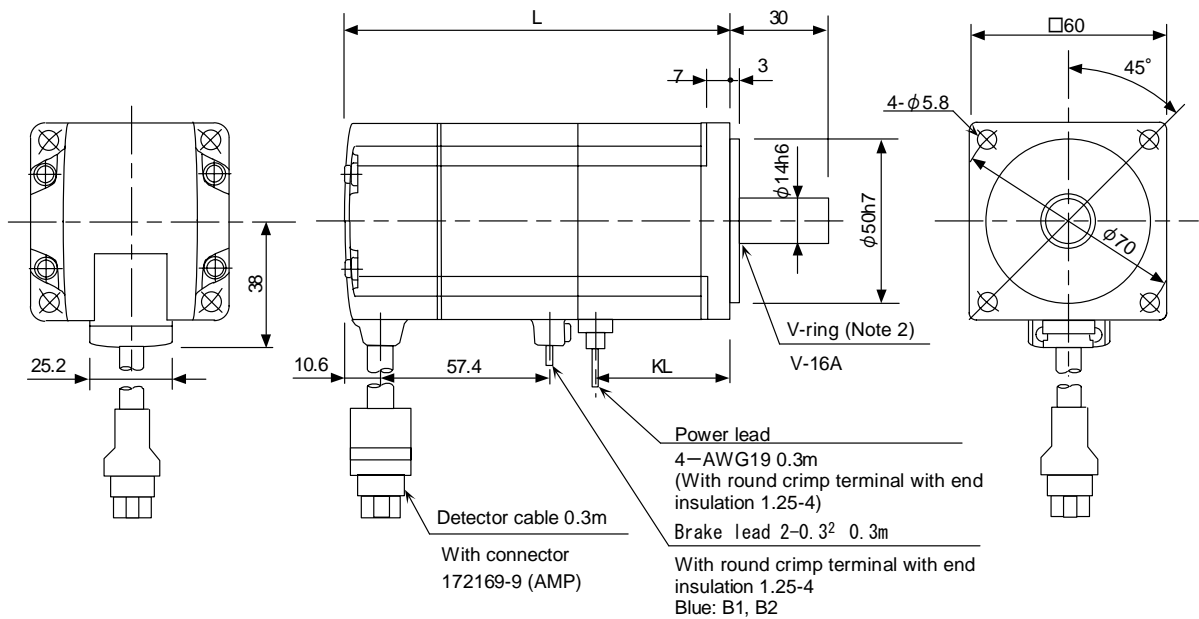
| Servomotor type | L | KL |
|---|---|---|
| HC-MF23B(-UE) | 131.5(140.5) | 50(59) |
| HC-MF43B(-UE) | 156.5(165.5) | 75(84) |

Note 1. Use a frictional coupler (Shupan ring, etc.) when connecting to the load.
Note 2. The EN Standards compliant part (HC-MF23B-UE, HC-MF43B-UE) has a V-ring.
Note 3. Refer to section 12-2-4 for the dimensions of K (keyway).

• HC-MF73 (K) (-UE)

[Unit:mm]
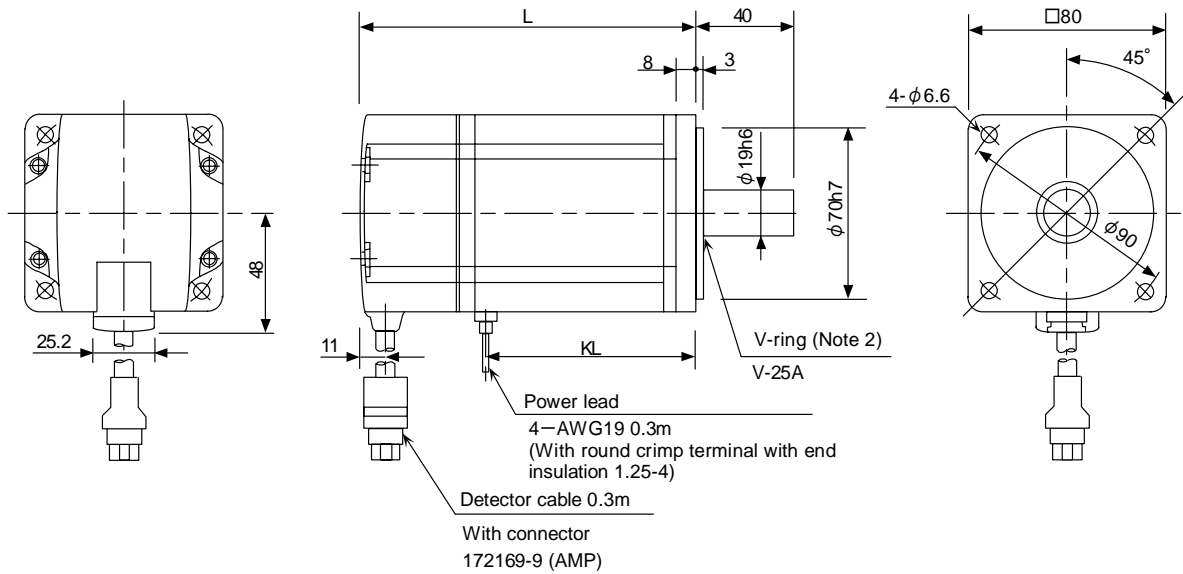
| Servomotor type | L | KL |
|---|---|---|
| HC-MF73(-UE) | 142(150) | 90(98) |

**Note 1.** Use a frictional coupler (Shupan ring, etc.) when connecting to the load.
**Note 2.** The EN Standards compliant part (HC-MF73-UE) has a V-ring.
**Note 3.** Refer to section 12-2-4 for the dimensions of K (keyway).

• HC-MF73B (K) (-UE)

[Unit:mm]
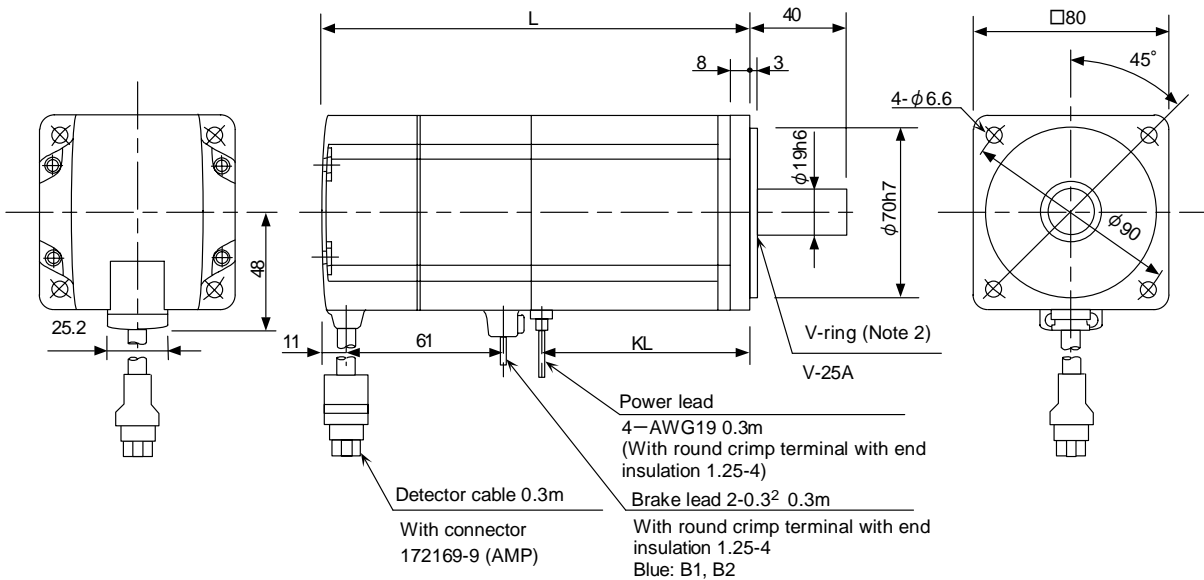
| Servomotor type | L | KL |
|---|---|---|
| HC-MF73B(-UE) | 177.5(185.5) | 90(98) |

**Note 1.** Use a frictional coupler (Shupan ring, etc.) when connecting to the load.
**Note 2.** The EN Standards compliant part (HC-MF73B-UE) has a V-ring.
**Note 3.** Refer to section 12-2-4 for the dimensions of K (keyway).

• HC-MF13 (D)-S15

[Unit:mm]



Detector cable 0.5m
Connector: RM15WTP-10P
Cord clamp RM15WTP-CP(7)
(Hirose)

Power supply cable 0.5m (oil-proof cable)
Connector: RM15WTP-4P
Cord clamp RM15WTP-CP(8)
(Hirose)
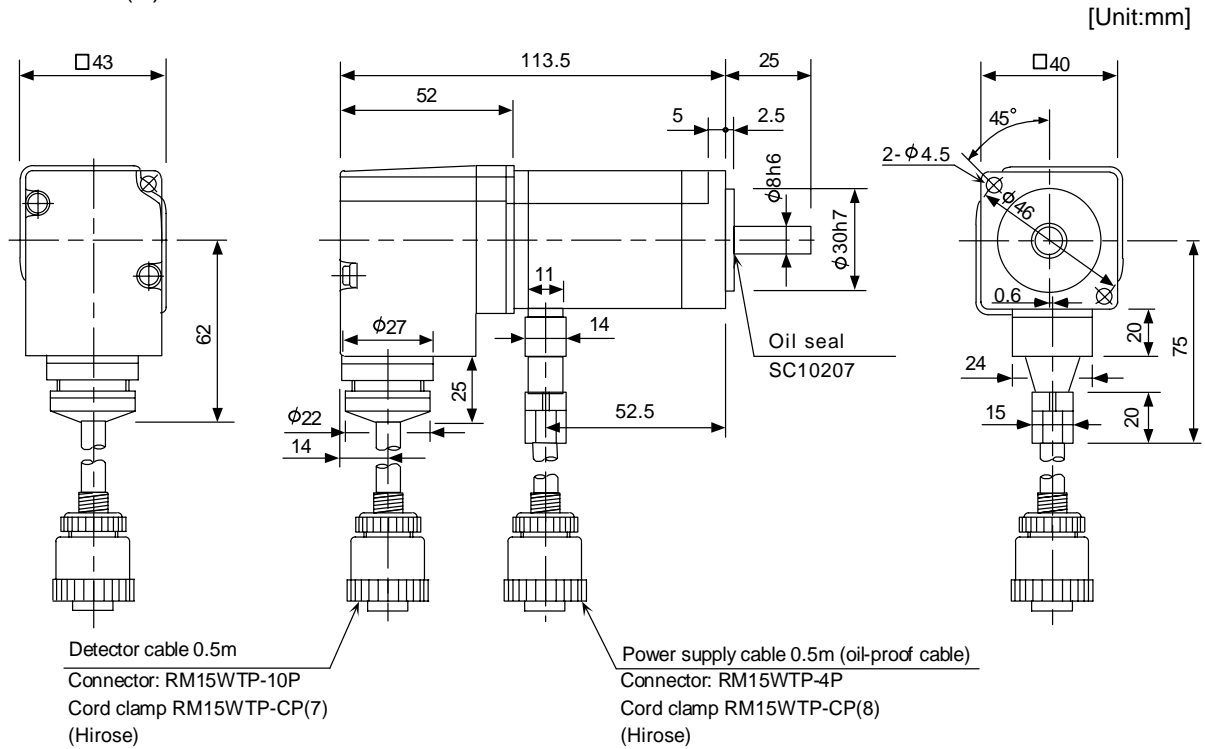
**Note 1.** Use a frictional coupler (Shupan ring, etc.) when connecting to the load.
**Note 2.** Refer to section 12-2-4 for the dimensions of D (D cut).
**Note 3.** The magnetic brakes are special specifications. Contact Mitsubishi or your dealer for details on the specifications.

• HC-MF23 (K)-S15
• HC-MF43 (K)-S15

[Unit:mm]



Detector cable 0.5m
Connector: RM15WTP-10P
Cord clamp RM15WTP-CP(7)
(Hirose)

Power supply cable 0.5m (oil-proof cable)
Connector: RM15WTP-4P
Cord clamp RM15WTP-CP(8)
(Hirose)
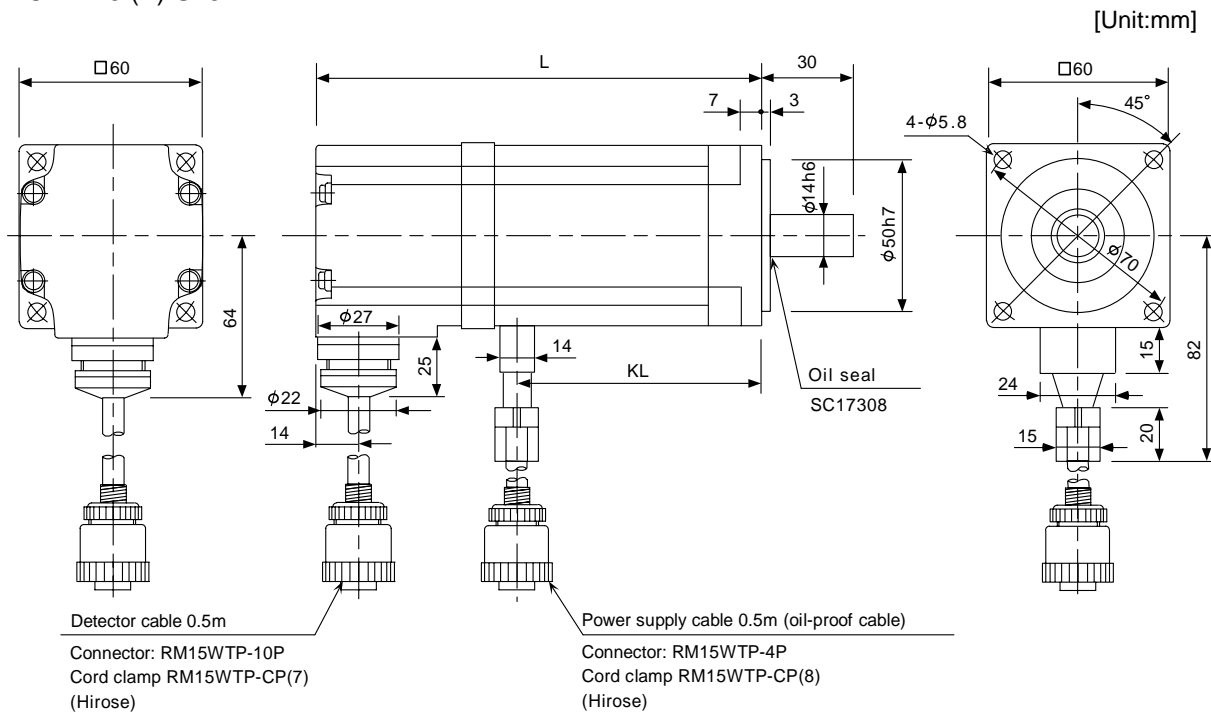
| Servomotor type | L | KL |
|---|---|---|
| HC-MF23-S15 | 126.5 | 58 |
| HC-MF43-S15 | 151.5 | 81 |

**Note 1.** Use a frictional coupler (Shupan ring, etc.) when connecting to the load.
**Note 2.** Refer to section 12-2-4 for the dimensions of K (keyway).
**Note 3.** The magnetic brakes are special specifications. Contact Mitsubishi or your dealer for details on the specifications.

• HC-MF73 (K)-S15

[Unit:mm]
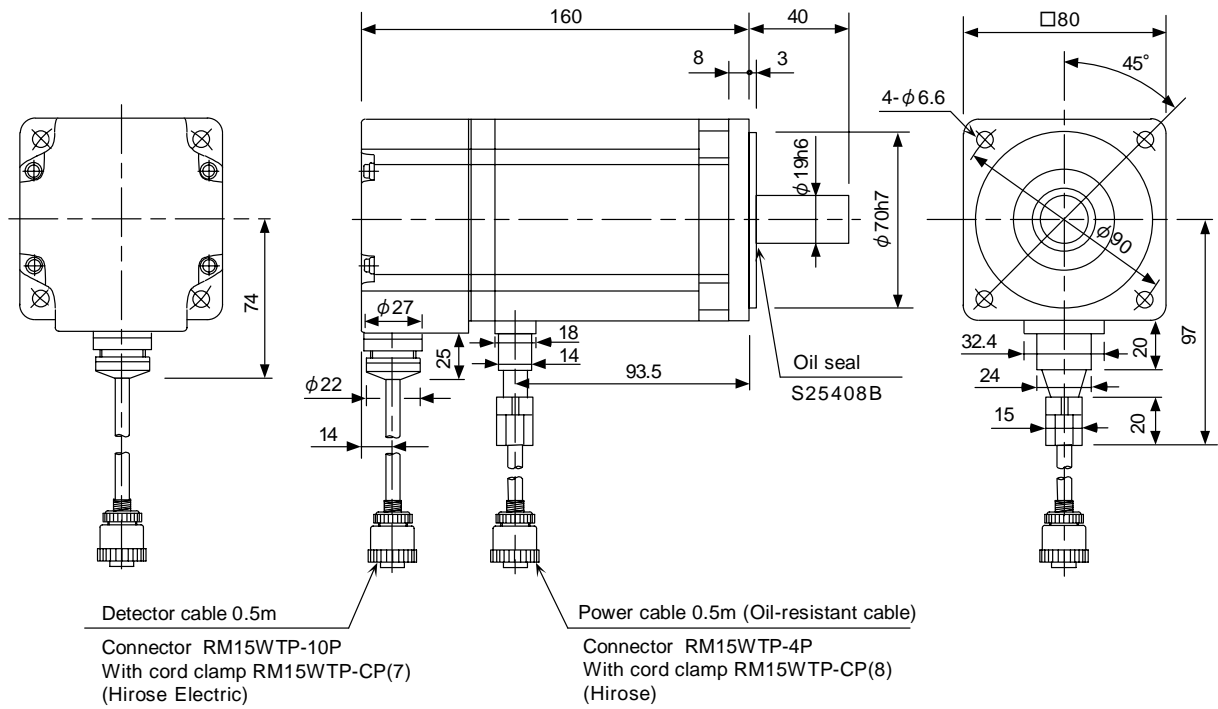


Detector cable 0.5m
Connector  RM15WTP-10P
With cord clamp RM15WTP-CP(7)
(Hirose Electric)

Power cable 0.5m (Oil-resistant cable)
Connector  RM15WTP-4P
With cord clamp RM15WTP-CP(8)
(Hirose)

**Note 1.** Use a frictional coupler (Shupan ring, etc.) when connecting to the load.
**Note 2.** Refer to section 12-2-4 for the dimensions of K (keyway).
**Note 3.** The magnetic brakes are special specifications. Contact Mitsubishi or your dealer for details on the specifications.

## 12-2-4　Special axis servomotor

The servomotors have a no keyway, straight axis as a standard. However, a keyway axis and D-cut axis have been prepared as special shaft shapes. Note that models HA-FF23 to 63 have keyway axes as a standard. Also, some motors may not be compatible.

| Servomotor type | Shaft shape | |
|---|---|---|
| | Key way | D cut |
| HC-MF053, 13 | × | ○ |
| HC-MF23 ~ 73 | **(Note 1)** ○ | × |
| HA-FF053, 13 | × | ○ |
| HA-FF23 ~ 63 | **(Note 2)** ○ | × |

| Servomotor type | Shaft shape | |
|---|---|---|
| | Key way | D cut |
| HC-SF52 ~ 352 | ○ | × |
| HC-SF53 ~ 353 | ○ | × |
| HC-RF103 ~ 203 | ○ | × |

**(Note 1)**　With key.
**(Note 2)**　With key as a standard. Refer to section "12-2-3 Outline dimensions drawings" for the shapes.

---

**With key**



**Changed dimensions table**　(Unit: mm)

| Servomotor type | Changed dimensions | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | S | R | Q | W | QK | QL | U | H | Y |
| HC-MF23K HC-MF43K | 14h6 | 30 | 27 | 5 | 20 | 3 | 3 | 5 | M4 × 0.7 Depth 15 |
| HC-MF73K | 19h6 | 40 | 37 | 6 | 25 | 5 | 3.5 | 6 | M5 × 0.8 Depth 20 |

---

**With key**



**Cross-section A-A**

**Changed dimensions table**　(Unit : mm)

| Servomotor type | Changed dimensions | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | S | R | Q | W | QK | QL | U | r |
| HC-SF52K ~ 152K HC-SF53K ~ 153K | 24h6 | 55 | 50 | $8_{-0.036}^{0}$ | 36 | 5 | $4_{0}^{+0.2}$ | 4 |
| HC-SF202K ~ 352K HC-SF203K ~ 353K | $35_{0}^{+0.01}$ | 79 | – | $10_{-0.036}^{0}$ | 55 | 5 | $5_{0}^{+0.2}$ | 5 |
| HC-RF103K ~ 203K | 24h6 | 45 | 40 | $8_{-0.036}^{0}$ | 25 | 5 | $4_{0}^{+0.2}$ | 4 |

---

**D cut**



**Changed dimensions table**　(Unit : mm)

| Servomotor type | Changed dimensions | |
|---|---|---|
| | R | QK |
| HC-MF053D, 13D | 25 | 20.5 |
| HA-FF053D, 13D | 30 | 25.5 |

# Chapter 13   Selection

## 13-1   Outline

### 13-1-1   Servomotor

It important to select a servomotor matched to the purpose of the machine that will be installed. If the servomotor and machine to be installed do not match, the motor performance cannot be fully realized, and it will also be difficult to adjust the parameters. Be sure to understand the servomotor characteristics in this chapter to select the correct motor.

**(1)  Motor inertia**
The servomotor series is mainly categorized according to the motor inertia size. The features in Table 13-1 are provided according to the motor inertia size.

**Table 13-1    Motor inertia**

| Motor model | Medium inertia motor | Low inertia motor |
|---|---|---|
| Motor type | HC-SF | HC-RF, HA-FF, HC-MF |
| Inertia | The flange size is large. The inertia is comparatively large. | The flange size is small. The inertia is small. |
| Acceleration/deceleration | The acceleration/deceleration time constant does not change much even for a low inertia load. The effect of the motor inertia is large. | Acceleration/deceleration is possible with a short time constant in respect to low inertia loads. The effect of the motor inertia is small. |
| Installation | The motor size in respect to the output capacity is large, and the installation space is large. | The motor size in respect to the output capacity is small, and the installation space is smaller. |
| Disturbance characteristics | The effect of disturbance is small. | The effect of disturbance is large. |
| Speed fluctuation | The effect of the torque ripple and cogging torque is small, and speed fluctuation does not occur easily. | The effect of the torque ripple and cogging torque is large, and speed fluctuation occurs easily. |
| Suitability | Suitable for high precision interpolation control | Suitable for high speed high frequency positioning |

The servomotor has an optimum load inertia scale. If the load inertia exceeds the optimum range, the control becomes unstable and the servo parameters become difficult to adjust. When the load inertia is too large, decelerate with the gears (The motor axis conversion load inertia is proportional to the square of the deceleration ratio.), or change to a motor with a large inertia.

---

**POINT**

The HC-MF motor has the lowest inertia. This series pursues low inertia motor performance. To realize the proper acceleration/deceleration performance of the low inertia motor, set the load inertia to within five times of the motor inertia. If the load inertia ratio increases, the control stability will deteriorate, and in the end the positioning will take longer.

---

**(2)  Rated speed**
Even with motors having the same capacity, the rated speed will differ according to the motor. The motor's rated output is designed to be generated at the rated speed, and the output P (W) is expressed with expression (13-1). Thus, even when the motors have the same capacity, the rated torque will differ according to the rated speed.

$$P = 2\pi NT \text{ (W)} \quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad (13\text{-}1)$$

$$N : \text{Motor speed (1/s)}$$

$$T : \text{Output torque (N·m)}$$

In other words, even with motors having the same capacities, the one with the lower rated speed will generate a larger torque. When actually mounted on the machine, if the positioning distance is short and the motor cannot reach the maximum speed, the motor with the lower rated speed will have a shorter positioning time. When selecting the motor, consider the axis stroke and usage methods, and select the motor with the optimum rated speed.
Due to the relation with the above expression, the continuous characteristic torque will be less than the rated torque in the range from the rated speed to the maximum speed.

## 13-1-2  Regeneration methods

When the servomotor decelerates, rotating load inertia or the operation energy of the moving object is returned to the servo drive unit through the servomotor as electrical power. This is called "regeneration". The three general methods of processing regeneration energy are shown below.

**Table 13-2  Servo drive unit regeneration methods**

| Regeneration method | Explanation |
|---|---|
| 1. Condenser regeneration method | This is a regeneration method for small-capacity drive units. The regeneration energy is charged to the condenser in the drive unit, and this energy is used during the next acceleration.<br>The regeneration capacity decreases as the power supply voltage becomes higher. |
| 2. Resistance regeneration method | If the condenser voltage rises too high when regenerating with the condenser only, the regenerative electrical power is consumed using the resistance. If the regeneration energy is small, it will only be charged to the condenser. Because regeneration energy becomes heat due to resistance, heat radiation must be considered.<br>In large capacity servo drive units the regenerative resistance becomes large and this is not practical. |
| 3. Power supply regeneration method | This is a method to return the regeneration energy to the power supply. The regeneration energy does not become heat as in regenerative resistance. (Heat is generated due to regeneration efficiency problems.)<br>The circuit becomes complicated, but in large capacity servo drive units having large regeneration capacity this method is more advantageous than resistance regeneration. |

The condenser regeneration method and resistance regeneration method are used in the MR-J2-CT. For drive units (20CT and higher) of 200W or more, the regenerative resistor is mounted in the drive unit as a standard. If the regenerative capacity becomes large, an option regenerative resistor is connected externally to the drive unit. (Combined use with the built-in resistor is not possible.)

| | |
|---|---|
| **POINT** | The MR-J2-10CT (100W) uses condenser regeneration as a standard. A built-in regenerative resistor is not mounted. |

## 13-2   Selection of servomotor series

### 13-2-1   Motor series characteristics

The servomotor series is categorized according to purpose, motor inertia size, and detector resolution. Select the motor series that matches the purpose of the machine to be installed.

**Table 13-3   Motor series characteristics**

| Motor series | Capacity (rated speed) | Detector resolution | Characteristics |
|---|---|---|---|
| HC-SF | 0.5 to 3.5kW (2000r/min) 0.5 to 3.5kW (3000r/min) | 16384p/rev | This is a motor for medium inertia and medium capacity. It is suitable for comparatively heavy load positioning such as for pallet changers, etc. It is drip-proofed against cutting oil entering the unit, and it clears IP65 specifications for environmental resistance performance. |
| HC-RF | 1.0 to 2.0kW (3000r/min) | 16384p/rev | This is a motor for medium inertia and medium capacity. It has a high output, compact design, and is suitable for high speed driving of light loads such as loaders. It is drip-proofed against cutting oil entering the unit, and it clears IP65 specifications for environmental resistance performance. |
| HA-FF | 50 to 600W (3000r/min) | 8192p/rev | This is a motor for low inertia and small capacity. It is suitable for high speed positioning of light loads such as for tool changers and turrets. The HA-FF∗∗C-UE Series with canon plug specifications wiring is also available. |
| HC-MF | 50 to 750W (3000r/min) | 8192p/rev | This is a motor for ultra-low inertia and small capacity. It is suitable for ultra-high speed positioning of light loads such as high speed arms and machine end sections. A molded structure using high heat conducting resin is utilized to realize a high output motor with a compact design. The motor characteristics can be realized even further and the positioning time shortened by making the load inertia ratio smaller. |

### 13-2-2   Servomotor precision

The control precision of the servomotor is determined by the detector resolution, motor characteristics and parameter adjustment. This section examines the following three types of servomotor control precision when the servo parameters are adjusted. When selecting a servo, confirm that these types of precision satisfy the machine specifications before determining the servomotor series.

**(1)   Theoretic precision: $\Delta\varepsilon$**
This value is determined from the motor detector precision, and is the control resolution per machine side rotation.

**(2)   Positioning precision : $\Delta\varepsilon p$**
This value expresses the machine positioning precision. When the motor is a single unit, this matches with the theoretic precision $\Delta\varepsilon$. However, when the motor is actually installed on a machine, the positioning precision $\Delta\varepsilon$ becomes 1 to 2 times the theoretic precision $\Delta\varepsilon$. This is due to the effect on the motor control by the machine rigidity, etc. Furthermore, the value to which the error from the motor shaft to the machine is added becomes the actual machine positioning precision $\Delta\varepsilon p$.

**(3)   Absolute position repeatability : $\Delta\varepsilon a$**
This is the precision outline that affects the absolute position system machine, and expresses the repeatability of the position before the power was shut off and the position when the power is turned on again.
With the single motor unit, the precision is 1 to 2 times the theoretic precision $\Delta\varepsilon$. Note that the absolute position repeatability $\Delta\varepsilon a$ is the difference from when the power was turned off last and returned on. This error is not cumulated.

**Table 13-4   Precision by motor series**

| Motor series | Control resolution RNG (pulse/rev) | Theoretic precision $\Delta\varepsilon$ (°) | Positioning precision $\Delta\varepsilon p$(°) | Absolute position repeatability $\Delta\varepsilon a$(°) |
|---|---|---|---|---|
| HC-SF | 16384 | $\dfrac{360 \times *PC1}{RNG \times *PC2}$ | $\Delta\varepsilon \sim 2\Delta\varepsilon$ | $\Delta\varepsilon \sim 2\Delta\varepsilon$ |
| HC-RF | 16384 | | | |
| HA-FF | 8192 | | | |
| HC-MF | 8192 | | | |

**(Note 1)**  PC1: Motor side gear ratio, PC2: Machine side gear ratio
**(Note 2)**  The calculation expression in the table expresses the approximate precision at the motor end. The actual precision at the machine side is obtained by adding the machine precision to this value.

## 13-3   Selection of servomotor capacity

The following three elements are used to determine the servomotor capacity.

1. Load inertia ratio
2. Short time characteristics (acceleration/deceleration torque)
3. Continuous characteristics (continuous effective load torque)

Carry out appropriate measures, such as increasing the motor capacity, if any of the above conditions is not fulfilled.

### 13-3-1   Load inertia ratio

Each servomotor has an appropriate load inertia ratio (load inertia/motor inertia). The control becomes unstable when the load inertia ratio is too large, and the positioning time cannot be shortened due to the lengthening of the settling time.
If the load inertia ratio exceeds the recommended value in the servomotor list of specifications, increase the motor capacity or change to a motor series with a large inertia. Note that the recommended value for the load inertia ratio is strictly one guideline. This does not mean that controlling a load with inertia exceeding the recommended value is impossible.

### 13-3-2   Short time characteristics

In addition to the rated output, the servomotor has an output range that can only be used for short times such as acceleration/deceleration. This range is expressed at the maximum torque. The maximum torque differs for each motor even at the same capacity, so confirm the torque in section "12-2 Servomotor".
The maximum torque affects the acceleration/deceleration time constant that can be driven. The linear acceleration/deceleration time constant ta can be approximated from the machine specifications using expression (13-2). Determine the maximum motor torque required from this expression, and select the motor capacity. The same selection can also be made by using the "Simple motor capacity selection diagrams" on the page 13-8.

$$ ta = \frac{(J_L + J_M) \times N}{95.5 \times (0.8 \times T_{MAX} - T_L)} \quad (ms) \qquad\qquad .................................................. \quad (13\text{-}2) $$

| | | |
|---|---|---|
| $N$ | : Motor reach speed | (r/min) |
| $J_L$ | : Motor shaft conversion load inertia | (kg·cm$^2$) |
| $J_M$ | : Motor inertia | (kg·cm$^2$) |
| $T_{MAX}$ | : Maximum motor torque | (N·m) |
| $T_L$ | : Motor shaft conversion load (friction, unbalance) torque | (N·m) |

### 13-3-3    Continuous characteristics

A typical operation pattern is assumed, and the motor's continuous effective load torque (Trms) is calculated from the motor shaft conversion and load torque. If numbers ① to ⑧ in the following drawing were considered a one cycle operation pattern, the continuous effective load torque is obtained from the root mean square of the torque during each operation, as shown in the expression (13-3).
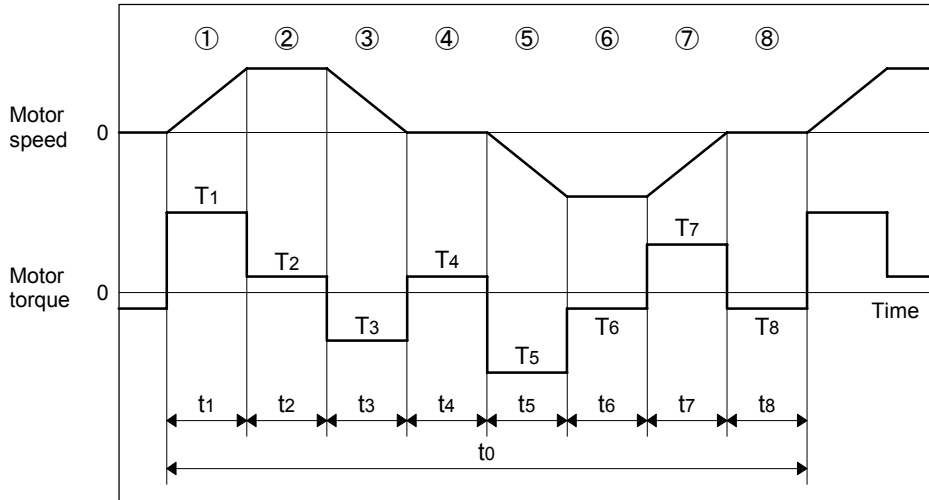


**Fig. 13-1    Continuous operation pattern**

$$Trms = \sqrt{\frac{T1^2 \cdot t1 + T2^2 \cdot t2 + T3^2 \cdot t3 + T4^2 \cdot t4 + T5^2 \cdot t5 + T6^2 \cdot t6 + T7^2 \cdot t7 + T8^2 \cdot t8}{t0}} \quad \text{.................. (13-3)}$$

Select a motor so that the continuous effective load torque (Trms) is 80% or less of the motor rated torque (Tra).

$$Trms \leq 0.8 \cdot Tra \qquad\qquad \text{................................................. (13-4)}$$

The amount of acceleration torque (Ta) shown in tables 13-5 and 13-6 is the torque to accelerate the load inertia in a frictionless state. It can be calculated by the expression (13-5). (For linear acceleration/deceleration)

$$Ta = \frac{(J_L + J_M) \times N}{95.5 \times ta} \quad (N \cdot m) \qquad \text{................................................. (13-5)}$$

$N$ : Motor reach speed (r/min)
$J_L$ : Motor shaft conversion load inertia $(kg \cdot cm^2)$
$J_M$ : Motor inertia $(kg \cdot cm^2)$
$ta$ : Linear acceleration/deceleration time constant (ms)

In case of axis with imbalance torque. Select a motor so that a motor shaft conversion load torque ($T_L$) (friction torque + unbalance torque) is 60% or less of the motor rated torque (Tra).

$$T_L \leq 0.6 \cdot Tra \qquad\qquad \text{................................................. (13-6)}$$

**(1) Horizontal axis load torque**

When operations ① to ⑧ are for a horizontal axis, calculate so that the following torques are required in each period.

**Table 13-5   Load torques of horizontal axes**

| Period | Load torque calculation method | Explanation |
|---|---|---|
| ① | (Amount of acceleration torque) + (Kinetic friction torque) | Normally the acceleration/deceleration time constant is calculated so this torque is 80% of the maximum torque of the motor. |
| ② | (Kinetic friction torque) | |
| ③ | (Amount of deceleration torque) + (Kinetic friction torque) | The signs for the amount of acceleration torque and amount of deceleration torque are reversed when the absolute value is the same value. |
| ④ | (Static friction torque) | Calculate so that the static friction torque is always required during a stop. |
| ⑤ | − (Amount of acceleration torque) − (Kinetic friction torque) | The signs are reversed with period ① when the kinetic friction does not change according to movement direction. |
| ⑥ | − (Kinetic friction torque) | The signs are reversed with period ② when the kinetic friction does not change according to movement direction. |
| ⑦ | − (Amount of deceleration torque) − (Kinetic friction torque) | The signs are reversed with period ③ when the kinetic friction does not change according to movement direction. |
| ⑧ | − (Static friction torque) | Calculate so that the static friction torque is always required during a stop. |

**(2) Unbalance axis load torque**

When operations ① to ⑧ are for an unbalance axis, calculate so that the following torques are required in each period. Note that the forward speed shall be an upward movement.

**Table 13-6   Load torques of unbalance axes**

| Period | Load torque calculation method | Explanation |
|---|---|---|
| ① | (Amount of acceleration torque) + (Kinetic friction torque) + (Unbalance torque) | Normally the acceleration/deceleration time constant is calculated so this torque is 80% of the maximum torque of the motor. |
| ② | (Kinetic friction torque) + (Unbalance torque) | |
| ③ | (Amount of deceleration torque) + (Kinetic friction torque) + (Unbalance torque) | The signs for the amount of acceleration torque and amount of deceleration torque are reversed when the absolute value is the same value. |
| ④ | (Static friction torque) + (Unbalance torque) | The holding torque during a stop becomes fairly large. (Upward stop) |
| ⑤ | − (Amount of acceleration torque) − (Kinetic friction torque) + (Unbalance torque) | |
| ⑥ | − (Kinetic friction torque) + (Unbalance torque) | The generated torque may be in the reverse of the movement direction, depending on the size of the unbalance torque. |
| ⑦ | − (Amount of deceleration torque) − (Kinetic friction torque) + (Unbalance torque) | |
| ⑧ | − (Static friction torque) + (Unbalance torque) | The holding torque becomes smaller than the upward stop. (Downward stop) |

| | |
|---|---|
| 💡 **POINT** | During a stop, the static friction torque may constantly be applied. The static friction torque and unbalance torque may particularly become larger during an unbalance upward stop, and the torque during a stop may become extremely large. Therefore, caution is advised. |

**< Acceleration/deceleration time constant 2 for servomotors >**
   When No. = Rated speed.



Motor shaft conversion load inertia (kg·cm$^2$)
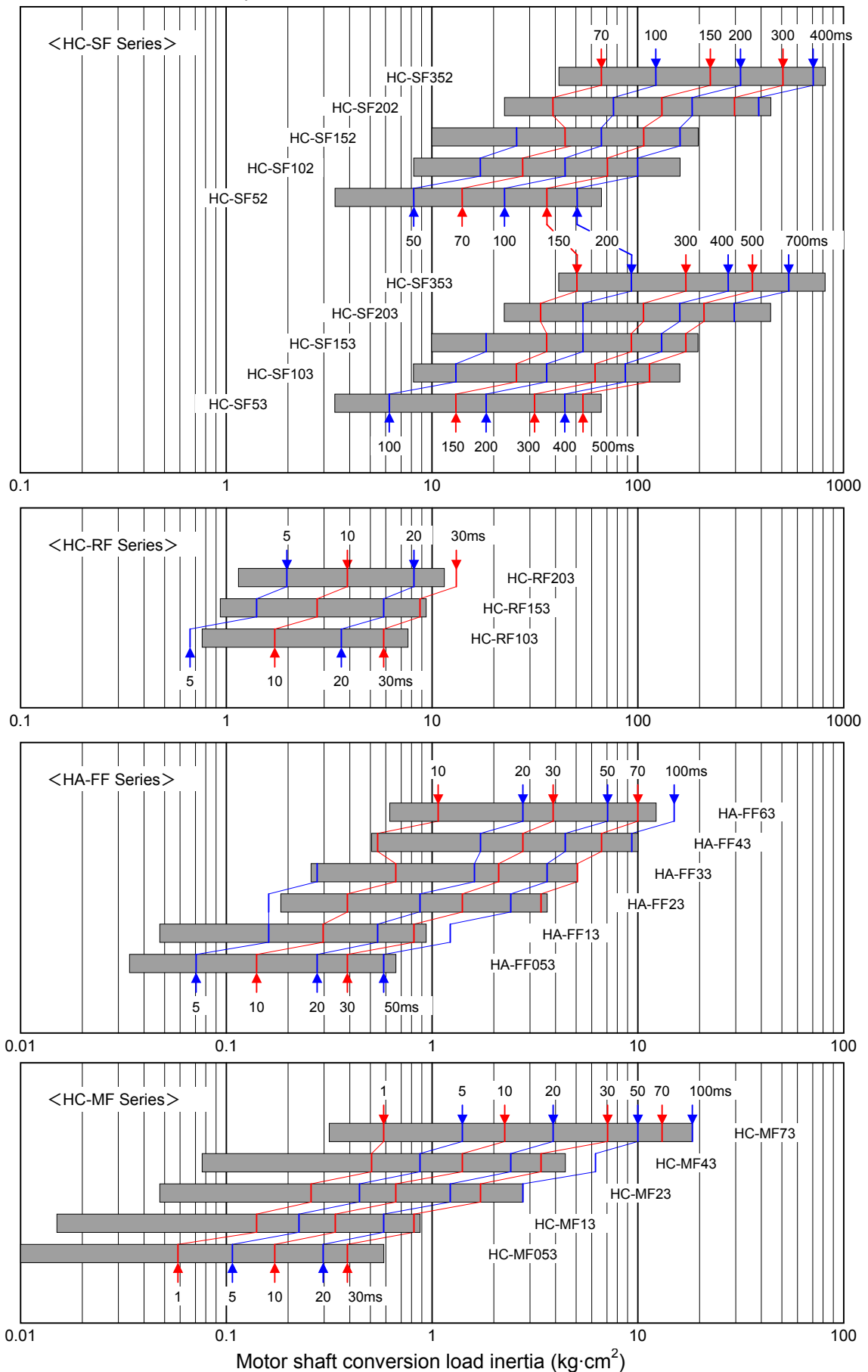
**Fig. 13-2 (2)   Simple motor capacity selection diagram**
   (Friction and unbalance torque are not considered in this diagram.)

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## 13-4    Selection of regenerative resistor

To select the regenerative resistor, first the regenerative energy from when each axis stops (is positioned) is calculated. A regenerative resistor having a capacity to satisfy the positioning frequency, determined from the machine specifications, is selected.

### 13-4-1    Calculation of regenerative energy

#### (1)    For horizontal axis

For the horizontal axis, the regenerative energy $E_R$ consumed by the regenerative resistor can be calculated with the expression (13-7). If the $E_R$ value is negative, all of the regenerative energy is absorbed (condenser regeneration) by the capacitor on the drive unit, and the energy consumption by the regenerative resistor is zero ($E_R = 0$).

$$E_R = 5.48 \times 10^{-7} \cdot \eta \cdot (J_L + J_M) \cdot N^2 - E_c \text{ (J)} \qquad \text{.................................................} \quad (13\text{-}7)$$

$\eta$ : Motor reverse effect
$J_L$ : Motor inertia $\qquad$ (kg·cm$^2$)
$J_M$ : Load inertia $\qquad$ (kg·cm$^2$)
$N$ : Motor speed $\qquad$ (r/min)
$E_c$ : Drive unit charging energy $\qquad$ (J)

> **Example**
>
> The regeneration energy is obtained for when the axis stops from the rated speed while a load with the same inertia as the motor is connected to the HC-SF52 motor.
> Regeneration energy $E_R$ is calculated using expression (13-7) below.
>
> $$E_R = 5.48 \times 10^{-7} \times 0.85 \times (6.6 + 6.6) \times 2000^2 - 11 = 13.6 \text{ (J)}$$

**Table 13-7    Servomotor reverse effect and drive unit charging energy**

| Servomotor | Motor reverse effect $\eta$ | Charging energy $E_c$ (J) | Servomotor | Motor reverse effect $\eta$ | Charging energy $E_c$ (J) |
|---|---|---|---|---|---|
| HA-SF52 | 0.85 | 11 | HA-FF053 | 0.35 | 9 |
| HA-SF102 | 0.85 | 20 | HA-FF13 | 0.55 | 9 |
| HA-SF152 | 0.85 | 40 | HA-FF23 | 0.70 | 9 |
| HA-SF202 | 0.85 | 40 | HA-FF33 | 0.75 | 9 |
| HA-SF352 | 0.85 | 40 | HA-FF43 | 0.85 | 9 |
| HA-SF53 | 0.85 | 11 | HA-FF63 | 0.85 | 11 |
| HA-SF103 | 0.85 | 20 | | | |
| HA-SF153 | 0.85 | 40 | HC-MF053 | 0.35 | 9 |
| HA-SF203 | 0.85 | 40 | HC-MF13 | 0.55 | 9 |
| HA-SF353 | 0.85 | 40 | HC-MF23 | 0.70 | 9 |
| | | | HC-MF43 | 0.85 | 9 |
| HC-RF103 | 0.85 | 40 | HC-MF73 | 0.85 | 20 |
| HC-RF153 | 0.85 | 40 | | | |
| HC-RF203 | 0.85 | 40 | | | |

> **POINT**
>
> The regenerative energy is the value for when the drive unit input power voltage is 220 V.
> If the input voltage is higher than this, the charging energy will decrease and the regeneration energy will increase.

**(2) For an unbalance axis (for linear axes)**

The regenerative energy differs in the upward stop and downward stop for an unbalance axis. A constant regeneration state results during downward movement if the unbalance torque is the same as or larger than the friction torque.

| | **Regeneration energy** |
|---|---|
| Upward stop | A regeneration state only occurs when deceleration torque (downward torque) is generated.<br><br>$E_{RU} = 5.24 \times 10^{-5} \cdot \eta \cdot T_{du} \cdot N \cdot td - Ec$ (J)............................................................... (13-8)<br><br>$\eta$   : Motor reverse efficiency<br>$T_{du}$  : Upward stop deceleration torque   (N·m)<br>N   : Motor speed   (r/min)<br>td   : Deceleration time (time constant)   (ms)<br>Ec   : Drive unit charging energy   (J) |
| Downward stop | A regeneration state occurs even during constant rate feed when the upward torque Ts during dropping is generated.<br>Calculated so that Ts = 0 when Ts is downward.<br><br>$E_{RD} = \dfrac{2\pi \cdot \eta \cdot Ts \cdot L}{\Delta S} + 5.24 \times 10^{-5} \cdot \eta \cdot T_{dd} \cdot N \cdot td - Ec$ (J)................................ (13-9)<br><br>$\eta$   : Motor reverse efficiency<br>Ts   : Upward torque during dropping   (N·m)<br>L   : Constant rate travel   (mm)<br>$\Delta S$   : Travel per motor rotation   (mm)<br>$T_{dd}$   : Downward stop deceleration torque  (N·m)<br>N   : Motor speed   (r/min)<br>td   : Deceleration time (time constant)   (ms)<br>Ec   : Drive unit charging energy   (J) |
| | One return is assumed to be one cycle, and the regeneration energy per cycle ($E_R$) is obtained using expression (13-10).<br>   $E_R = E_{RU} + E_{RD}$ (J)                  .......................................... (13-10) |

**(Example)**

In a vertical axis driven by an HC-SF52 motor, a return operation is executed at an acceleration/deceleration time constant of 50ms. The operation is executed with a feed of 20000mm/min for a distance of 200mm. The regenerative energy per return operation is obtained at this time.

Note the following :

|   Travel per upward motor rotation | : 10mm |
|---|---|
|   Upward stop deceleration torque | : 5N·m |
|   Downward stop deceleration torque | : 8N·m |
|   Upward torque during downward movement | : 0.5N·m |

Using expression (13-8), the upward stop regeneration energy $E_{RU}$ is as follows :

   $E_{RU} = 5.24 \times 10^{-5} \times 0.85 \times 5 \times 2000 \times 50 - 11 = 11.3$ (J)

The acceleration/deceleration distance required to accelerate at the 50ms acceleration/deceleration time constant to 20000mm/min. is as follows:

$\dfrac{20000 \times 50}{2 \times 60 \times 1000} = 8.3$ (mm)

Therefore, the constant speed travel is 183.4mm.
The downward stop regeneration energy $E_{RD}$ is obtained using the following expression (13-9).

   $E_{RD} = \dfrac{2\pi \times 0.85 \times 0.5 \times 183.4}{10} + 5.24 \times 10^{-5} \times 0.85 \times 8 \times 2000 \times 50 - 11 = 73.6$ (J)

Thus, the regeneration energy per return operation $E_R$ is as follows :
   $E_R = 11.3 + 73.6 = 84.9$ (J)

### 13-4-2   Calculation of positioning frequency

Select the regenerative resistor so that the positioning frequency DP (times/minute) calculated by the regenerative resistor capacity $P_R$ (W) and the regenerative energy ER (J) consumed by the regenerative resistor is within the range shown in expression (13-11). With the unbalance axis, the number of times for one cycle to raise and lower the axis is judged as DP.

$$DP \quad < \quad 48 \cdot \frac{P_R}{E_R} \quad \text{(times/minute)} \qquad \qquad \text{.................................................. (13-11)}$$

**Table 13-8   Regenerative resistor correspondence table**

| Corresponding servo drive unit | Standard built-in regenerative resistor | | External option regenerative resistor | | | | |
| | | | MR-RB032 | MR-RB12 | MR-RB32 | MR-RB30 | MR-RB50 |
| | PR = Regeneration amount | | 30W | 100W | 300W | 300W | 500W |
| | | Resistance value | 40Ω | 40Ω | 40Ω | 13Ω | 13Ω |
| MR-J2-10CT | No built-in resistor | | ○ | | | | |
| MR-J2-20CT | 10W | 100Ω | ○ | ○ | | | |
| MR-J2-40CT | 10W | 100Ω | ○ | ○ | | | |
| MR-J2-60CT | 10W | 100Ω | ○ | ○ | | | |
| MR-J2-70CT | 20W | 40Ω | | ○ | ○ | | |
| MR-J2-100CT | 20W | 40Ω | | ○ | ○ | | |
| MR-J2-200CT | 100W | 13Ω | | | | ○ | ○ |
| MR-J2-350CT | 100W | 13Ω | | | | ○ | ○ |

## 13-5   Example of servo selection

A servomotor is selected using a magazine with the following specifications as an example.

| Specification item | Unit | Magazine axis |
|---|---|---|
| Axis type | | Rotation |
| No. of mounting tools | tools | 40 |
| Tool spacing | mm | 100 |
| Magazine circumferential speed | mm/min | 40000 |
| Maximum tool weight | kg | 10 |
| Chain drive frictional force | kgf | 80 |
| Motor deceleration ratio | | 1/200 |
| Motor shaft conversion load inertia (with no tools) | kg·cm$^2$ | 20.0 |
| Positioning time | ms | Within 4000 |
| Positioning frequency | time/min | 3 |
| Motor brakes | | Available |
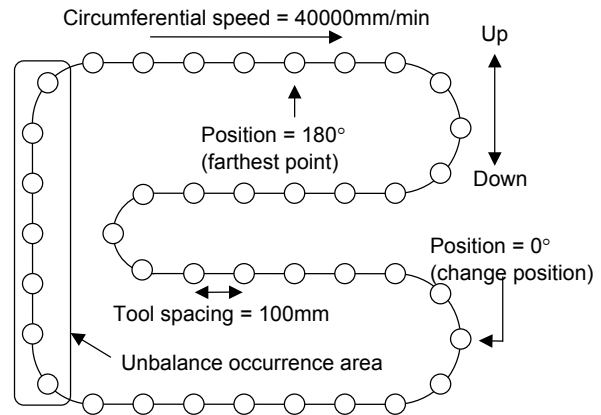
**Fig. 13-3     40-magazine configuration**

### 13-5-1   Motor selection calculation

**(1)  Obtaining load inertia**

The load inertia in the selection is always judged as the maximum value. Because the load inertia without tools is provided by the specifications, the load inertia at maximum load when all tools are attached is obtained. The tool inertia for a chain-driven magazine can be calculated as the object of linear movement. Due to this, the motor shaft conversion load inertia of one tool weighing the maximum 10kg is obtained.

- **Motor shaft conversion load inertia per tool: $J_T$**

  Obtain the tool movement amount per motor rotation $\Delta S$ before calculating the inertia.

  $$\Delta S = \text{Chain circumference} \times \text{deceleration ratio} = (40 \times 100) \cdot \frac{1}{200} = 20 \text{ (mm)}$$

  Conversion to the motor shaft by the deceleration ratio is included in the movement amount per motor rotation. Refer to "13-7 Calculation of load inertia".

  $$J_T = W \cdot \left( \frac{\Delta S}{20\pi} \right)^2 = 10 \cdot \left( \frac{20}{20\pi} \right)^2 = 1.013 \text{ (kg·cm}^2\text{)}$$

- **Motor shaft conversion total load inertia: $J_L$**

  This is the sum of the load inertia with no tools and the tool inertia.

  $$J_L = 20.0 + 40 \times 1.013 = 60.5 \text{ (kg·cm}^2\text{)}$$

**(2)  Obtaining unbalance torque**

The unbalance torque is the largest when all the tools are in the unbalance occurrence area on the left side of Fig. 13-3, and no tools are on the vertical movement area on the right side. For simplification purposes here, if it is assumed all seven tools in the unbalance occurrence area are in a part where they move vertically, then an unbalance weight of 70kg would act upon the magazine chain. If the magazine and motor are likened to 4000mm and 20mm circumference pulleys, as in Fig. 13-4, 70kg of unbalance weight acts upon the motor side pulley.

Thus, the unbalance torque is obtained as follows:

**Fig. 13-4   Unbalance torque**

$$T_U = \frac{70 \times g \times ((\text{motor side pulley radius})}{1000\text{mm}} = \frac{70 \times 9.8 \times 20}{1000 \times 2\pi} = 2.2 \text{ (N·m)}$$

**(3)  Obtaining friction torque**
The friction torque is obtained from the chain drive frictional force, in the same manner as the unbalance torque.

$$T_F = \frac{80 \times 9.8 \times 20}{1000 \times 2\pi} = 2.5 \ (N{\cdot}m)$$

**(4)  Selecting the appropriate motor from the load inertia ratio**
The motor series is limited to the HC-SF Series, because of the load inertia and recommended load inertia of the motor. The motor speed is 2000r/min, because of the magazine circumferential speed and deceleration ratio. Furthermore, because a motor with brakes is required, a 2000r/min-rated HC-SF series motor with brakes is selected.
Determine the motor series at this time, also giving careful consideration to the details in sections "13-1 Outline" and "13-2 Selection of servomotor series".

| Motor type | Motor inertia (kg·cm²) | Load inertia (kg·cm²) | Load inertia magnification | Judgment |
|---|---|---|---|---|
| HC-SF52B | 8.6 | 60.5 | 7.03 | O |
| HC-SF102B | 15.7 | 60.5 | 3.85 | O |
| HC-SF152B | 22.0 | 60.5 | 2.75 | O |
| HC-SF202B | 52.5 | 60.5 | 1.15 | O |
| HC-SF352B | 92.0 | 60.5 | 0.66 | O |

**(5)  Selecting the appropriate motor from the short time characteristics**
If the acceleration/deceleration time constant is included in the specifications, the appropriate motor is selected by calculating the acceleration/deceleration time constant for each motor from expression (13-2). Judgment here is by the positioning time rather than the acceleration/deceleration time constant. The positioning that takes the most time is that from the farthest point (180 degree position), and that positioning time will be calculated here using the HC-SF52B motor.

● **Acceleration/deceleration time constant: ta**
This is obtained from expression (13-2).

$$ta = \frac{(J_L + J_M) \times N}{95.5 \times (0.8 \times T_{MAX} - T_U - T_F)} = \frac{(60.5 + 8.6) \times 2000}{95.5 \times (0.8 \times 7.16 - 2.2 - 2.5)} = 1408 \ (ms)$$

● **Acceleration/deceleration distance: La**
This value is obtained with a linear acceleration/deceleration carried out at the angle that the axis moves from the start until the acceleration finishes and the maximum speed (3600°/min) is reached. The circumferential speed 4000mm/min becomes 3600°/min at the MR-J2-CT parameter settings (angular speed setting).

$$La = \frac{1}{2} \times \frac{3600 \times 1408}{60 \times 1000} = 42.2 \ (°)$$

● **Constant rate travel: Lc**
This is the angle at which the axis moves at maximum speed.

$$Lc = 180 - 2 \times 42.2 = 95.6 \ (°)$$

● **Longest positioning time: P**
The positioning time at a movement angle of 180° is calculated. When actually controlled with a motor, a settling time is required from when the commands become zero to when the motor starts positioning. That time is considered to be 100ms here.

$$P = 1408 \times 2 + \frac{95.6 \times 60 \times 1000}{3600} + 100 = 2816 + 1593 + 100 = 4509 \ (ms)$$

The following table shows the results when these values are calculated for other motors in the same manner. The acceleration/deceleration time constants of the HC-SF152B and HC-SF202B motors do not change much. This is because the inertia of the motor itself greatly increases due to the larger flange sizes on HC-SF202 or higher rated motors. An HC-SF102B or higher rated motor satisfies the specifications (4000ms).

| Motor type | Acceleration/ deceleration time constant (ms) | Constant rate travel distance (°) | Constant rate travel time (ms) | Longest positioning time (ms) | Judgment |
|---|---|---|---|---|---|
| HC-SF52B | 1408 | 95.6 | 1593 | 4509 | × |
| HC-SF102B | 234 | 166.0 | 2767 | 3335 | ○ |
| HC-SF152B | 137 | 171.8 | 2863 | 3237 | ○ |
| HC-SF202B | 131 | 172.2 | 2870 | 3232 | ○ |
| HC-SF352B | 90 | 174.6 | 2910 | 3190 | ○ |

**(6)  Selecting the appropriate motor from the continuous characteristics**
The torque generated in each state is obtained using the HC-SF102B motor as an example. In rotation axes, because the direction of the unbalance torque differs from that of linear axes and cannot be defined, the torque is always obtained as if it acts in the direction of the load. Because there is always a possibility that friction torque and unbalance torque act also when the motor is stopped, these are also considered in the calculation.

- **Acceleration torque: Ta**

  $T_a = 0.8 \cdot T_{MAX} = 0.8 \times 14.4 = 11.5$ (N·m)

- **Torque during constant rate travel**

  $T_C = T_U + T_F = 2.2 + 2.5 = 4.7$ (N·m)

- **Deceleration torque**

  $T_d = T_a - 2 \times T_F = 11.5 - 2 \times 2.5 = 6.5$ (N·m)

- **Torque during stop**

  $T_s = T_U + T_F = 2.2 + 2.5 = 4.7$ (N·m)

Following the specifications, the continuous effective load torque is obtained when positioning is carried out three times per minute.

$$T_{rms} = \sqrt{\frac{11.5^2 \times 702 + 4.7^2 \times 8301 + 6.5^2 \times 702 + 4.7^2 \times 50295}{60 \times 1000}} = 4.86 \text{ (N·m)}$$

The following table shows the results when the continuous effective load torque is obtained for other motors in the same manner. An HC-SF152B or higher rated motor satisfies the expression (13-4).

| Motor type | Rated torque (N·m) | During acceleration | | During constant rate travel | | During deceleration | | During stop | | Effective load torque | Judg- ment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Torque (N·m) | Time (ms) | Torque (N·m) | Time (ms) | Torque (N·m) | Time (ms) | Torque (N·m) | Time (ms) | | |
| HC-SF102B | 4.78 | 11.5 | 702 | 4.7 | 8301 | 6.5 | 702 | 4.7 | 50295 | 4.86 | × |
| HC-SF152B | 7.16 | 17.3 | 411 | 4.7 | 8589 | 12.3 | 411 | 4.7 | 50589 | 4.98 | ○ |
| HC-SF202B | 9.55 | 22.8 | 393 | 4.7 | 8610 | 17.8 | 393 | 4.7 | 50604 | 5.22 | ○ |
| HC-SF352B | 16.7 | 40.1 | 270 | 4.7 | 8730 | 35.1 | 270 | 4.7 | 50730 | 5.89 | ○ |

As a result of the selection calculations above, the motors that satisfy conditions (4) to (6) are the HC-SF152B to HC-SF352B models. Thus, the appropriate motor for this magazine axis is the HC-SF152B (MR-J2-200CT).

> **POINT**    Because there is always a possibility that friction torque and unbalance torque act also when the motor is stopped, the sum of these is calculated as the torque during stop.

## 13-5-2 Regenerative resistor selection calculation

Because unbalance torque occurs in this magazine axis, the regenerative load should be calculated as an unbalance axis. However, because the direction of the unbalance torque generation cannot be defined, the regenerative load is calculated from the load inertia only (as a horizontal axis).

**(1) Obtaining the regeneration energy**

The regeneration energy per braking is obtained from expression (13-7) for MR-J2-200CT + HC-SF152B.

$$E_R = 5.48 \times 10^{-7} \times 0.85 \times (60.5 + 22.0) \times 2000^2 - 40 = 113.7 \text{ (J)}$$

**(2) Obtaining the tolerable No. of positionings**

The tolerable cycle operation frequency per minute DP is calculated for a standard built-in regenerative resistor. Refer to expression (13-11).

$$DP = 48 \cdot \frac{P_R}{E_R} = 48 \times \frac{100}{113.7} = 42.2 \text{ (times)}$$

Because the No. of positionings shown in the specifications is 3 times/min., the standard built-in regenerative resistor can be judged to be sufficient.

| | |
|---|---|
| **POINT** | Try to choose a resistor with some allowance, because the regeneration load can easily become large compared to a horizontal axis. |

## 13-5-3 Servo selection results
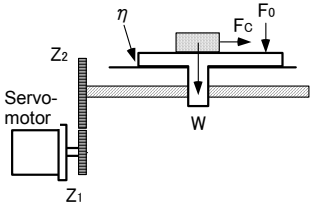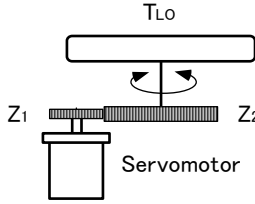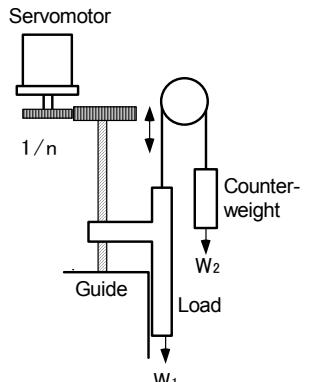
As a result of calculating the servo selection, the servo specifications for this magazine axis have been determined.

| Item | Type |
|---|---|
| Servo drive unit | MR-J2-200CT |
| Servomotor | HC-SF152B |
| Regenerative resistor | Built-in |

The shape of the motor shaft (with/without key) will be determined based on separate machine specifications.
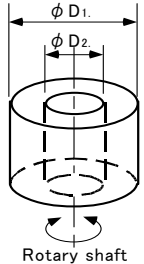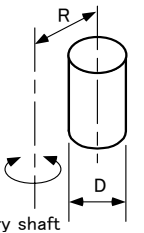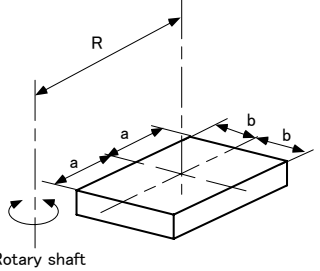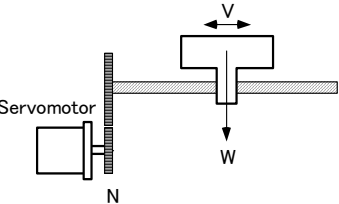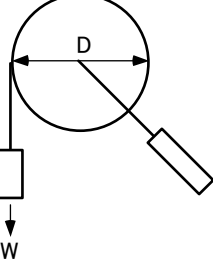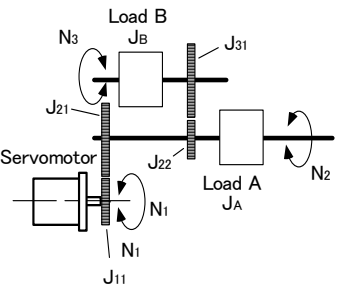
## 13-6  Motor shaft conversion load torque

The main load torque calculation expressions are shown below.

| Type | Mechanism | Calculation expression |
|------|-----------|------------------------|
| Linear movement |  | $$T_L = \frac{F}{2\times10^3\pi\eta} \cdot \left(\frac{V}{N}\right) = \frac{F\cdot\triangle S}{2\times10^3\pi\eta}$$ $T_L$ : Load torque (N·m)<br>F  : Force in axial direction of linear motion machine (N)<br>$\eta$ : Drive system efficiency (%)<br>V : Speed of linear operation object (mm/min)<br>N : Motor speed (r/min)<br>$\triangle S$: Object movement amount per motor rotation (mm)<br>$Z_1, Z_2$: Deceleration ratio<br><br>F in the above expression is obtained from the lower expression when the table is moved as shown on the left.<br><br>$F = Fc + \mu (W \cdot g \cdot F_0)$<br>Fc : Force applied on axial direction of moving section (N)<br>$F_0$ : Tightening force on inner surface of table guide (N)<br>W : Total weight of moving section (kg)<br>g : Gravitational acceleration (m/s$^2$)<br>$\mu$ : Friction coefficient |
| Rotary movement |  | $$T_L = \frac{Z_1}{Z_2} \cdot \frac{1}{\eta} \cdot T_{LO} + T_F = \frac{1}{n} \cdot \frac{1}{\eta} \cdot T_{LO} + T_F$$ $T_L$        : Load torque (N·m)<br>$T_{LO}$      : Load torque on load shaft (N)<br>$T_F$        : Motor shaft conversion load friction torque (N·m)<br>$\eta$        : Drive system efficiency<br>$Z_1, Z_2$   : Deceleration ratio<br>n          : Deceleration rate |
| Vertical movement |  | When rising<br>$T_L = T_U + T_F$<br><br>When lowering<br>$T_L = -T_U \cdot \eta^2 + T_F$<br>$T_L$ : Load torque (N·m)<br>$T_U$ : Unbalanced torque (N·m)<br>$T_F$ : Friction torque on moving section (N·m)<br><br>$$T_U = \frac{(W_1 - W_2) \cdot g}{2 \times 10^3\pi\eta} \cdot \left(\frac{V}{N}\right) = \frac{(W_1 - W_2) \cdot g \cdot \triangle S}{2 \times 10^3\pi\eta}$$ $$T_F = \frac{\mu \cdot (W_1 + W_2) \cdot g \cdot \triangle S}{2 \times 10^3\pi\eta}$$ $W_1$ : Load weight (kg)<br>$W_2$ : Counterweight weight (kg)<br>$\eta$ : Drive system efficiency<br>g : Gravitational acceleration = 9.8 (m/s$^2$)<br>V : Speed of linear operation object (mm/min)<br>N : Motor speed (r/min)<br>$\triangle S$: Object movement speed per motor rotation (mm)<br>$\mu$ : Friction coefficient |

## 13-7   Expressions for load inertia calculation

The calculation method for a representative load inertia is shown.

| Type | Mechanism | Calculation expression |
|---|---|---|
| Cylinder | Rotary shaft is cylinder center | $J_L = \dfrac{\pi \cdot \rho \cdot L}{32}(D_1{}^4 - D_2{}^4) = \dfrac{W}{8}(D_1{}^2 - D_2{}^2)$ <br><br> $J_L$ : Load inertia [kg·cm²] <br> $\rho$ : Density of cylinder material [kg·cm²] <br> L : Length of cylinder [cm] <br> $D_1$ : Outer diameter of cylinder [cm] <br> $D_2$ : Inner diameter of cylinder [cm] <br> W : Weight of cylinder [kg] <br><br> **Reference data** <br> Material densities Iron <br> ..... $7.80 \times 10^{-3}$ [kg/cm³] <br> Aluminum <br> ..... $2.70 \times 10^{-3}$ [kg/cm³] <br> Copper <br> ..... $8.96 \times 10^{-3}$ [kg/cm³] |
| | When rotary shaft and cylinder shaft are deviated | $J_L = \dfrac{W}{8}(D^2 + 8R^2)$ <br><br> $J_L$ : Load inertia [kg·cm²] <br> W : Weight of cylinder [kg] <br> D : Outer diameter of cylinder [cm] <br> R : Distance between rotary axis and cylinder axis [cm] |
| Column | | $J_L = W\left(\dfrac{a^2 + b^2}{3} + R^2\right)$ <br><br> $J_L$ : Load inertia [kg·cm²] <br> W : Weight of cylinder [kg] <br> a.b.R : Left diagram [cm] |
| Object that moves linearly | | $J_L = W\left(\dfrac{1}{2\pi N} \cdot \dfrac{V}{10}\right)^2 = W\left(\dfrac{\Delta S}{20\pi}\right)^2$ <br><br> $J_L$ : Load inertia [kg·cm²] <br> W : Weight of object that moves linearly [kg] <br> N : Motor speed [r/min] <br> V : Speed of object that moves linearly [mm/min] |
| Suspended object | | $J_L = W\left(\dfrac{D}{2}\right)^2 + J_P$ <br><br> $J_L$ : Load inertia [kg·cm²] <br> W : Weighty of object [kg] <br> D : Diameter of pulley [cm] <br> $J_P$ : Inertia of pulley [kg·cm²] |
| Converted load | | $J_L = J_{11} + (J_{21} + J_{22} + J_A) \cdot \left(\dfrac{N_2}{N_1}\right)^2 + (J_{31} + J_B) \cdot \left(\dfrac{N_3}{N_1}\right)^2$ <br><br> $J_L$ : Load inertia [kg·cm²] <br> $J_A, J_B$ : Inertia of load A, B [kg·cm²] <br> $J_{11} \sim J_{31}$ : Inertia [kg·cm²] <br> $N_1 \sim N_3$ : Each shaft's speed [r/min] |

# Appendix   Parameter Lists

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|-----|---------|----------------|---------------|------|-------------|---------------|
| #001 | ∗MSR | Motor series | 0000 | | Set the motor series. This is automatically judged by the system when the default value (0000) is set. | |
| #002 | ∗RTY | Regeneration option type | | | Set the regenerative resistor type. Do not set values without a description.<br><br>`0 0 0 0`  (Default setting value)<br><br>| Setting value | Description |<br>|---|---|<br>| 0 | Drive unit standard built-in resistor (10CT has no built-in resistor) |<br>| 1 | Setting prohibited |<br>| 2 | MR-RB032    (30W) |<br>| 3 | MR-RB12    (100W) |<br>| 4 | MR-RB32    (300W) |<br>| 5 | MR-RB30    (300W) |<br>| 6 | MR-RB50    (500W) |<br>| 7~F | Setting prohibited | | |
| #003 | ∗PC1 | Motor side gear ratio (machine rotation ratio) | 1 | | Set the No. of gear teeth on the motor side and the No. of gear teeth on the machine side as an integer reduced to its lowest terms. Set the total gear ratio if there are multiple gear levels. For rotation axes, set the No. of motor rotations per machine rotation. | 1 ~ 32767 |
| #004 | ∗PC2 | Machine side gear ratio (motor rotation ratio) | 1 | | | 1 ~ 32767 |
| #005 | ∗PIT | Feed pitch | 360 | ° (mm) | Set 360 (default value) for rotation axes. Set the feed lead for linear axes. | 1 ~ 32767 |
| #006 | INP | In-position detection width | 50 | 1/1000 ° (μm) | In-position is detected when the position droop becomes this setting value or less. | 1 ~ 32767 |
| #007 | ATU | Auto-tuning | | | Set the adjustment of the auto-tuning. Do not set values without a description.<br><br>`0 1 0 2`  (Default setting value)<br><br>| Setting value | Description |<br>|---|---|<br>| 1 | Low response (low-rigidity loads, loads which easily vibrate) |<br>| 2 | Standard setting value |<br>| 3 | Standard setting value |<br>| 4 | Standard setting value |<br>| 5 | High response (high-rigidity loads, loads which do not easily vibrate) |<br><br>| Setting value | Description |<br>|---|---|<br>| 0 | Standard |<br>| 1 | Large friction amount (set the position loop gain slightly lower) |<br><br>| Setting value | Description |<br>|---|---|<br>| 0 | Only auto-tune PG2, VG2, VIC, and GD2. |<br>| 1 | Only auto-tune PG1, PG2, VG1, VG2, VIC, and GD2 (total gain). |<br>| 2 | No auto-tuning. | | |
| #008 | PG1 | Position loop gain 1 | 70 | rad/s | Set the position loop gain of the model loop. Determine the tracking ability regarding the position commands. | 4 ~ 1000 |
| #009 | | | 0 | | Not used. | |
| #010 | EMGt | Deceleration control time constant | 500 | ms | Set the deceleration time from the clamp speed (Aspeed1). For normal rapid traverse, set the same value as the acceleration/deceleration time constant. | 0 ~ 32768 |

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|-----|---------|----------------|---------------|------|-------------|---------------|
| #011 | | | 0 | | Not used. | |
| #012 | | | 0 | | Not used. | |
| #013 | MBR | Vertical axis drop prevention time | 100 | ms | Input the time to delay servo OFF when the servo OFF command is input. Increase the setting by 100ms at a time and set the minimum value where the axis does not drop. | 0 ~ 1000 |
| #014 | NCH | Notch filter No. | | | Set the frequency of the mechanical resonance control filter. Do not set values without a description. | |
| #015 | | | 0 | | Not used | |
| #016 | JIT | Jitter compensation | | | Set the No. of ignored jitter compensation pulses. Do not set values without a description. | |
| #017 | | | 0 | | Not used. | |
| #018 | | | 0 | | Not used. | |
| #019 | PG2 | Position loop gain 2 | 25 | rad/s | Set the position loop gain of the actual loop. Determine the position responsiveness for external disturbance. | 1 ~ 500 |
| #020 | VG1 | Speed loop gain 1 | 1200 | rad/s | Set the speed loop gain of the model loop. Determine the tracking ability regarding the speed commands. | 20 ~ 5000 |
| #021 | VG2 | Speed loop gain 2 | 600 | rad/s | Set the speed loop gain of the actual loop. Determine the speed responsiveness for external disturbance. | 20 ~ 8000 |
| #022 | VIC | Speed integral compensation | 20 | ms | Determine the characteristics of the speed low-frequency region. | 1 ~ 1000 |
| #023 | VDC | Speed differential compensation | 1000 | | PI control normally results from a default value of 1000. Adjust the override amount by lowering in increments of 20. | 0 ~ 1000 |
| #024 | GD2 | Load inertia ratio | | -fold | Set the load inertia ratio for the motor inertia. | 0.0 ~ 50.0 |
| #025 | | | | | Not used | |
| #030 | ∗MTY | Motor type | | | Set the motor type. This is automatically judged by the system when the default value (0000) is set. | |

For #014 NCH:

| Setting value | Frequency (Hz) |
|---------------|----------------|
| 0 | No start |
| 1 | 1125 |
| 2 | 563 |
| 3 | 375 |
| 4 | 282 |
| 5 | 225 |
| 6 | 188 |
| 7 | 161 |

For #016 JIT:

| Setting value | No. of ignored pulses. |
|---------------|------------------------|
| 0 | No start |
| 1 | 1 |
| 2 | 2 |
| 3 | 3 |

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | | Setting range |
|---|---|---|---|---|---|---|---|
| #050 | MD1 | D/A output channel 1 data Nos. | | | Set the Nos. of the data to be output on D/A output channel 1.<br><br>`0 0 0 0`  (Default setting value)<br><br>(see table below) | | |
| #051 | MO1 | D/A output channel 1 output offset | 0 | mV | Set this value when the zero level of D/A output channel 1 is not suitable. | | −999 ~ 999 |
| #052 | | | 0 | | Not used | | |
| #053 | MD2 | D/A output channel 2 data No. | | | Set the Nos. of the data to be output on D/A output channel 2.<br>The descriptions are the same as those of #050 MD1D/A output channel data No. 1. | | |
| #054 | MO2 | D/A output channel 2 output offset | 0 | mV | Set this value when the zero level of D/A output channel 2 is not suitable. | | −999 ~ 999 |
| #055 | | | 0 | | Not used | | |
| #100 | *station | No. of indexing stations | 2 | | Set the No. of stations. For linear axes, this value is expressed by: No. of divisions = No. of stations − 1. | | 2 ~ 360 |
| #101 | *Cont1 | Control parameter 1 | | | This is a HEX setting parameter. Set bits without a description to their default values. | | |

#050 MD1 data description:

| No. | Description | Magnification |
|---|---|---|
| 0 | Speed feedback (with sign) | Maximum speed = 8V |
| 1 | Current feedback (with sign) | Maximum current (torque) = 8V |
| 2 | Speed feedback (without sign) | Maximum speed = 8V |
| 3 | Current feedback (without sign) | Maximum current (torque) = 8V |
| 4 | Current command | Maximum current (torque) = 8V |
| 5 | Command F⊿T | 100000 [°/min] = 10V |
| 6 | Position droop 1 (1/1) | 2048 [pulse] = 10V |
| 7 | Position droop 2 (1/4) | 8192lse] = 10V |
| 8 | Position droop 3 (1/16) | 32768lse] = 10V |
| 9 | Position droop 4 (1/32) | 65536 [pulse] = 10V |
| A | Position droop 5 (1/64) | 131072 [pulse] = 10V |

#101 *Cont1 Control parameter 1:

| bit | F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Default value | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| bit | Meaning when "0" is set. | Meaning when "1" is set. |
|---|---|---|
| 0 | | |
| 1 | High-speed zero point return after establishment of zero point. | Dog-type return for each zero point return operation. |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | Reference point return direction (+) | Reference point return direction (−) |
| 9 | Rotation direction determined by DIR | Rotation direction in the shortcut direction |
| A | Machine reference position becomes the reference point | Electrical zero point becomes the reference position |
| B | | |
| C | | |
| D | Coordinate zero point creation valid | Zero point established at power supply ON position |
| E | Rotation direction in DIR or in the shortcut direction | Rotation direction in the random position command sign direction |
| F | Stopper direction is positioning direction | Stopper direction is in the sign direction of the stopper amount |

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #102 | *Cont2 | Control parameter 2 | | | This is a HEX setting parameter. Set bits without a description to their default values. | |

| bit | F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Default value | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |

| bit | Meaning when "0" is set. | Meaning when "1" is set. |
|---|---|---|
| 0 | | |
| 1 | Error not corrected at servo OFF | Error corrected at servo OFF |
| 2 | Linear axis | Rotation axis |
| 3 | Station assignment direction CW | Station assignment direction CCW |
| 4 | Uniform index | Non-uniform index |
| 5 | DO channel standard assignment | DO channel reverse assignment |
| 6 | 2-wire detector communication | 4-wire detector communication |
| 7 | Incremental detection | Absolute position detection |
| 8 | | |
| 9 | | |
| A | | |
| B | | |
| C | | |
| D | | |
| E | | |
| F | | |

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #103 | *Emgcont | Emergency stop control | | | | |

| bit | F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Default value | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

| bit | Meaning when "0" is set. | Meaning when "1" is set. |
|---|---|---|
| 0 | External emergency stop valid | External emergency stop invalid (default value) |
| 1 | Dynamic brake stop at emergency stop | Deceleration control stop at emergency stop |
| 2 | CNC bus emergency stop input valid | CNC bus emergency stop input invalid |
| 3 | CNC bus emergency stop output valid | CNC bus emergency stop output invalid |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| A | | |
| B | | |
| C | | |
| D | | |
| E | | |
| F | | |

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #104 | *tleng | Linear axis stroke length | 100.000 | mm | Set the movement stroke length for linear axes. This is meaningless when setting non-uniform assignments or commanding random positions. | 0.001 ~ 99999.999 |
| #110 | ZRNspeed | Reference point return speed | 1000 | °/min (mm/min) | Set the clamp value of the feedrate when a reference point return is carried out. The feedrate becomes the manual operation speed of the parameter group selected at that time, but it is clamped by this parameter setting value. | 1 ~ 100000 |
| #111 | ZRNcreep | Reference point return creep speed | 200 | °/min (mm/min) | Set the approach speed to the reference point after dog detection during a reference point return. | 1 ~ 65535 |

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|-----|---------|----------------|---------------|------|-------------|---------------|
| #112 | grid mask | Grid mask | 0 | 1/1000 ° (μm) | Set the amount that the dog is artificially extended. Set 1/2 the grid spacing as a standard. | 0 ~ 65536 |
| #113 | ∗ grspc | Grid spacing | 0 | $1/2^n$ divisions | Divide the grid spacing that is the conventional motor rotation movement amount into 2, 4, 8, or 16 divisions. | 0 ~ 4 |
| #114 | ZRNshift | Reference point shift amount | 0 | 1/1000 ° (μm) | Set the shift amount in a dog-type reference point return from the electric zero point determined on the grid to the reference point. | 0 ~ 65536 |
| #115 | ST.offset | Station offset | 0.000 | ° (mm) | Set the distance (offset) from the reference point to station 1. | −99999.999 ~99999.999 |
| #116 | ∗ABS Base | Absolute position zero point | 0.000 | ° (mm) | When movement of the machine coordinate zero point from the reference point is required during absolute position default setting, set that movement amount. | −99999.999 ~99999.999 |
| #117 | Limit (+) | Soft limit (+) | 1.000 | mm | Commands in the plus direction that exceed this setting value are not possible. If the machine is in a position exceeding the setting value, commands in the minus direction are possible. The soft limit function will not operate if Limit (+) and Limit (−) are set to the same value. | −99999.999 ~99999.999 |
| #118 | Limit (−) | Soft limit (−) | 1.000 | mm | Commands in the minus direction that exceed this value are not possible. If the machine is in a position exceeding the setting value, commands in the plus direction are possible. | −99999.999 ~99999.999 |
| #120 | ABS type | Absolute position detection parameter | | | This is a HEX setting parameter. Set bits without a description to their default values. | |

| bit | F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-----|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Default value | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

| bit | Meaning when "0" is set. | Meaning when "1" is set. |
|-----|--------------------------|--------------------------|
| 0 | | |
| 1 | Dogless-type method default setting | Dog-type method default setting |
| 2 | Mechanical stopper method default setting | Reference point matching method default setting |
| 3 | Electrical zero point direction (+) | Electrical zero point direction (−) |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| A | | |
| B | | |
| C | | |
| D | | |
| E | | |
| F | | |

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|-----|---------|----------------|---------------|------|-------------|---------------|
| #123 | ABS check | Absolute position power OFF tolerable movement value | 0.000 | ° (mm) | Set the value for the tolerable amount of movement for a machine that moved during power OFF in an absolute position detection system. The "Absolute position power OFF movement exceeded (ABS)" signal will turn ON if the machine moves more that this setting value during while the power is OFF. The movement amount is not checked when this parameter is set to 0.000. | 0.000 ~ 99999.999 |
| #130 | backlash | Backlash compensation amount | 0 | 1/1000 ° (μm) | Set the backlash compensation amount. | 0 ~ 9999 |
| #132 | | | 0 | | Not used | |
| #133 | | | 0 | | Not used | |
| #134 | | | 0 | | Not used | |
| #135 | | | 0 | | Not used | |

## < Operation parameter group 1 >

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|-----|---------|----------------|---------------|------|-------------|---------------|
| #150 | Aspeed1 | Operation parameter group 1 Automatic operation speed | 5000 | ° /min (mm/min) | Set the feedrate during automatic operation when operation parameter group 1 is selected. This parameter functions as the clamp value for the automatic operation speeds and manual operation speeds of all operation groups. A speed exceeding Aspeed1 cannot be commanded, even if set in the parameters. | 1 ~ 100000 |
| #151 | Mspeed1 | Operation parameter group 1 Manual operation speed | 2000 | ° /min (mm/min) | Set the feedrate during manual operation and JOG operation when operation parameter group 1 is selected. | 1 ~ 100000 |
| #152 | time1.1 | Operation parameter group 1 Acceleration/deceleration time constant 1 | 100 | ms | Set the linear acceleration/deceleration time for the operation parameter group 1 automatic operation speed (clamp speed) when operation parameter group 1 is selected. When operating at speeds less than the clamp speed, the axis will linearly accelerate/decelerate at the inclination determined above. When this is set together with acceleration/deceleration time constant 2, S-character acceleration/deceleration is carried out. In this case, set the acceleration/deceleration time of the linear part in this parameter. | 1 ~ 9999 |
| #153 | time1.2 | Operation parameter group 1 Acceleration/deceleration time constant 2 | 1 | ms | Set this parameter when carrying out S-character acceleration/deceleration. When S-character acceleration/deceleration is carried out, set the total time of the non-linear parts. When 1 is set in this parameter, linear acceleration/deceleration is carried out. For the handle feed operation mode, this becomes the linear acceleration/deceleration that is the acceleration/deceleration time constant. | 1 ~ 9999 |
| #154 | TL1 | Operation parameter group 1 Torque limit value | 500 | % | Set the motor output torque limit value when operation parameter group 1 is selected. At the default value, the torque is limited at the maximum torque of the motor specifications. Set the default value when torque limiting is not especially required. In the stopper positioning operation mode, this becomes the torque limit value when positioning to the stopper starting coordinates. | 1 ~ 500 |
| #155 | OD1 | Operation parameter group 1 Excessive error detection width | 100 | ° (mm) | Set the excessive error detection width when operation parameter group 1 is selected. An excessive error alarm (S03 0052) is detected when the position droop becomes larger than this setting value. | 0 ~ 32767 |
| #156 | just1 | Operation parameter group 1 Set position output width | 0.500 | ° (mm) | The signal indicating that the machine position is at any one of the stations is the set position reached (JST) signal. During automatic operation, the automatic set position reached (JSTA) signal is also output under the same conditions. Set the tolerable values at which these signals are output when operation parameter group 1 is selected. These signals turn OFF when the machine position is separated from the station by more than this value. | 0.000 ~ 99999.999 |
| #157 | near1 | Operation parameter group 1 Near set position output width | 1.000 | ° (mm) | The signal indicating that the machine position is near any one of the station positions is the near set position (NEAR) signal. Set the tolerable values at which these signals are output when operation parameter group 1 is selected. These values are generally set wider than the set position output width. During operations, this is related to special commands when the station selection is 0. Refer to section "6-4-3 Automatic operation." | 0.000 ~ 99999.999 |

**< Operation parameter group 2 >**

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|-----|---------|----------------|---------------|------|-------------|---------------|
| #158 | Aspeed2 | Operation parameter group 2 Automatic operation speed | 5000 | °/min (mm/min) | Set the feedrate during automatic operation when operation parameter group 2 is selected. | 1 ~ 100000 |
| #159 | Mspeed2 | Operation parameter group 2 Manual operation speed | 2000 | °/min (mm/min) | Set the feedrate during manual operation and JOG operation when operation parameter group 2 is selected. | 1 ~ 100000 |
| #160 | time2.1 | Operation parameter group 2 Acceleration/deceleration time constant 1 | 100 | ms | Set the linear acceleration/deceleration time for the operation parameter group 1 automatic operation speed (clamp speed) when operation parameter group 2 is selected. When operating at speeds less than the clamp speed, the axis will linearly accelerate/decelerate at the inclination determined above. When this is set together with acceleration/deceleration time constant 2, S-character acceleration/deceleration is carried out. In this case, set the acceleration/deceleration time of the linear part in this parameter. | 1 ~ 9999 |
| #161 | time2.2 | Operation parameter group 2 Acceleration/deceleration time constant 2 | 1 | ms | Set this parameter when carrying out S-character acceleration/deceleration. When S-character acceleration/deceleration is carried out, set the total time of the non-linear parts. When 1 is set in this parameter, linear acceleration/deceleration is carried out. For the handle feed operation mode, this becomes the linear acceleration/deceleration that is the acceleration/deceleration time constant. | 1 ~ 9999 |
| #162 | TL2 | Operation parameter group 2 Torque limit value | 500 | % | Set the motor output torque limit value when operation parameter group 2 is selected. At the default value, the torque is limited at the maximum torque of the motor specifications. In the stopper positioning operation mode, this becomes the torque limit value during stopper operation. | 1 ~ 500 |
| #163 | OD2 | Operation parameter group 2 Excessive error detection width | 100 | ° (mm) | Set the excessive error detection width when operation parameter group 2 is selected. An excessive error alarm (S03 0052) is detected when the position droop becomes larger than this setting value. In the stopper positioning operation mode, this becomes the torque limit value excessive error detection width during stopper operation. | 0 ~ 32767 |
| #164 | just2 | Operation parameter group 2 Set position output width | 0.500 | ° (mm) | The signal indicating that the machine position is at any one of the stations is the set position reached (JST) signal. During automatic operation, the automatic set position reached (JSTA) signal is also output under the same conditions. Set the tolerable values at which these signals are output when operation parameter group 2 is selected. These signals turn OFF when the machine position is separated from the station by more than this value. | 0.000 ~ 99999.999 |
| #165 | near2 | Operation parameter group 2 Near set position output width | 1.000 | ° (mm) | The signal indicating that the machine position is near any one of the station positions is the near set position (NEAR) signal. Set the tolerable values at which these signals are output when operation parameter group 2 is selected. These values are generally set wider than the set position output width. During operations, this is related to special commands when the station selection is 0. Refer to section "6-4-3 Automatic operation." | 0.000 ~ 99999.999 |

**< Operation parameter group 3 >**

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #166 | Aspeed3 | Operation parameter group 3 Automatic operation speed | 5000 | °/min (mm/min) | Set the feedrate during automatic operation when operation parameter group 3 is selected. | 1 ~ 100000 |
| #167 | Mspeed3 | Operation parameter group 3 Manual operation speed | 2000 | °/min (mm/min) | Set the feedrate during manual operation and JOG operation when operation parameter group 3 is selected. | 1 ~ 100000 |
| #168 | time3.1 | Operation parameter group 3 Acceleration/deceleration time constant 1 | 100 | ms | Set the linear acceleration/deceleration time for the operation parameter group 1 automatic operation speed (clamp speed) when operation parameter group 3 is selected. When operating at speeds less than the clamp speed, the axis will linearly accelerate/decelerate at the inclination determined above. When this is set together with acceleration/deceleration time constant 2, S-character acceleration/deceleration is carried out. In this case, set the acceleration/deceleration time of the linear part in this parameter. | 1 ~ 9999 |
| #169 | time3.2 | Operation parameter group 3 Acceleration/deceleration time constant 2 | 1 | ms | Set this parameter when carrying out S-character acceleration/deceleration. When S-character acceleration/deceleration is carried out, set the total time of the non-linear parts. When 1 is set in this parameter, linear acceleration/deceleration is carried out. For the handle feed operation mode, this becomes the linear acceleration/deceleration that is the acceleration/deceleration time constant. | 1 ~ 9999 |
| #170 | TL3 | Operation parameter group 3 Torque limit value | 500 | % | Set the motor output torque limit value when operation parameter group 3 is selected. At the default value, the torque is limited at the maximum torque of the motor specifications. In the stopper positioning operation mode, this becomes the pressing torque limit value after completion of the positioning. | 1 ~ 500 |
| #171 | OD3 | Operation parameter group 3 Excessive error detection width | 100 | ° (mm) | Set the excessive error detection width when operation parameter group 3 is selected. An excessive error alarm (S03 0052) is detected when the position droop becomes larger than this setting value. In the stopper positioning operation mode, this becomes the excessive error detection width during pressing after completion of the positioning. | 0 ~ 32767 |
| #172 | just3 | Operation parameter group 3 Set position output width | 0.500 | ° (mm) | The signal indicating that the machine position is at any one of the stations is the set position reached (JST) signal. During automatic operation, the automatic set position reached (JSTA) signal is also output under the same conditions. Set the tolerable values at which these signals are output when operation parameter group 3 is selected. These signals turn OFF when the machine position is separated from the station by more than this value. | 0.000 ~ 99999.999 |
| #173 | near3 | Operation parameter group 3 Near set position output width | 1.000 | ° (mm) | The signal indicating that the machine position is near any one of the station positions is the near set position (NEAR) signal. Set the tolerable values at which these signals are output when operation parameter group 3 is selected. These values are generally set wider than the set position output width. During operations, this is related to special commands when the station selection is 0. Refer to section "6-4-3 Automatic operation." | 0.000 ~ 99999.999 |

**< Operation parameter group 4 >**

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|-----|---------|----------------|---------------|------|-------------|---------------|
| #174 | Aspeed4 | Operation parameter group 4 Automatic operation speed | 5000 | ° /min (mm/min) | Set the feedrate during automatic operation when operation parameter group 4 is selected. | 1 ~ 100000 |
| #175 | Mspeed4 | Operation parameter group 4 Manual operation speed | 2000 | ° /min (mm/min) | Set the feedrate during manual operation and JOG operation when operation parameter group 4 is selected. | 1 ~ 100000 |
| #176 | time4.1 | Operation parameter group 4 Acceleration/deceleration time constant 1 | 100 | ms | Set the linear acceleration/deceleration time for the operation parameter group 1 automatic operation speed (clamp speed) when operation parameter group 4 is selected. When operating at speeds less than the clamp speed, the axis will linearly accelerate/decelerate at the inclination determined above. When this is set together with acceleration/deceleration time constant 2, S-character acceleration/deceleration is carried out. In this case, set the acceleration/deceleration time of the linear part in this parameter. | 1 ~ 9999 |
| #177 | time4.2 | Operation parameter group 4 Acceleration/deceleration time constant 2 | 1 | ms | Set this parameter when carrying out S-character acceleration/deceleration. When S-character acceleration/deceleration is carried out, set the total time of the non-linear parts. When 1 is set in this parameter, linear acceleration/deceleration is carried out. For the handle feed operation mode, this becomes the linear acceleration/deceleration that is the acceleration/deceleration time constant. | 1 ~ 9999 |
| #178 | TL4 | Operation parameter group 4 Torque limit value | 500 | % | Set the motor output torque limit value when operation parameter group 4 is selected. At the default value, the torque is limited at the maximum torque of the motor specifications. In the stopper default setting mode in absolute position detection systems, this becomes the torque limit value during stopper operation. | 1 ~ 500 |
| #179 | OD4 | Operation parameter group 4 Excessive error detection width | 100 | ° (mm) | Set the excessive error detection width when operation parameter group 4 is selected. An excessive error alarm (S03 0052) is detected when the position droop becomes larger than this setting value. In the stopper default setting mode in absolute position detection systems, this becomes the excessive error detection width during stopper operation. | 0 ~ 32767 |
| #180 | just4 | Operation parameter group 4 Set position output width | 0.500 | ° (mm) | The signal indicating that the machine position is at any one of the stations is the set position reached (JST) signal. During automatic operation, the automatic set position reached (JSTA) signal is also output under the same conditions. Set the tolerable values at which these signals are output when operation parameter group 4 is selected. These signals turn OFF when the machine position is separated from the station by more than this value. | 0.000 ~ 99999.999 |
| #181 | near4 | Operation parameter group 4 Near set position output width | 1.000 | ° (mm) | The signal indicating that the machine position is near any one of the station positions is the near set position (NEAR) signal. Set the tolerable values at which these signals are output when operation parameter group 4 is selected. These values are generally set wider than the set position output width. During operations, this is related to special commands when the station selection is 0. Refer to section "6-4-3 Automatic operation." | 0.000 ~ 99999.999 |

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #190 | stops2 | Station 2 coordinate value | 0.000 | ° (mm) | Set the coordinate value of each station when non-uniform assignment is selected. The station 1 coordinate value is fixed at 0.000 (machine coordinate zero point). | −99999.999 ~99999.999 |
| #191 | stops3 | Station 3 coordinate value | | | | |
| #192 | stops4 | Station 4 coordinate value | | | | |
| #193 | stops5 | Station 5 coordinate value | | | | |
| #194 | stops6 | Station 6 coordinate value | | | | |
| #195 | stops7 | Station 7 coordinate value | | | | |
| #196 | stops8 | Station 8 coordinate value | | | | |
| #197 | stops9 | Station 9 coordinate value | | | | |
| #200 | PSWcheck | PSW detection method | | | This is a HEX setting parameter. Set bits without a description to their default values. | |

| bit | F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Default value | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| bit | position switch | Meaning when "0" is set. | Meaning when "1" is set. |
|---|---|---|---|
| 0 | PSW1 | The position switch output is judged by the machine position of the command system. | The position switch output is judged by the machine FB position (actual position). |
| 1 | PSW2 | | |
| 2 | PSW3 | | |
| 3 | PSW4 | | |
| 4 | PSW5 | | |
| 5 | PSW6 | | |
| 6 | PSW7 | | |
| 7 | PSW8 | | |
| 8 | | | |
| 9 | | | |
| A | | | |
| B | | | |
| C | | | |
| D | | | |
| E | | | |
| F | | | |

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|---|---|---|---|---|---|---|
| #201 | PSW1dog1 | PSW1 region setting 1 | 0.000 | ° (mm) | When the machine position is in the region between region settings 1 and 2, the position switch of each No. will turn ON. The size of the setting value for region setting 1 and 2 does not affect the position switch operation. For rotation axes, the output turns ON at the region not including 0.000° | −99999.999 ~99999.999 |
| #202 | PSW1dog2 | PSW1 region setting 2 | | | | |
| #203 | PSW2dog1 | PSW2 region setting 1 | | | | |
| #204 | PSW2dog2 | PSW2 region setting 2 | | | | |
| #205 | PSW3dog1 | PSW3 region setting 1 | | | | |
| #206 | PSW3dog2 | PSW3 region setting 2 | | | | |
| #207 | PSW4dog1 | PSW4 region setting 1 | | | | |
| #208 | PSW4dog2 | PSW4 region setting 2 | | | | |
| #209 | PSW5dog1 | PSW5 region setting 1 | | | | |
| #210 | PSW5dog2 | PSW5 region setting 2 | | | | |
| #211 | PSW6dog1 | PSW6 region setting 1 | | | | |
| #212 | PSW6dog2 | PSW6 region setting 2 | | | | |
| #213 | PSW7dog1 | PSW7 region setting 1 | | | | |
| #214 | PSW7dog2 | PSW7 region setting 2 | | | | |
| #215 | PSW8dog1 | PSW8 region setting 1 | | | | |
| #216 | PSW8dog2 | PSW8 region setting 2 | | | | |
| #220 | push | Stopper amount | 0.000 | ° (mm) | Set the command stroke of the stopper operation during stopper positioning operations. | 0.000 ~ 359.999 |
| #221 | pusht1 | Stopper standby time | 0 | ms | Set the standby time from the stopper starting coordinate positioning to the stopper operation start during stopper positioning operations. | 0 ~ 9999 |
| #222 | pusht2 | Stopper torque release time | 0 | ms | Set the time from the completion of the stopper operation to the changeover of the pressing torque during stopper positioning operations. | 0 ~ 9999 |

| No. | Abbrev. | Parameter name | Default value | Unit | Explanation | Setting range |
|-----|---------|----------------|---------------|------|-------------|---------------|
| #223 | pusht3 | Set position signal output delay time | 0 | ms | Set the time from the completion of the stopper operation to the output of the automatic set position reached (JSTA), set position reached (JST), and near set position (NEAR) signals during stopper positioning operations. | 0 ~ 9999 |

# Revision History

| Date of revision | Manual No. | Revision details |
|---|---|---|
| Jun. 1997 | BNP-B3944C(ENG) | • First edition created. |
| Jan. 1999 | BNP-B3944D(ENG) | • HC-SF(3000r/min rated)series, that includes (HC-SF53, HC-SF103, HC-SF153, HC-SF203, HC-SF353) were added.<br>• Miswrites were corrected. |
| Jun. 1999 | BNP-B3944E(ENG) | • Notation units were unified to a SI unit to be based on new regulations of measurement.<br>• Explanation to support UL/c-UL standard was added.<br>• Specifications for taper axis of HC-SF and HC-RF motors were added.<br>• HC-MF**-S15 (specifications for IP65) was added.<br>• Miswrites were corrected. |
| Jun. 2003 | BNP-B3944F(ENG) | • Contents of all the bits are described for the bit parameters in the parameter list.<br>• Miswrites were corrected. |
| Nov. 2005 | BNP-B3944G(ENG) | • The section " Transportation restrictions for lithium batteries" was added.<br>• The section "Compliance with china compulsory product certification (CCC certification) system" was added.<br>• Miswrites were corrected. |
| May. 2007 | BNP-B3944H(ENG) | • "Introduction" and "Precautions for safety" were revised.<br>• "Transportation restrictions for lithium batteries" was revised.<br>• "Compliance with Restrictions in China" was revised.<br>• Descriptions of the compliant OS for the setup software were changed.<br>• "2-2-3 How to use the control circuit terminal block (MR-J2-10CT to 100CT)" was revised.<br>• "4-9-3 Surge absorber" was revised.<br>• "BTCASE" was added to the battery option.<br>• "4-2 Battery option (MDS-A-BT, MR-BAT)" was revised.<br>• "Corresponding servo drive unit type" in the servomotor specifications list was corrected.<br>• "Global service network" was revised. |
| Feb. 2008 | BNP-B3944J(ENG) | • "Instruction Manual for Compliance with UL/c-UL Standard" was revised. |
|  |  |  |

# Global service network



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## North America FA Center (MITSUBISHI ELECTRIC AUTOMATION INC.)

**Illinois CNC Service Center**
500 CORPORATE WOODS PARKWAY, VERNON HILLS, IL. 60061, U.S.A.
TEL: +1-847-478-2500 (Se          FAX:  +1-847-478-2650 (Se
**California CNC Service Center**
5665 PLAZA DRIVE, CYPRESS, CA. 90630, U.S.A.
TEL: +1-714-220-4796          FAX:  +1-714-229-3818
**Georgia CNC Service Center**
2810 PREMIERE PARKWAY SUITE 400, DULUTH, GA., 30097, U.S.A.
TEL: +1-678-258-4500          FAX:+1-678-258-4519
**New Jersey CNC Service Center**
200 COTTONTAIL LANE SOMERSET, NJ. 08873, U.S.A.
TEL: +1-732-560-4500          FAX:  +1-732-560-4531
**Michigan CNC Service Satellite**
2545 38TH STREET, ALLEGAN, MI., 49010, U.S.A.
TEL: +1-847-478-2500          FAX:+1-269-673-4092
**Ohio CNC Service Satellite**
62 W. 500 S., ANDERSON, IN., 46013, U.S.A.
TEL: +1-847-478-2608          FAX: +1-847-478-2690
**Texas CNC Service Satellite**
1000, NOLEN DRIVE SUITE 200, GRAPEVINE, TX. 76051, U.S.A.
TEL: +1-817-251-7468          FAX: +1-817-416-1439
**Canada CNC Service Center**
4299 14TH AVENUE MARKHAM, ON. L3R OJ2, CANADA
TEL: +1-905-475-7728          FAX: +1-905-475-7935
**Mexico CNC Service Center**
MARIANO ESCOBEDO 69 TLALNEPANTLA, 54030 EDO. DE MEXICO
TEL: +52-55-9171-7662          FAX:  +52-55-9171-7698
**Monterrey CNC Service Satellite**
ARGENTINA 3900, FRACC. LAS TORRES, MONTERREY, N.L., 64720, MEXICO
TEL: +52-81-8365-4171          FAX: +52-81-8365-4171
**Brazil MITSUBISHI CNC Agent Service Center**
 **(AUTOMOTION IND. COM. IMP. E EXP. LTDA.)**
ACESSO JOSE SARTORELLI, KM 2.1 18550-000 BOITUVA – SP, BRAZIL
TEL: +55-15-3363-9900          FAX:  +55-15-3363-9911

## European FA Center (MITSUBISHI ELECTRIC EUROPE B.V.)

**Germany CNC Service Center**
GOTHAER STRASSE 8, 40880 RATINGEN, GERMANY
TEL: +49-2102-486-0          TEL:+49-2102486-591
**South Germany CNC Service Center**
KURZE STRASSE. 40, 70794 FILDERSTADT-BONLANDEN, GERMANY
TEL: +49-711-3270-010          FAX:  +49-711-3270-0141
**France CNC Service Center**
25, BOULEVARD DES BOUVETS, 92741 NANTERRE CEDEX FRANCE
TEL: +33-1-41-02-83-13          FAX: +33-1-49-01-07-25
**Lyon CNC Service Satellite**

**U.K CNC Service Center**
TRAVELLERS LANE, HATFIELD, HERTFORDSHIRE, AL10 8XB, U.K.
TEL: +44-1707-282-846          FAX:-44-1707-278-992
**Italy CNC Service Center**
VIALE COLLEONI 7 - PALAZZO SIRIO, CENTRO DIREZIONALE COLLEONI, 20041 AGRATE BRIANZA -   (MI), ITALY
TEL: +39-039-60531-342          FAX: +39-039-6053-206
**Spain CNC Service Satellite**
CTRA. DE RUBI, 76-80 -APDO.420 08190 SAINT CUGAT DEL VALLES, BARCELONA SPAIN
TEL: +34-935-65-2236          FAX:
**Turkey MITSUBISHI CNC Agent Service Center**
 **(GENEL TEKNIK SISTEMLER LTD. STI.)**
DARULACEZE CAD. FAMAS IS MERKEZI A BLOCK NO.43 KAT2 80270 OKMEYDANI ISTANBUL, TURKEY
TEL: +90-212-320-1640          FAX:  +90-212-320-1649
**Poland MITSUBISHI CNC Agent Service Center (MPL Technology Sp. z. o. o)**
UL SLICZNA 34, 31-444 KRAKOW, POLAND
TEL: +48-12-632-28-85          FAX:
**Wroclaw MITSUBISHI CNC Agent Service Satellite (MPL Technology Sp. z. o. o)**
UL KOBIERZYCKA 23, 52-315 WROCLAW, POLAND
TEL: +48-71-333-77-53          FAX: +48-71-333-77-53
**Czech MITSUBISHI CNC Agent Service Center**
 **(AUTOCONT CONTROL SYSTEM S.R.O.   )**
NEMOCNICNI 12, 702 00 OSTRAVA 2 CZECH REPUBLIC
TEL: +420-596-152-426          FAX:  +420-596-152-112

## ASEAN FA Center (MITSUBISHI ELECTRIC ASIA PTE. LTD.)

**Singapore CNC Service Center**
307 ALEXANDRA ROAD #05-01/02 MITSUBISHI ELECTRIC BUILDING SINGAPORE    159943
TEL: +65-6473-2308          FAX:  +65-6476-7439
**Thailand MITSUBISHI CNC Agent Service Center (F. A. TECH CO., LTD)**
898/19,20,21,22 S.V. CITY BUILDING OFFICE TOWER 1 FLOOR 12,14   RAMA III RD BANGPONGPANG, YANNAWA, BANGKOK 10120. THAILAND
TEL: +66-2-682-6522          FAX:  +66-2-682-6020
**Malaysia MITSUBISHI CNC Agent Service Center**
 **(FLEXIBLE AUTOMATION SYSTEM SDN. BHD.)**
60, JALAN USJ 10/1B 47620 UEP SUBANG JAYA SELANGOR DARUL EHSAN MALAYSIA
TEL: +60-3-5631-7605          FAX: +60-3-5631-7636
**JOHOR MITSUBISHI CNC Agent Service Satellite**
 **(FLEXIBLE AUTOMATION SYSTEM SDN. BHD.)**
NO. 16, JALAN SHAHBANDAR 1, TAMAN UNGKU TUN AMINAH, 81300 SKUDAI, JOHOR MALAYSIA
TEL: +60-7-557-8218          FAX:  +60-7-557-3404
**Indonesia MITSUBISHI CNC Agent Service Center**
 **(PT. AUTOTEKNINDO SUMBER MAKMUR)**
WISMA NUSANTARA 14TH FLOOR JL. M.H. THAMRIN 59, JAKARTA 10350 INDONESIA
TEL:  +62-21-3917-144          FAX:  +62-21-3917-164
**India MITSUBISHI CNC Agent Service Center (MESSUNG SALES & SERVICES PVT. LTD.)**
B-36FF, PAVANA INDUSTRIAL PREMISES M.I.D.C., BHOASRI PUNE 411026, INDIA
TEL: +91-20-2711-9484          FAX: +91-20-2712-8115
**BANGALORE MITSUBISHI CNC Agent Service Satellite**
 **(MESSUNG SALES & SERVICES PVT. LTD.)**
S 615, 6TH FLOOR, MANIPAL CENTER, BANGALORE 560001, INDIA
TEL: +91-80-509-2119          FAX: +91-80-532-0480
**Delhi MITSUBISHI CNC Agent Parts Center (MESSUNG SALES & SERVICES PVT. LTD.)**
1197, SECTOR 15 PART-2, OFF DELHI-JAIPUR HIGHWAY BEHIND 32ND MILESTONE    GURGAON 122001, INDIA
TEL: +91-98-1024-8895          FAX:
**Philippines MITSUBISHI CNC Agent Service Center**
 **(FLEXIBLE AUTOMATION SYSTEM CORPORATION)**
UNIT No.411, ALABAMG CORPORATE CENTER KM 25. WEST SERVICE ROAD SOUTH SUPERHIGHWAY, ALABAMG MUNTINLUPA METRO MANILA, PHILIPPINES 1771
TEL: +63-2-807-2416          FAX: +63-2-807-2417
**Vietnam MITSUBISHI CNC Agent Service Center (SA GIANG TECHNO CO., LTD)**
47-49 HOANG SA ST. DAKAO WARD, DIST.1 HO CHI MINH CITY, VIETNAM
TEL: +84-8-910-4763          FAX: +84-8-910-2593

## China FA Center (MITSUBISHI ELECTRIC AUTOMATION (SHANGHAI) LTD.)

**China CNC Service Center**
2/F., BLOCK 5 BLDG.AUTOMATION INSTRUMENTATION PLAZA, 103 CAOBAO RD.    SHANGHAI 200233, CHINA
TEL: +86-21-6120-0808          FAX: +86-21-6494-0178
**Shenyang CNC Service Center**
TEL: +86-24-2397-0184          FAX: +86-24-2397-0185
**Beijing CNC Service Satellite**
9/F, OFFICE TOWER1, HENDERSON CENTER, 18 JIANGUOMENNEI DAJIE,    DONGCHENG DISTRICT, BEIJING 100005, CHINA
TEL: +86-10-6518-8830          FAX: +86-10-6518-8030
**China MITSUBISHI CNC Agent Service Center**
 **(BEIJING JIAYOU HIGHTECH TECHNOLOGY DEVELOPMENT CO.)**
RM 709, HIGH TECHNOLOGY BUILDING NO.229 NORTH SI HUAN ZHONG ROAD, HAIDIAN DISTRICT , BEIJING 100083, CHINA
TEL: +86-10-8288-3030          FAX: +86-10-6518-8030
**Tianjin CNC Service Satellite**
RM909, TAIHONG TOWER, NO220 SHIZILIN STREET, HEBEI DISTRICT, TIANJIN, CHINA 300143
TEL: -86-22-2653-9090          FAX: +86-22-2635-9050
**Shenzhen CNC Service Satellite**
RM02, UNIT A, 13/F, TIANAN NATIONAL TOWER, RENMING SOUTH ROAD, SHENZHEN, CHINA 518005
TEL:  +86-755-2515-6691          FAX: +86-755-8218-4776
**Changchun Service Satellite**
TEL: +86-431-5021446          FAX: +86-431-5021690
**Hong Kong CNC Service Center**
UNIT A, 25/F RYODEN INDUSTRIAL CENTRE, 26-38 TA CHUEN PING STREET, KWAI CHUNG, NEW TERRITORIES, HONG KONG
TEL: +852-2619-8588          FAX: +852-2784-1323

## Taiwan FA Center (MITSUBISHI ELECTRIC TAIWAN CO., LTD.)

**Taichung CNC Service Center**
NO.8-1, GONG YEH 16TH RD., TAICHUNG INDUSTIAL PARK TAICHUNG CITY, TAIWAN R.O.C.
TEL: +886-4-2359-0688          FAX: +886-4-2359-0689
**Taipei CNC Service Satellite**
TEL: +886-4-2359-0688          FAX: +886-4-2359-0689
**Tainan CNC Service Satellite**
TEL: +886-4-2359-0688          FAX: +886-4-2359-0689

## Korean FA Center (MITSUBISHI ELECTRIC AUTOMATION KOREA CO., LTD.)

**Korea CNC Service Center**
1480-6, GAYANG-DONG, GANGSEO-GU SEOUL 157-200, KOREA
TEL: +82-2-3660-9631          FAX:  +82-2-3664-8668

| MODEL | |
|---|---|

| MODEL | MR-J2-CT Series |
|---|---|
| MODEL CODE | 008 — 110 |
| Manual No. | BNP-B3944J(ENG) |

Specifications subject to change without notice.