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.

![Prohibited Symbol]

Indicates a prohibited matter. For example, "Fire Prohibited" is indicated as ☒.

![Mandatory Symbol]

Indicates a mandatory matter. For example, grounding is indicated as ☐.

The meaning of each pictorial sign is as follows.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>CAUTION</td>
</tr>
<tr>
<td>☐</td>
<td>CAUTION Rotated Object</td>
</tr>
<tr>
<td>☐</td>
<td>CAUTION HOT</td>
</tr>
<tr>
<td>☐</td>
<td>Danger Electric Shock Risk</td>
</tr>
<tr>
<td>☐</td>
<td>Danger Explosive</td>
</tr>
<tr>
<td>☒</td>
<td>Prohibited</td>
</tr>
<tr>
<td>☒</td>
<td>Disassembly is prohibited</td>
</tr>
<tr>
<td>☒</td>
<td>KEEP FIRE AWAY</td>
</tr>
<tr>
<td>☐</td>
<td>General Instruction</td>
</tr>
<tr>
<td>☒</td>
<td>Earth Ground</td>
</tr>
</tbody>
</table>

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, servo motor and spindle motor, etc.

In this section "Precautions for safety", the following items are generically called the "motor".

- Servo motor
- Linear servo motor
- Spindle motor
- Direct-drive 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

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**POINT**

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

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**For Safe Use**

Mitsubishi CNC is designed and manufactured solely for applications to machine tools to be used for industrial purposes.

Do not use this product in any applications other than those specified above, especially those which are substantially influential on the public interest or which are expected to have significant influence on human lives or properties.
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. For the motor, ground it via the drive unit.

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

⚠️ Wire the servo drive unit and servo motor 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.

⚠️ Always insulate the power terminal connection section. Failure to observe this could lead to electric shocks.

⚠️ After assembling the built-in IPM spindle motor, if the rotor is rotated by hand etc., voltage occurs between the terminals of lead. Take care not to get electric shocks.
2. Injury prevention

⚠️ When handling a motor, perform operations in safe clothing.

⚠️ 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.)

⚠️ The linear servo motor, direct-drive motor and built-in IPM spindle motor uses permanent magnets in the rotor, so observe the following precautions.

(1) Handling
   - The linear servo motor, direct-drive motor and built-in IPM spindle motor could adversely affect medical electronics such as pacemakers, etc., therefore, do not approach the rotor.
   - Do not place magnetic materials as iron.
   - When a magnetic material as iron is placed, take safety measure not to pinch fingers or hands due to the magnetic attraction force.
   - Remove metal items such as watch, piercing jewelry, necklace, etc.
   - Do not place portable items that could malfunction or fail due to the influence of the magnetic force.
   - When the rotor is not securely fixed to the machine or device, do not leave it unattended but store it in the package properly.
   - When installing the motor to the machine, take it out from the package one by one, and then install it.
   - It is highly dangerous to lay out the motor or magnetic plates together on the table or pallet, therefore never do so.

(2) Transportation and storage
   - Correctly store the rotor in the package to transport and store.
   - During transportation and storage, draw people's attention by applying a notice saying "Strong magnet-Handle with care" to the package or storage shelf.
   - Do not use a damaged package.

(3) Installation
   - Take special care not to pinch fingers, etc., when installing (and unpacking) the linear servo motor.
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 (+,-). 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., so that it cannot be touched after installation. Touching the cooling fan during operation could lead to injuries.

⚠️ Take care not to suck hair, clothes, etc. into the cooling fan.
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 encoder 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.

⚠️ Provide adequate protection using a material such as connector for conduit to prevent screws, metallic detritus, water and other conductive matter or oil and other combustible matter from entering the motor through the power line lead-out port.

⚠️ The units, motors and encoders are precision devices, so do not drop them or apply strong impacts to them.
⚠️ Store and use the units under the following environment conditions.

<table>
<thead>
<tr>
<th>Environment</th>
<th>Unit</th>
<th>Motor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ambient temperature</strong></td>
<td>Operation: 0 to 55°C (with no freezing), Storage / Transportation: -15°C to 70°C (with no freezing)</td>
<td>Operation: 0 to 40°C (with no freezing), Storage: -15°C to 70°C (Note2) (with no freezing)</td>
</tr>
<tr>
<td><strong>Ambient humidity</strong></td>
<td>Operation: 90%RH or less (with no dew condensation) Storage / Transportation: 90%RH or less (with no dew condensation)</td>
<td>Operation: 80%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)</td>
</tr>
<tr>
<td><strong>Atmosphere</strong></td>
<td>Indoors (no direct sunlight)</td>
<td>With no corrosive gas, inflammable gas, oil mist, dust or conductive fine particles</td>
</tr>
<tr>
<td><strong>Altitude</strong></td>
<td>Operation/Storage: 1000 meters or less above sea level, Transportation: 13000 meters or less above sea level</td>
<td>Operation: 1000 meters or less above sea level, Storage: 10000 meters or less above sea level</td>
</tr>
<tr>
<td><strong>Vibration/impact</strong></td>
<td>According to each unit or motor specification</td>
<td></td>
</tr>
</tbody>
</table>

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

⚠️ When disinfectants or insecticides must be used to treat wood packaging materials, always use methods other than fumigation (for example, apply heat treatment at the minimum wood core temperature of 56 °C for a minimum duration of 30 minutes (ISPM No. 15 (2009))).
If products such as units are directly fumigated or packed with fumigated wooden materials, halogen substances (including fluorine, chlorine, bromine and iodine) contained in fumes may contribute to the erosion of the capacitors.
When exporting the products, make sure to comply with the laws and regulations of each country.

⚠️ Do not use the products in conjunction with any components that contain halogenated flame retardants (bromine, etc). Failure to observe this may cause the erosion of the capacitors.

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

⚠️ Always install the servo motor 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 servo motor shaft end, do not apply an impact by hammering, etc. The encoder could be damaged.

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

⚠️ Store the motor in the package box.

⚠️ When inserting the shaft into the built-in IPM spindle 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 built-in IPM spindle motor, direct-drive motor and linear servo motor.

⚠️ Always provide a mechanical stopper on the end of the linear servo motor’s travel path.

⚠️ 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.

⚠️ Install the heavy peripheral devices to the lower part in the panel and securely fix it not to be moved due to vibration.
(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 servo motor. 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. (Refer to "EMC Installation Guidelines")

⚠️ 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.

(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 combinations and parameters before starting trial operation.

⚠️ The direct-drive motor and linear servo motor do not have a stopping device such as magnetic brakes. Install a stopping device on the machine side.

⚠️ When using the linear servo motor for an unbalance axis, adjust the unbalance weight to 0 by installing an air cylinder, etc. on the machine side. The unbalance weight disables the initial magnetic pole adjustment.
(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 servo motor 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 servo motor 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.

⚠️ Mitsubishi spindle motor is dedicated to machine tools. Do not use for other purposes.

(5) Troubleshooting

⚠️ If a hazardous situation is predicted during power failure or product trouble, use a servo motor 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.

⚠️ Always turn the main circuit power of the motor OFF when an alarm occurs.

⚠️ If an alarm occurs, remove the cause, and secure the safety before resetting the alarm.
(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 dealer for repairs or part replacement.

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

⚠ If the battery low warning is issued, immediately replace the battery. Replace the batteries while applying the drive unit's control power.

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

⚠ For after-purchase servicing of the built-in motor, only the servicing parts for MITSUBISHI encoder can be supplied. For the motor body, prepare the spare parts at the machine manufacturers.

⚠ For maintenance, part replacement, and services in case of failures in the built-in motor (including the encoder), take necessary actions at the machine manufacturers. For drive unit, Mitsubishi can offer the after-purchase servicing as with the general drive unit.

(7) Disposal

⚠ Take the batteries and backlights for LCD, etc., off from the controller, drive unit and motor, and dispose of them as general industrial wastes.

⚠ 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 servo motor 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.

(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"
   (a) Recycle as much of this product as possible when finished with use.
   (b) 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"
   (a) 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.
   (b) When disposing a product that cannot be resold, it shall be treated as a waste product.
   (c) 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.
   (d) Batteries correspond to "primary batteries", and must be disposed of according to local disposal laws.
Disposal

(Note) This symbol mark is for EU countries only.
This symbol mark is according to the directive 2006/66/EC Article 20 Information for end-users and Annex II.

Your MITSUBISHI ELECTRIC product is designed and manufactured with high quality materials and components which can be recycled and/or reused.
This symbol means that batteries and accumulators, at their end-of-life, should be disposed of separately from your household waste.
If a chemical symbol is printed beneath the symbol shown above, this chemical symbol means that the battery or accumulator contains a heavy metal at a certain concentration. This will be indicated as follows:
Hg: mercury (0.0005%), Cd: cadmium (0.002%), Pb: lead (0.004%)
In the European Union there are separate collection systems for used batteries and accumulators. Please, dispose of batteries and accumulators correctly at your local community waste collection/recycling centre.

Please help us to conserve the environment we live in!
Trademarks

MELDAS, MELSEC, EZSocket, EZMotion, iQ Platform, MELSOFT, GOT, CC-Link, CC-Link/LT and CC-Link IE are either trademarks or registered trademarks of Mitsubishi Electric Corporation in Japan and/or other countries.

Other company and product names that appear in this manual are trademarks or registered trademarks of the respective companies.
本製品の取扱いについて

(日本語 /Japanese)
本製品は工業用 (クラス A) 電磁環境適合機器です。販売者あるいは使用者はこの点に注意し、住商業環境以外での使用をお願いいたします。

Handling of our product

(English)
This is a class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

본 제품의 취급에 대해서

(한국어 /Korean)
이 기기는 업무용 (A 급) 전자파적합기기로서 판매자 또는 사용자는 이 점을 주의하시기 바라며 가정외의 지역에서 사용하는 것을 목적으로 합니다.
WARRANTY

Please confirm the following product warranty details before using MITSUBISHI CNC.

1. Warranty Period and Coverage
Should any fault or defect (hereafter called "failure") for which we are liable occur in this product during the warranty period, we shall provide repair services at no cost through the distributor from which the product was purchased or through a Mitsubishi Electric service provider. Note, however, that this shall not apply if the customer was informed prior to purchase of the product that the product is not covered under warranty. Also note that we are not responsible for any on-site readjustment and/or trial run that may be required after a defective unit is replaced.

[Warranty Term]
The term of warranty for this product shall be twenty-four (24) months from the date of delivery of product to the end user, provided the product purchased from us in Japan is installed in Japan (but in no event longer than thirty (30) months, including the distribution time after shipment from Mitsubishi Electric or its distributor).
Note that, for the case where the product purchased from us in or outside Japan is exported and installed in any country other than where it was purchased; please refer to "2. Service in overseas countries" as will be explained.

[Limitations]
(1) The customer is requested to conduct an initial failure diagnosis by him/herself, as a general rule. It can also be carried out by us or our service provider upon the customer's request and the actual cost will be charged.
(2) This warranty applies only when the conditions, method, environment, etc., of use are in compliance with the terms and conditions and instructions that are set forth in the instruction manual, user's manual, and the caution label affixed to the product, etc.
(3) Even during the term of warranty, repair costs shall be charged to the customer in the following cases:
   (a) a failure caused by improper storage or handling, carelessness or negligence, etc., or a failure caused by the customer's hardware or software problem
   (b) a failure caused by any alteration, etc., to the product made by the customer without Mitsubishi Electric's approval
   (c) a failure which may be regarded as avoidable, if the customer's equipment in which this product is incorporated is equipped with a safety device required by applicable laws or has any function or structure considered to be indispensable in the light of common sense in the industry
   (d) a failure which may be regarded as avoidable if consumable parts designated in the instruction manual, etc. are duly maintained and replaced
   (e) any replacement of consumable parts (including a battery, relay and fuse)
   (f) a failure caused by external factors such as inevitable accidents, including without limitation fire and abnormal fluctuation of voltage, and acts of God, including without limitation earthquake, lightning, and natural disasters
   (g) a failure which is unforeseeable under technologies available at the time of shipment of this product from our company
   (h) any other failures which we are not responsible for or which the customer acknowledges we are not responsible for

2. Service in Overseas Countries
If the customer installs the product purchased from us in his/her machine or equipment, and export it to any country other than where he/she bought it, the customer may sign a paid warranty contract with our local FA center. This falls under the case where the product purchased from us in or outside Japan is exported and installed in any country other than where it was purchased.
For details please contact the distributor from which the customer purchased the product.

3. Exclusion of Loss in Opportunity and Secondary Loss from Warranty Liability
Regardless of the gratis warranty term, Mitsubishi shall not be liable for compensation to:
(1) Damages caused by any cause found not to be the responsibility of Mitsubishi.
(2) Loss in opportunity, lost profits incurred to the user by Failures of Mitsubishi products.
(3) Special damages and secondary damages whether foreseeable or not, compensation for accidents, and compensation for damages to products other than Mitsubishi products.
(4) Replacement by the user, maintenance of on-site equipment, start-up test run and other tasks.

4. Changes in Product Specifications
Specifications shown in our catalogs, manuals or technical documents are subject to change without notice.

5. Product Application
(1) For the use of this product, its applications should be those that may not result in a serious damage even if any failure or malfunction occurs in the product, and a backup or fail-safe function should operate on an external system to the product when any failure or malfunction occurs.
(2) Mitsubishi CNC is designed and manufactured solely for applications to machine tools to be used for industrial purposes. Do not use this product in any applications other than those specified above, especially those which are substantially influential on the public interest or which are expected to have significant influence on human lives or properties.
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Introduction
1.1 Servo Drive System Configuration

1.1.1 System Configuration

< MDS-E Series >

![Diagram of MDS-E Series system configuration]

**CAUTION**

Keep the detection sensor cable away from the power cable.
< MDS-D2 Series >

CAUTION

Keep the detection sensor cable away from the power cable.
CAUTION

Keep the detection sensor cable away from the power cable.
CAUTION

Keep the detection sensor cable away from the power cable.
1.2 Explanation of Type

1.2.1 Direct-drive Motor Type

(1) TM-RB Series

< Primary side (coil side) >

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Rated torque</th>
<th>Dimension</th>
<th>Rated speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>012</td>
<td>12 N·m</td>
<td>C DIA 130 mm</td>
<td>10 100 r/min</td>
</tr>
<tr>
<td>036</td>
<td>36 N·m</td>
<td>E DIA 180 mm</td>
<td>20 200 r/min</td>
</tr>
<tr>
<td>048</td>
<td>48 N·m</td>
<td>G DIA 230 mm</td>
<td></td>
</tr>
<tr>
<td>105</td>
<td>105 N·m</td>
<td>J DIA 330 mm</td>
<td></td>
</tr>
<tr>
<td>150</td>
<td>150 N·m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>340</td>
<td>340 N·m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>500</td>
<td>500 N·m</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Note 1) This explains the model name system of direct-drive motors, but does not mean all the combinations are available.
(Note 2) The primary and secondary sides having the same variable part of the name are combined to form a direct-drive motor.

< Secondary side (magnet side) >

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Rated torque</th>
<th>Dimension</th>
<th>Rated speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>012</td>
<td>12 N·m</td>
<td>C DIA 130 mm</td>
<td>10 100 r/min</td>
</tr>
<tr>
<td>036</td>
<td>36 N·m</td>
<td>E DIA 180 mm</td>
<td>20 200 r/min</td>
</tr>
<tr>
<td>048</td>
<td>48 N·m</td>
<td>G DIA 230 mm</td>
<td></td>
</tr>
<tr>
<td>105</td>
<td>105 N·m</td>
<td>J DIA 330 mm</td>
<td></td>
</tr>
<tr>
<td>150</td>
<td>150 N·m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>340</td>
<td>340 N·m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>500</td>
<td>500 N·m</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Note 1) This explains the model name system of direct-drive motors, but does not mean all the combinations are available.
(Note 2) The primary and secondary sides having the same variable part of the name are combined to form a direct-drive motor.
Specifications
2.1 Direct-drive Motor

2.1.1 Environmental Conditions

<table>
<thead>
<tr>
<th>Environment</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient temperature</td>
<td>0°C to +40°C (with no freezing)</td>
</tr>
<tr>
<td>Ambient humidity</td>
<td>80% RH or less (with no dew condensation)</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-15°C to +70°C (with no freezing)</td>
</tr>
<tr>
<td>Storage humidity</td>
<td>90% RH or less (with no dew condensation)</td>
</tr>
<tr>
<td>Atmosphere</td>
<td>Indoors (no direct sunlight); no corrosive gas, inflammable gas or dust No oil or water splash</td>
</tr>
<tr>
<td>Vibration</td>
<td>5G or less (2.5G or less for TM-RBP340J20, TM-RBP500J20)</td>
</tr>
<tr>
<td>Altitude</td>
<td>1000m or less above sea level</td>
</tr>
</tbody>
</table>
2.1.2 Precautions for Storage

**WARNING**

1. Correctly store the direct-drive motor in the package to transport and store.
   -> As the secondary side has permanent magnets in it, and the magnetic attraction force is generated between magnetic material as iron, unexpected accidents or failures may occur if the secondary side is left unattended.
2. During transportation and storage, draw people's attention by applying a notice saying "Strong magnet-Handle with care" to the package or storage shelf.

**CAUTION**

1. Do not arrange the product, or do not give a shock.
2. Do not get on top of or place heavy objects on the product.
3. When suspending the product with lifting sling, etc, do not give a shock or stress to the mold.
4. If the product has been stored for a long time, please contact your local service center or service station.

**<How to suspend the product>**

(1) **Primary side stator**
   Before you suspend the primary side stator alone, attach eye bolts, etc. to the fixing screws on a surface end.
   Please ensure that the wires put no stress on the mold, connector or cooling vent when suspending the product. In addition, please be careful that no stress is applied to the lead wire when you use lead-out type.
   When suspending the product, support it with at least 3 screws.

(2) **Secondary side rotor**
   Before you suspend the secondary side, attach the eye bolts, etc. to the fixing screws.
   In order to avoid any risks posed by the magnetic attraction force, the rotary axis must be in the vertical direction, and support it at 3 or more points to keep its posture.

**<Dust and drip proof structure>**

Even if the coil end of the primary side stator has mold structure, it cannot guarantee full dust and drip proof. So please make sure to construct your machine structure to be able to avoid chips, water, oil, cutting fluid, etc. from entering in the motor.

**<Cooling>**

Construct the liquid-cooling (oil cooling) structure around the primary side stator according to your conditions, for example, put a cooling jacket around the primary side stator.
### 2.1.3 Specifications List

**< TM-RB Series >**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Compatible servo drive unit type</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>MDS-E-V1-</td>
<td>40</td>
<td>80</td>
<td>80</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>200</td>
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<td>MDS-E-V2-</td>
<td>40</td>
<td>80</td>
<td>80</td>
<td>160</td>
<td>160</td>
<td>160</td>
<td>160</td>
<td>320</td>
</tr>
<tr>
<td>MDS-E-J-V1-</td>
<td>40</td>
<td>80</td>
<td>80</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>MDS-D2-V1-</td>
<td>40</td>
<td>80</td>
<td>80</td>
<td>160</td>
<td>160</td>
<td>160</td>
<td>160</td>
<td>320</td>
</tr>
<tr>
<td>MDS-D2-V2-</td>
<td>40</td>
<td>80</td>
<td>80</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>MDS-D2-V2-</td>
<td>40</td>
<td>80</td>
<td>80</td>
<td>160</td>
<td>160</td>
<td>160</td>
<td>160</td>
<td>320</td>
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<tr>
<td>Continuous characteristics</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Rated output [W]</td>
<td>252</td>
<td>754</td>
<td>1005</td>
<td>1100</td>
<td>2199</td>
<td>3141</td>
<td>7120</td>
<td>10471</td>
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<tr>
<td>Rated current [A]</td>
<td>6.1</td>
<td>12</td>
<td>12</td>
<td>21</td>
<td>25</td>
<td>33</td>
<td>54</td>
<td>82</td>
</tr>
<tr>
<td>Rated torque [N·m]</td>
<td>12</td>
<td>38</td>
<td>48</td>
<td>105</td>
<td>105</td>
<td>150</td>
<td>340</td>
<td>500</td>
</tr>
<tr>
<td>Power facility capacity [kVA]</td>
<td>1.07</td>
<td>2.08</td>
<td>2.01</td>
<td>3.86</td>
<td>5.00</td>
<td>7.20</td>
<td>14.03</td>
<td>20.82</td>
</tr>
<tr>
<td>Rated rotation speed [r/min]</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>100</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Maximum rotation speed [r/min]</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>250</td>
<td>500</td>
<td>500</td>
<td>400</td>
<td>400</td>
</tr>
<tr>
<td>Maximum current [A]</td>
<td>18</td>
<td>36</td>
<td>36</td>
<td>52</td>
<td>63</td>
<td>83</td>
<td>135</td>
<td>210</td>
</tr>
<tr>
<td>Maximum torque [N·m]</td>
<td>36</td>
<td>108</td>
<td>144</td>
<td>260</td>
<td>260</td>
<td>375</td>
<td>850</td>
<td>1200</td>
</tr>
<tr>
<td>Power rate at continuous rated torque [kW/s]</td>
<td>65.4</td>
<td>102.0</td>
<td>82.2</td>
<td>279.1</td>
<td>279.1</td>
<td>441.1</td>
<td>416.1</td>
<td>706.6</td>
</tr>
<tr>
<td>Rotor inertia [$10^{-4}$kg·m²]</td>
<td>22</td>
<td>127</td>
<td>280</td>
<td>395</td>
<td>395</td>
<td>510</td>
<td>2778</td>
<td>3538</td>
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<tr>
<td>Degree of protection</td>
<td>IP00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Required cooling capacity [kW]</td>
<td>0.5</td>
<td>0.7</td>
<td>0.4</td>
<td>1.6</td>
<td>1.3</td>
<td>1.9</td>
<td>2.7</td>
<td>4.1</td>
</tr>
<tr>
<td>Cooling water volume</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>Min: 5 l/min</td>
<td>Max: 6 l/min</td>
<td>at 20°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambient humidity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atmosphere</td>
<td>Indoor (no direct sunlight)</td>
<td>no corrosive gas, inflammable gas or dust</td>
<td>No oil or water splash</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Altitude</td>
<td>1000 m or less above sea level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vibration</td>
<td>5G or less</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dimensions [mm]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary side outer diameter</td>
<td>DIA 130</td>
<td>DIA 180</td>
<td>DIA 230</td>
<td>DIA 230</td>
<td>DIA 230</td>
<td>DIA 330</td>
<td>DIA 330</td>
<td>DIA 330</td>
</tr>
<tr>
<td>Secondary side inner diameter</td>
<td>DIA 56</td>
<td>DIA 100</td>
<td>DIA 130</td>
<td>DIA 130</td>
<td>DIA 130</td>
<td>DIA 205</td>
<td>DIA 205</td>
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<tr>
<td>Height</td>
<td>76</td>
<td>91</td>
<td>80</td>
<td>105</td>
<td>105</td>
<td>130</td>
<td>154</td>
<td>191</td>
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<td>Mass [kg]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Primary side (coil)</td>
<td>3.9</td>
<td>7.1</td>
<td>10</td>
<td>13</td>
<td>13</td>
<td>16</td>
<td>33</td>
<td>41</td>
</tr>
<tr>
<td>Secondary side (magnet)</td>
<td>1.7</td>
<td>3.7</td>
<td>5</td>
<td>7</td>
<td>7</td>
<td>9</td>
<td>20</td>
<td>26</td>
</tr>
<tr>
<td>Heat-resistant class</td>
<td>155(F)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note 1** The above characteristics values are representative values. The maximum current and maximum torque are the values when combined with the drive unit.

**Note 2** The encoder should be procured by the user.
### 2.1.4 Torque Characteristics

< TM-RB Series >

<table>
<thead>
<tr>
<th>Model</th>
<th>Rotation Speed [r/min]</th>
<th>Torque [N·m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ TM-RBP012C20 ]</td>
<td>0 - 200</td>
<td>0 - 10</td>
</tr>
<tr>
<td></td>
<td>200 - 500</td>
<td>10 - 30</td>
</tr>
<tr>
<td>[ TM-RBP036E20 ]</td>
<td>0 - 200</td>
<td>0 - 40</td>
</tr>
<tr>
<td></td>
<td>200 - 500</td>
<td>40 - 120</td>
</tr>
<tr>
<td>[ TM-RBP048G20 ]</td>
<td>0 - 200</td>
<td>0 - 40</td>
</tr>
<tr>
<td></td>
<td>200 - 500</td>
<td>40 - 160</td>
</tr>
<tr>
<td>[ TM-RBP105G10 ]</td>
<td>0 - 200</td>
<td>0 - 100</td>
</tr>
<tr>
<td></td>
<td>200 - 500</td>
<td>100 - 300</td>
</tr>
<tr>
<td>[ TM-RBP105G20 ]</td>
<td>0 - 200</td>
<td>0 - 100</td>
</tr>
<tr>
<td></td>
<td>200 - 500</td>
<td>100 - 300</td>
</tr>
<tr>
<td>[ TM-RBP150G20 ]</td>
<td>0 - 200</td>
<td>0 - 100</td>
</tr>
<tr>
<td></td>
<td>200 - 500</td>
<td>100 - 500</td>
</tr>
<tr>
<td>[ TM-RBP340J20 ]</td>
<td>0 - 200</td>
<td>0 - 300</td>
</tr>
<tr>
<td></td>
<td>200 - 400</td>
<td>300 - 1500</td>
</tr>
<tr>
<td>[ TM-RBP500J20 ]</td>
<td>0 - 200</td>
<td>0 - 300</td>
</tr>
<tr>
<td></td>
<td>200 - 400</td>
<td>300 - 1500</td>
</tr>
</tbody>
</table>

(Note) The above graphs show the data when applied the input voltage of 200VAC. When the input voltage is 200VAC or less, the short time operation range is limited.
2.1.5 Outline Dimension Drawings

< TM-RB Series >

[ TM-RBP012C20 ]

[TM-RBS012C20]

Power supply lead: 3-AWG18 (Finish outer diameter: 2.3mm)
U, V, W
Thermistor lead: 2-AWG18 (Finish outer diameter: 2.3mm)
1φ, 1φ
Ground lead: 1-AWG18 (Finish outer diameter: 2.89mm)

[Unit:mm]

(Outline drawing of TM-RBP012C20)

(Outline drawing of TM-RBS012C20)

(Note 1) Do not move the stator by holding the lead wire.
(Note 2) Take special care for the magnet part not to hit against a thing (A crack or chip may occur).
(Note 3) Degree of protection is IP00. Use explosion-proof oil, etc., as necessary.
(Note 4) There is no problem on the functionality or performance even if the molded parts include sink marks or voids, etc.
2 Specifications

**[ TM-RBP036E20 ]**

[Unit:mm]

- Power supply lead: 3-AWG18 (Finish outer diameter: 2.3)
- Thermistor lead: 2-AWG18 (Finish outer diameter: 2.3)
- Ground lead: 1-AWG18 (Finish outer diameter: 2.3)

Effective length: 300

- Recommended installation position for cooling liquid: 91
- Recommended installation position for cooling liquid: 20

- Wire mark: 19
- Wire mark: 19

- 8-M6 screw: Depth 14
- 8-M6 screw: Depth 14

- Ø170
- Ø170

**Details**

(Note 1) Do not move the stator by holding the lead wire.

(Note 2) Degree of protection is IP00. Use explosion-proof oil, etc., as necessary.

(Note 3) Continuous rated torque is assured only when the required cooling capacity is satisfied.

(Note 4) There is no problem on the functionality or performance even if the molded parts include sink marks or voids, etc.

---

**[ TM-RBS036E20 ]**

[Unit:mm]

- Recommended inlet/outlet position for cooling liquid: 20
- Recommended inlet/outlet position for cooling liquid: 19

- Wire mark: 19
- Wire mark: 19

- Ø132.6 (rotor inner diameter)
- Ø134 (stator inner diameter)

**Details**

(Note 1) Deliverable rotors are magnetized. Please note the magnetic attraction.

(Note 2) Take special care for the magnetic part not to hit against a thing (A crack or chip may occur).

(Note 3) Degree of protection is IP00. Use explosion-proof oil, etc., as necessary.

(Note 4) There is no problem on the functionality or performance even if the molded parts include sink marks or voids, etc.
Direct Drive Motor Specifications and Instruction Manual

2 Specifications

[ TM-RBP048G20 ]

[ Unit:mm ]

Power supply lead 3-AWG10 (Finish outer diameter: 4.3)
Thermistor lead 2-AWG18 (Finish outer diameter: 2.3)
Ground lead 1-AWG10 (Finish outer diameter: 4.7)

Effective length 300

Recommended inlet/outlet position for cooling liquid

Wire mark (Wire mark position)

8-M6 screw Depth 14

8-M6 screw Depth 14

8-M6 screw Depth 14

(0.72 (rotor inner diameter))

(0.174 (rotor outer diameter))

(250) (Cooling groove)

(13)

Note 1: Do not move the stator by holding the lead wire.
Note 2: Degree of protection is IP00. Use explosion-proof oil, etc., as necessary.
Note 3: Continuous rated torque is assured only when the required cooling capacity is satisfied.
Note 4: There is no problem on the functionality or performance even if the molded parts include sink marks or voids, etc.

[ TM-RBS048G20 ]

[ Unit:mm ]

(13)

8-M6 screw Depth 14

8-M6 screw Depth 14

8-M6 screw Depth 14

(0.72 (rotor inner diameter))

(0.174 (rotor outer diameter))

(250) (Cooling groove)

(13)

(Note 1) Deliverable rotors are magnetized. Please note the magnetic attraction.
(Note 2) Take special care for the magnet part not to hit against a thing (A crack or chip may occur).
(Note 3) Degree of protection is IP00. Use explosion-proof oil, etc., as necessary.
(Note 4) There is no problem on the functionality or performance even if the molded parts include sink marks or voids, etc.
Direct Drive Motor Specifications and Instruction Manual

2 Specifications

[ TM-RBP105G10 ]

Power supply lead - 3-AWG10 (Finish outer diameter = 4.3)
Thermistor lead - 2-AWG18 (Finish outer diameter = 2.3)
Ground lead - 1-AWG10 (Finish outer diameter = 4.73)

Effective length: 300mm

Recommended inlet/outlet position for cooling liquid

[ Unit: mm ]

(1) Do not move the stator by holding the lead wire.
(2) Degree of protection is IP00. Use explosion-proof oil, etc., as necessary.
(3) Continuous rated torque is assured only when the required cooling capacity is satisfied.
(4) There is no problem on the functionality or performance even if the molded parts include sink marks or voids, etc.

[ TM-RBS105G10 ]

[ Unit: mm ]

(1) Deliverable rotors are magnetized. Please note the magnetic attraction.
(2) Take special care for the magnet part not to hit against a thing (A crack or chip may occur).
(3) Degree of protection is IP55. Use explosion-proof oil, etc., as necessary.
(4) There is no problem on the functionality or performance even if the molded parts include sink marks or voids, etc.
[ TM-RBP105G20 ]

- Power supply lead: 3-AWG10 (Finish outer diameter>4.3)
- Thermistor lead: 2-AWG18 (Finish outer diameter<2.3)
- Ground lead: 1-AWG10 (Finish outer diameter>4.7)

- Effective length: 300
- Recommended inlet/outlet position for cooling liquid

- Wire mark position

(Note 1) Do not move the stator by holding the lead wire.
(Note 2) Degree of protection is IP00. Use explosion-proof oil, etc., as necessary.
(Note 3) There is no problem on the functionality or performance even if the molded parts include sink marks or voids, etc.

[ TM-RBS105G20 ]

- 8-M6 screw Depth 14
- Recommended inlet/outlet position for cooling liquid

(Note 1) Deliverable rotors are magnetized. Please note the magnetic attraction.
(Note 2) Take special care for the magnet part not to hit against a thing (A crack or chip may occur).
(Note 3) Degree of protection is IP00. Use explosion-proof oil, etc., as necessary.
(Note 4) There is no problem on the functionality or performance even if the molded parts include sink marks or voids, etc.
[ TM-RBP150G20 ]

[Unit:mm]

Power supply lead: 3-AWG10 (Finish outer diameter=4.3)
Thermistor lead: 2-AWG18 (Finish outer diameter=2.3)
Ground lead: 1-AWG10 (Finish outer diameter=4.7)

Effective length

Recommended installation position for cooling liquid

Recommended inlet/outlet position for cooling liquid

Power supply lead
3-AWG10 (Finish outer diameter=4.3)

Thermistor lead
2-AWG18 (Finish outer diameter=2.3)

Ground lead
1-AWG10 (Finish outer diameter=4.7)

Lead-out range of lead wire

(Note 1) Do not move the stator by holding the lead wire.
(Note 2) Degree of protection is IP00. Use explosion-proof oil, etc., as necessary.
(Note 3) Continuous rated torque is assured only when the required cooling capacity is satisfied.
(Note 4) There is no problem on the functionality or performance even if the molded parts include sink marks or voids, etc.

[ TM-RBS150G20 ]

[Unit:mm]

8-M6 screw
Depth 14

116

20

8-M6 screw
Depth 14

(Note 1) Deliverable rotors are magnetized. Please note the magnetic attraction.
(Note 2) Take special care for the magnet part not to hit against a thing (A crack or chip may occur).
(Note 3) Degree of protection is IP00. Use explosion-proof oil, etc., as necessary.
(Note 4) There is no problem on the functionality or performance even if the molded parts include sink marks or voids, etc.
Direct Drive Motor Specifications and Instruction Manual

2 Specifications

[ TM-RBP340J20 ]

Power supply lead: 3-AWG8 (Finish outer diameter: 5.8)
Thermistor lead: 2-AWG18 (Finish outer diameter: 2.3)
Ground lead: 1-AWG8 (Finish outer diameter: 6.5)

Effective length: 360
Recommended inlet/outlet position for cooling liquid:

(1) 30°
(2) 30°
(3) 30°

Lead-out range of lead wire:

12-M8 screw Depth 18

Detail A

(Note 1) Do not move the stator by holding the lead wire.
(Note 2) Degree of protection is IP00. Use explosion-proof oil, etc., as necessary.
(Note 3) Continuous rated torque is assured only when the required cooling capacity is satisfied.
(Note 4) There is no problem on the functionality or performance even if the molded parts include sink marks or voids, etc.

[ TM-RBS340J20 ]

Power supply lead: 3-AWG8 (Finish outer diameter: 5.8)
Thermistor lead: 2-AWG18 (Finish outer diameter: 2.3)
Ground lead: 1-AWG8 (Finish outer diameter: 6.5)

Effective length: 360
Recommended inlet/outlet position for cooling liquid:

(1) 30°
(2) 30°
(3) 30°

Lead-out range of lead wire:

12-M8 screw Depth 18

Detail A

(Note 1) Deliverable rotors are magnetized. Please note the magnetic attraction.
(Note 2) Degree of protection is IP00. Use explosion-proof oil, etc., as necessary.
(Note 3) Continuous rated torque is assured only when the required cooling capacity is satisfied.
(Note 4) There is no problem on the functionality or performance even if the molded parts include sink marks or voids, etc.
Direct Drive Motor Specifications and Instruction Manual

2 Specifications

[ TM-RBP500J20 ]

Power supply lead: 3-AWG6 (Finish outer diameter: 6.7)
Thermistor lead: 2-AWG18 (Finish outer diameter: 2.3)
Ground lead: 1-AWG6 (Finish outer diameter: 7.04) Effective length

Recommended inlet/outlet position for cooling liquid

Lead-out range of lead wire

(1) Do not move the stator by holding the lead wire.
(2) Do not move the stator by holding the lead wire.
(3) Do not move the stator by holding the lead wire.
(4) Do not move the stator by holding the lead wire.

[ TM-RBS500J20 ]

12-M8 screw Depth 18

(1) Deliverable rotors are magnetized. Please note the magnetic attraction.
(2) Deliverable rotors are magnetized. Please note the magnetic attraction.
(3) Deliverable rotors are magnetized. Please note the magnetic attraction.
(4) Deliverable rotors are magnetized. Please note the magnetic attraction.
Characteristics
3.1 Direct-drive Motor

3.1.1 Overload Protection Characteristics

The servo drive unit has an electronic thermal relay to protect the motor and servo drive unit from overloads. The operation characteristics of the electronic thermal relay are shown below when standard parameters (SV021=60, SV022=150) are set. If overload operation over the electronic thermal relay protection curve shown below is carried out, overload 1 (alarm 50) will occur. If the maximum torque is commanded continuously for one second or more due to a machine collision, etc., overload 2 (alarm 51) will occur.

< MDS-E and MDS-D2 Series >

![Graphs showing overload protection characteristics for different models](image-url)
< MDS-EJ and MDS-DJ Series >

**TM-RBP012C20**

- When stopped
- When rotating

**TM-RBP036E20**

- When stopped
- When rotating

**TM-RBP048G20**

- When stopped
- When rotating

**TM-RBP105G10**

- When stopped
- When rotating
3.1.2 Dynamic Brake Characteristics

If a servo alarm that cannot control the motor occurs, the dynamic brakes will function to stop the direct-drive motor regardless of the parameter settings.

(1) Deceleration torque

The dynamic brake uses 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.

![Deceleration torque characteristics of a dynamic brake]

< MDS-E and MDS-D2 Series >

<table>
<thead>
<tr>
<th>Motor type</th>
<th>Rated torque (N•m)</th>
<th>Tdp (N•m)</th>
<th>Ndp (r/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TM-RBP012C20</td>
<td>12.0</td>
<td>32.15</td>
<td>2125</td>
</tr>
<tr>
<td>TM-RBP036E20</td>
<td>36.0</td>
<td>168.89</td>
<td>2416</td>
</tr>
<tr>
<td>TM-RBP048G20</td>
<td>48.0</td>
<td>197.39</td>
<td>1253</td>
</tr>
<tr>
<td>TM-RBP105G10</td>
<td>105.0</td>
<td>310.09</td>
<td>929</td>
</tr>
<tr>
<td>TM-RBP105G20</td>
<td>105.0</td>
<td>300.32</td>
<td>1124</td>
</tr>
<tr>
<td>TM-RBP150G20</td>
<td>150.0</td>
<td>422.03</td>
<td>1199</td>
</tr>
<tr>
<td>TM-RBP340J20</td>
<td>340.0</td>
<td>1736.57</td>
<td>2457</td>
</tr>
<tr>
<td>TM-RBP500J20</td>
<td>500.0</td>
<td>2266.02</td>
<td>1943</td>
</tr>
</tbody>
</table>

< MDS-EJ and MDS-DJ Series >

<table>
<thead>
<tr>
<th>Motor type</th>
<th>Rated torque (N•m)</th>
<th>Tdp (N•m)</th>
<th>Ndp (r/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TM-RBP012C20</td>
<td>12.0</td>
<td>32.15</td>
<td>2258</td>
</tr>
<tr>
<td>TM-RBP036E20</td>
<td>36.0</td>
<td>168.89</td>
<td>2679</td>
</tr>
<tr>
<td>TM-RBP048G20</td>
<td>48.0</td>
<td>197.39</td>
<td>1425</td>
</tr>
<tr>
<td>TM-RBP105G10</td>
<td>105.0</td>
<td>310.09</td>
<td>1442</td>
</tr>
</tbody>
</table>
(2) Coasting rotation distance during emergency stop

The angle that the motor coasts when stopping with the dynamic brakes can be approximated with the following expression.

\[
L_{\text{MAX}} = \frac{F}{60} \cdot \left( t_e + \left( 1 + \frac{J_L}{J_M} \right) \cdot \left( A \cdot N^2 + B \right) \right)
\]

- \(L_{\text{MAX}}\): Motor coasting angle [deg]
- \(F\): Axis feedrate [deg/min]
- \(N\): Motor speed [r/min]
- \(J_M\): Rotor inertia \([\times 10^{-4} \text{kg}\cdot\text{m}^2]\)
- \(J_L\): Motor shaft conversion load inertia \([\times 10^{-4} \text{kg}\cdot\text{m}^2]\)
- \(t_e\): Brake drive relay delay time [s] (Normally, 0.03s)
- \(A\): Coefficient A (Refer to the following table)
- \(B\): Coefficient B (Refer to the following table)

**MDS-E and MDS-D2 Series**

Coasting amount calculation coefficients table

<table>
<thead>
<tr>
<th>Motor type</th>
<th>(J_M) ([\times 10^{-4} \text{kg}\cdot\text{m}^2])</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>TM-RBP012C20</td>
<td>22</td>
<td>3.51×10^{-9}</td>
<td>7.62×10^{-3}</td>
</tr>
<tr>
<td>TM-RBP036E20</td>
<td>127</td>
<td>7.64×10^{-9}</td>
<td>9.51×10^{-3}</td>
</tr>
<tr>
<td>TM-RBP048G20</td>
<td>280</td>
<td>27.79×10^{-9}</td>
<td>9.30×10^{-3}</td>
</tr>
<tr>
<td>TM-RBP105G10</td>
<td>393</td>
<td>33.49×10^{-9}</td>
<td>6.16×10^{-3}</td>
</tr>
<tr>
<td>TM-RBP105G20</td>
<td>395</td>
<td>24.73×10^{-9}</td>
<td>7.59×10^{-3}</td>
</tr>
<tr>
<td>TM-RBP150G20</td>
<td>510</td>
<td>24.73×10^{-9}</td>
<td>7.59×10^{-3}</td>
</tr>
<tr>
<td>TM-RBP340J20</td>
<td>2778</td>
<td>28.41×10^{-9}</td>
<td>20.58×10^{-3}</td>
</tr>
<tr>
<td>TM-RBP500J20</td>
<td>3538</td>
<td>35.06×10^{-9}</td>
<td>15.89×10^{-3}</td>
</tr>
</tbody>
</table>

**MDS-EJ and MDS-DJ Series**

Coasting amount calculation coefficients table

<table>
<thead>
<tr>
<th>Motor type</th>
<th>(J_M) ([\times 10^{-4} \text{kg}\cdot\text{m}^2])</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>TM-RBP012C20</td>
<td>22</td>
<td>3.31×10^{-9}</td>
<td>8.09×10^{-3}</td>
</tr>
<tr>
<td>TM-RBP036E20</td>
<td>127</td>
<td>6.89×10^{-9}</td>
<td>10.55×10^{-3}</td>
</tr>
<tr>
<td>TM-RBP048G20</td>
<td>280</td>
<td>24.43×10^{-9}</td>
<td>10.59×10^{-3}</td>
</tr>
<tr>
<td>TM-RBP105G10</td>
<td>395</td>
<td>21.67×10^{-9}</td>
<td>9.62×10^{-3}</td>
</tr>
</tbody>
</table>
Dedicated Options
4.1 Encoder System Options

The option units are required depending on the encoder system configuration. Check the option units to be required referring the following items. Refer to the Specifications manual of the drive unit to be used for details of the battery options.

(1) Encoder system configuration

The applicable absolute position encoders are as follows.

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Encoder type</th>
<th>Interface unit type</th>
<th>Minimum detection resolution</th>
<th>Battery option</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mitsubishi Electric Corporation</td>
<td>MBA405W Series</td>
<td>(Provided)</td>
<td>0.0000049° (4,000,000p/rev)</td>
<td>Required</td>
<td>-</td>
</tr>
<tr>
<td>Magnescale Co., Ltd.</td>
<td>RU77</td>
<td>Not required</td>
<td>0.00000429° (8,388,608p/rev)</td>
<td>Not required</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>RCN223M</td>
<td>Not required</td>
<td>0.0000027° (134,217,728p/rev)</td>
<td>Not required</td>
<td>Mitsu02-4</td>
</tr>
<tr>
<td></td>
<td>RCN723M</td>
<td>Not required</td>
<td>0.0000027° (134,217,728p/rev)</td>
<td>Not required</td>
<td>Mitsu02-4</td>
</tr>
<tr>
<td></td>
<td>RCN227M</td>
<td>Not required</td>
<td>0.0000027° (134,217,728p/rev)</td>
<td>Not required</td>
<td>Mitsu02-4</td>
</tr>
<tr>
<td></td>
<td>RCN727M</td>
<td>Not required</td>
<td>0.0000027° (134,217,728p/rev)</td>
<td>Not required</td>
<td>Tolerable rotation speed 300r/min Mitsu02-4</td>
</tr>
<tr>
<td>Mitsubishi Heavy Industries Machine Tool Co., Ltd.</td>
<td>MPRZ Series</td>
<td>ADB-20J71</td>
<td>0.0000043° (8,388,608p/rev)</td>
<td>Not required</td>
<td>-</td>
</tr>
<tr>
<td>FAGOR</td>
<td>HAM Series</td>
<td>Not required</td>
<td>0.00000429° (8,388,608p/rev)</td>
<td>Not required</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>RA Series</td>
<td>Not required</td>
<td>0.0000027° (134,217,728p/rev)</td>
<td>Not required</td>
<td>-</td>
</tr>
<tr>
<td>Renishaw plc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<Contact information about other manufacturer's encoder>
- HEIDENHAIN CORPORATION: http://www.heidenhain.com/
- FAGOR Automation: http://www.fagorautomation.com/
- Renishaw plc.: http://www.renishaw.com/

(Note) The application may vary due to the specification changes or production discontinuance by the encoder manufacturer. Thus, be sure to carefully check each manufacturer's specifications before use.

⚠️ CAUTION

1. The above value does not guarantee the accuracy of the system.
2. The user shall prepare the above-mentioned encoder after inquiring of each manufacturer about the specifications and confirm them.
3. When using an encoder not listed above, contact the manufacturer to make sure that the encoder is compatible with Mitsubishi interface.
4.1.1 Twin-head Magnetic Encoder (MBA Series)

(1) Type description

MBA405W-B

(2) Specifications

<table>
<thead>
<tr>
<th>Encoder type</th>
<th>MBA405W-BE082</th>
<th>MBA405W-BF125</th>
<th>MBA405W-BG160</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encoder resolution</td>
<td>4,000,000p/rev</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Detection method</td>
<td>Absolute position method (battery backup method)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accuracy (*1) (*2)</td>
<td>±4 seconds</td>
<td>±3 seconds</td>
<td>±2 seconds</td>
</tr>
<tr>
<td>Wave number within one rotation</td>
<td>512 waves</td>
<td>768 waves</td>
<td>1024 waves</td>
</tr>
<tr>
<td>Encoder output data</td>
<td>Serial data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power consumption</td>
<td>0.2A or less</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mechanical characteristics for rotation</th>
<th>Inertia</th>
<th>Tolerable continuous rotation speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drum inner diameter</td>
<td>0.5×10⁻³kg·m²</td>
<td>3000r/min</td>
</tr>
<tr>
<td>Drum outer diameter</td>
<td>2.4×10⁻³kg·m²</td>
<td>2000r/min</td>
</tr>
<tr>
<td>Drums mass</td>
<td>8.7×10⁻³kg·m²</td>
<td>1500r/min</td>
</tr>
<tr>
<td>Degree of protection (*3)</td>
<td>IP67</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mechanical configuration</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Drum inner diameter</td>
<td>Ø82 mm</td>
</tr>
<tr>
<td>Drum outer diameter</td>
<td>Ø125 mm</td>
</tr>
<tr>
<td>Drum mass</td>
<td>Ø160 mm</td>
</tr>
<tr>
<td>Degree of protection (*3)</td>
<td>IP67</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Working environment</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient temperature range</td>
<td>0°C to +55°C</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>-20°C to +85°C</td>
</tr>
<tr>
<td>Humidity</td>
<td>95%RH</td>
</tr>
<tr>
<td>Vibration resistance</td>
<td>Horizontal direction to the axis: 5G or less, Vertical direction to the axis: 5G or less</td>
</tr>
<tr>
<td>Impact resistance</td>
<td>490m/s² (50G)</td>
</tr>
</tbody>
</table>

(*1) The values above are typical values after the calibration with our shipping test device and are not guaranteed.

(*2) The user is requested to install the magnetic drum and installation ring in the encoder within the accuracy range specified herein. Even when the accuracy of the encoder when shipped and when installed by the user is both within the specified range, there is a difference in the installation position. Therefore, the accuracy at the time of our shipment may not be acquired.

(*3) It is the degree of protection when fitted with a connector.

(3) Specifications of preamplifier

<table>
<thead>
<tr>
<th>Item</th>
<th>Specified value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output communication style</td>
<td>High-speed serial communication I/F</td>
</tr>
<tr>
<td>Working ambient temperature</td>
<td>0°C to +55°C</td>
</tr>
<tr>
<td>Working ambient humidity</td>
<td>90%RH or less (with no dew condensation)</td>
</tr>
<tr>
<td>Atmosphere</td>
<td>No toxic gases</td>
</tr>
<tr>
<td>Tolerable vibration</td>
<td>Horizontal direction to the axis: 5G or less, Vertical direction to the axis: 5G or less</td>
</tr>
<tr>
<td>Tolerable impact</td>
<td>490m/s² (50G)</td>
</tr>
<tr>
<td>Tolerable power voltage</td>
<td>DC5V±10%</td>
</tr>
<tr>
<td>Mass</td>
<td>0.33kg</td>
</tr>
<tr>
<td>Degree of protection (*2)</td>
<td>IP67</td>
</tr>
</tbody>
</table>

(*1) The values above are the specified values for the preamplifier provided with a twin-head magnetic encoder.

(*2) It is the degree of protection when fitted with a connector.
(4) Outline dimension drawing

< MBA405W-BE082 >

[Unit: mm]

< MBA405W-BF125 >

[Unit: mm]
< Explanation of connectors >

<table>
<thead>
<tr>
<th>Connector name</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>CN1-1</td>
<td>For connection with scale (main head)</td>
</tr>
<tr>
<td>CN1-2</td>
<td>For connection with scale (sub head)</td>
</tr>
<tr>
<td>CN2</td>
<td>For connection with servo drive unit</td>
</tr>
<tr>
<td>CN3</td>
<td>For connection with motor thermistor</td>
</tr>
</tbody>
</table>

< Connector pin layout >

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Function</th>
<th>Pin No.</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>BT</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>SD</td>
<td>3</td>
<td>MT1-i</td>
</tr>
<tr>
<td>4</td>
<td>SD*</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>SHD</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>MT1</td>
<td>6</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>RQ</td>
<td>7</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>RQ*</td>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>P5</td>
<td>9</td>
<td>MT2-i</td>
</tr>
<tr>
<td>10</td>
<td>LG</td>
<td>10</td>
<td>-</td>
</tr>
<tr>
<td>11</td>
<td>MT2</td>
<td>11</td>
<td>-</td>
</tr>
<tr>
<td>12</td>
<td>CNT</td>
<td>12</td>
<td>-</td>
</tr>
</tbody>
</table>
4.2 Cables and Connectors

4.2.1 Cable Connection Diagram

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. Purchase a connector set, etc., to create special length cables.

< MDS-E Series >

< MDS-D2 Series >
< MDS-EJ-V1 Series >

MDS-EJ-V1

- Encoder (MBA405W)
  * Prepared by user.
- MR sensor head (twin-head)

- Servo encoder cable
  < Motor side encoder cable >
- Power cable
- Thermistor signal
- Direct-drive motor

< MDS-DJ-V1 Series >

MDS-DJ-V1

- Encoder (MBA405W)
  * Prepared by user.
- MR sensor head (twin-head)

- Servo encoder cable
  < Motor side encoder cable >
- Power cable
- Thermistor signal
- Direct-drive motor
### 4.2.2 List of Cables and Connectors

**< Servo encoder cable and connector >**

<table>
<thead>
<tr>
<th>Item</th>
<th>Model</th>
<th>Contents</th>
</tr>
</thead>
</table>
| Encoder connector | CNU2S(AWG18) | Drive unit side connector (3M)  
Receptacle: 36210-0100PL  
Shell kit : 36310-3200-008  
Compatible part (Note 1)  
(MOLEX)  
Connector set : 54599-1019  
(J.S.T.)  
Plug connector : XV-10P-03-L-R  
Cable kit : XV-PCK10-R  
Compatible part (Note 1)  
(MOLEX)  
Connector set: 54599-1019  
(J.S.T.)  
Plug connector : XV-10P-03-L-R  
Cable kit : XV-PCK10-R |
| Cable for MBA405W | CNV2E-MB- □ M  
□ : Length  
2, 3, 4, 5, 7, 10, 15, 20m | Drive unit side connector (3M)  
Receptacle: 36210-0100PL  
Shell kit: 36310-3200-008  
Encoder preamplifier side connector  
(Hirose Electric)  
Plug: RM15WTPZK-12S  
Clamp: JR13WCCA-8 (72)  
Compatible part (Note 1)  
(MOLEX)  
Connector set: 54599-1019  
(J.S.T.)  
Plug connector : XV-10P-03-L-R  
Cable kit : XV-PCK10-R |
| Connector for MBA405W | CNEMB2S(8) | Encoder preamplifier side connector  
(Hirose Electric)  
Plug: RM15WTPZK-12S  
Cord clamp: JR13WCCA-8 (72) |
| Thermistor connector for MBA405W | CNEMB3S(8) | Encoder preamplifier side connector  
(Hirose Electric)  
Plug: RM15WTPZ-10S (72)  
Cord clamp: JR13WCCA-8 (72) |

(Note 1) The names of compatible parts may be changed at the manufacturer’s discretion. Contact each manufacturer for more information.
### Power connector

<table>
<thead>
<tr>
<th>Item</th>
<th>Model</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>For TE1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power connector for MDS-E-V1-40 to 160 MDS-E-V2-40 to 160 MDS-E-V3-40</td>
<td>CNU01SEF(AWG14)</td>
<td>Drive unit side power connector (J.S.T)</td>
</tr>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power connector for MDS-E-CV-37/75</td>
<td>CNU01SECV (AWG14)</td>
<td>Drive unit side power connector (J.S.T)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power connector for MDS-D2-V1-20 to 80 MDS-D2-V2-2020 to 8080 MDS-D2-SP-20 to 80 MDS-D2-SP2-2020 to 4040</td>
<td>CNU1S(AWG14)</td>
<td>Drive unit side power connector (DDK)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power connector for MDS-D2-V1-160 MDS-D2-V2-16080,160160 MDS-D2-SP2-8040,8080</td>
<td>CNU1S(AWG10)</td>
<td>Drive unit side power connector (DDK)</td>
</tr>
</tbody>
</table>

(Note 1) Hand crimping tools: 357J-22795
(Note 2) Hand crimping tools: 357J-22796

**Contact information**
- HIROSE ELECTRIC CO., LTD.: http://www.hirose.com/
- Sumitomo 3M Limited: http://www.3m.com/
- DDK Ltd.: https://www.ddknet.co.jp/English/index.html
- Molex Ltd.: http://www.molex.com/
(Note) Contact the relevant manufacturer about whether or not the PSV wiring is necessary.
< Twin-head magnetic encoder (MBA405W) connection diagram >

Drive unit side connector
(3M)
Receptacle: 36210-0100PL
Shell kit: 36310-3200-008
(MOLEX)
Connector set: 54599-1019

Encoder preamplifier side
connector (CN2)
(Hirose Electric)
Plug: RM15WTPZK-12S
Cord clamp: JR13WCCA-8 (72)

< For 10m or less >

< Twin-head magnetic encoder (MBA405W) motor thermistor cable connection diagram >

Encoder preamplifier side connector (CN3)
(Hirose Electric)
Plug: RM15WTPZK-10S (72)
Cord clamp: JR13WCCA-8 (72)

To motor thermistor
Selection
5.1 Selection of the Power Supply Unit
(Only MDS-E-V1/V2 and MDS-D2-V1/V2)

For the power supply unit, calculate the spindle motor output, servo motor output and direct-drive motor output each, and select the capacity satisfying the required rated capacity and the maximum momentary output. For details on the calculation method of motor output and selecting method for motors other than a direct-drive motor, refer to “MDS-E/EH Series Specifications Manual (IB-1501226(ENG))” or “MDS-D2/DH2 Series Specifications Manual (IB-1501124(ENG))”.

5.1.1 Calculation of Direct-drive Motor Output
(1) Selection with rated output
(2) Selection with maximum momentary output

For the rated output and maximum momentary at the maximum speed of the direct-drive motor, calculate from the output characteristics of each motor.

< Output characteristics >
Assembly and Installation
6.1 Installation

⚠️ **DANGER**

1. Installation must be done by a qualified technician.
2. Pay attention so that a person with a medical device such as pacemaker won’t approach the product. The device may be affected by the permanent magnets.
3. Do not place magnetic material such as iron close to the product.
4. Before installing, remove metal items such as watch, piercing jewelry, necklace, etc.
5. In installing the product and peripheral structures, make sure to use nonmagnetic tools.
6. Do not leave the product (primary and secondary side) unattended.
7. Immediately stop using the product if any abnormality is found about the product.
8. When multiple operators are engaged in the operation, confirm that no operator is within the range of motion before energizing the product. If any operator remains in the range of motion, take measures to prevent the motion with interlock system, etc.
9. As the motor doesn’t have the holding power when it is not energized, if you use the product not as a vertical axis, take measures to prevent the axis from rotating due to gravity.

⚠️ **CAUTION**

1. Do not arrange the product, or do not give a shock.
2. Do not get on top of or place heavy objects on the product.
3. Correctly and securely perform the wiring.
   - Especially, fix the terminals or connectors of the power cables firmly enough.
4. Perform the wiring after installing the product to the machine and device.
5. If iron chips, etc. adhere to the product during installation, completely remove them.
6. Do not install with wet hands.
6.2 The Structure of Direct-drive Motor

(1) **Stator**

The stator has laminated cores to which windings are applied. The cores are protected by mold. Compared with metal parts, the mold is susceptible to breaking or cracking due to shock or stress, which may deteriorate the product’s quality. Pay special attention in carrying and installing not to damage the mold.

(2) **Rotor**

Permanent magnets are on the core of the rotor, and mold is applied to the surface of it. As it has permanent magnets, magnetic attraction force is generated between it and magnetic material as iron. The magnetic attraction force is generated mainly on the magnet side (outer surface of rotor). (Almost no attraction force is generated on the inner surface.) Take safety measure in handling to avoid accidents due to the attraction force. In addition, the magnetic force is released into the air, so do not make devices that are affected by the magnetic force such as pacemaker, watch, etc. approach to the product.

< Example of direct-drive motor structure >

⚠️ **CAUTION**

1. O-rings for the cooling jacket are required to carry out a forced liquid cooling of the motor. O-rings are not provided with this motor, so the optimum ones should be prepared by users.

2. The motor’s lead wires are non movable cables. Fix the lead wire section not to move. The bending radius of the lead wires should be five times or more than its own diameter.

3. Make sure to take dust- and water-proof measures since this motor is rated IP00. The protection class of the motor assembling section should be IP54 or higher. If foreign matters enter the gap between the stator and the rotor, trouble may occur. Additionally, continuous exposure to oil or water may cause insulation degradation or rust.
6.3 Direct-drive Motor Assembly

⚠️ CAUTION
1. As a magnetic attraction force is generated on the rotor of direct-drive motor, take measures such as using nonmagnetic tools at the time of assembly.

2. A magnetic attraction force of about 200N (stator outer diameter $\phi 130$) to 1300N (stator outer diameter $\phi 330$) will be generated when a rotor is inserted into a stator.

Take necessary and sufficient safety measures such as using a jig considering the attraction force. Otherwise the rotor may suddenly be attracted to the stator during assembling, resulting in a great danger.

6.3.1 Example Procedure of Assembly

(1) Shaft assembly

Fit a shaft into the rotor using the pilot section of rotor inner diameter as a guide.

Use the screw holes on the rotor ends to fix the rotor and shaft by screws. Use as many holes on both ends as possible to fix them.

⚠️ CAUTION
1. Do not raise the temperature of the rotor to 40°C or higher before assembling since heat may demagnetize magnets. Do not shrink-fit the rotor.

2. The rotor has not balanced. If the balance of the rotor is a problem, adjust the dynamic balance after assembling the shaft to the rotor. Take special care for the magnetic attraction force acted on the rotor surface when balancing. Use the shaft part for balancing. Do not machine the rotor itself or install balancing screws.
(2) **Shaft and bearing housing assembly**
Insert the bearing into the bearing housing and assemble to fix them.

![Insert the bearing into the bearing housing and assemble them](image)

(3) **Cooling jacket assembly**
Assemble the cooling jacket by using the pilot section of bearing housing as a guide.
Perform the centering of the rotor and stator using the cooling jacket inner diameter as a guide.

![Assemble the cooling jacket into the bearing housing](image)

⚠️ **CAUTION**
Make sure that the concentricity deviation of the rotor inner diameter to the stator outer diameter is 0.1mm or smaller at the both fitting sections. (Keep them as concentric as possible.)

(4) **Stator assembly**

1. Install O-rings to the cooling jacket.
2. Insert the stator using the cooling jacket inner diameter as a guide.
3. Fix the stator to the housing with screws.
(5) **Bearing housing assembly**

[1] Assemble the other bearing and then assemble the bearing housing by using the pilot section of the cooling jacket as a guide.

[2] Fix the stator to the housing with screws.
Use as many screw holes on the both ends as possible to fix them.

(6) **Encoder assembly**

Assemble the encoder into the shaft end.

---

**CAUTION**

If the rotor rotates clockwise (right-hand turning) when viewed from the power line side, this direction is considered as plus (+) of the motor. When the rotation direction of the motor and plus direction of the encoder do not match, set the encoder installation polarity with the following parameter at the initial setup.

- #2217/bit0(SV017/bit0)

  0: Forward polarity  1: Reverse polarity

Refer to the section "7.2 Initial setup for the direct-drive motor system" for details.
6.4 Installing Twin-head Magnetic Encoder (MBA405W Series)

**CAUTION**

1. Handle with care as this is a precision component. Especially, do not apply external force on the sensor head component (thin metal film section) and the magnetized section (magnet) of the magnetic drum.

2. Pay attention not to apply excessive external force on the product by hauling the sensor head cable strongly or by hanging the installation ring with holding the cable. Applying such force will cause a fault.

3. The magnetic drum has magnets in it. Pay attention so that any magnetic dust will not adhere on the drum. If any dust adheres on it, remove it using air blow.

4. Do not make magnetic screw drivers or tools touched the magnetized section of the magnetic drum during installation.

5. Use iron screws (carbon steel, chromium molybdenum steel) for fixing the magnetic drum.

6. This product is equivalent of IP67 (IP67 is realized when cables are connected to all connectors). Note that, however, if the liquid such as oil, cutting fluid or water is constantly splashed on the product, it may cause a fault. Make sure to provide measures against splash on the machine side as much as possible.

7. Connect the preamp to the ground. Screw the preamp cabinet on the machine for grounding.

8. If the CN3 connector of the preamp is not used when using the product, leave the cap on it to prevent water from entering.

9. Accuracy of this product has been adjusted as a set of magnetic drum, installation ring (with main head and sub head) and preamp of the same serial No. So use this product as a set of those components. Note that normal accuracy cannot be achieved if this is replaced with another set having a different serial No.

[Method for checking the serial No.]
Check the serial No. of magnetic drum, installation ring (with main head and sub head) and preamp with each nameplate sticker attached on the following part.

- < Preamp >
- < Magnetic drum / installation ring >

Make sure that the serial Nos. (6 digits) of the nameplate stickers attached on the above three parts are the same.

10. This product compensates an offset deviation with age in analog signals.
(1) **Installing a magnetic drum**

Install a flange on the shaft side and fix with screw in the axial direction by using the magnetic drum installation hole. Center the core with centering track so that the amplitude to the shaft rotation center is 15μm or less to install the magnetic drum.

![Diagram showing the installation process](image)

**CAUTION**

1. To avoid the interference with the sensor head, design the flange outer diameter φC so that it is equal to the magnetic drum outer diameter or less.
2. Fix the magnetic drum with screw on the shaft. (Do not fix with shrink fitting.)
3. Center the core with centering track. Do not perform by striking on the magnetizing part as it may result in damages.
4. Adherence of magnetic materials to the magnetizing part could lead to incorrect detections. Perform an air blow when the core alignment is completed.

<table>
<thead>
<tr>
<th>Type</th>
<th>Centering track outer diameter [mm]</th>
<th>Magnetic drum installation hole position</th>
<th>Installation screw</th>
<th>Recommended screw torque [N•m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBA405W-BE082</td>
<td>φ98</td>
<td>8-φ3.4 through (evenly spaced around φ90 circumference)</td>
<td>M3</td>
<td>0.61 to 0.83</td>
</tr>
<tr>
<td>MBA405W-BF125</td>
<td>φ148.3</td>
<td>8-φ4.5 through (evenly spaced around φ134 circumference)</td>
<td>M4</td>
<td>1.39 to 1.89</td>
</tr>
<tr>
<td>MBA405W-BG160</td>
<td>φ198.6</td>
<td>8-φ4.5 through (evenly spaced around φ170 circumference)</td>
<td>M5</td>
<td>2.75 to 3.63</td>
</tr>
</tbody>
</table>
(2) Installing a installation ring

Create a spigot-joint on machine side and fit the installation ring on the inner diameter of the spigot-joint to install the installation ring. Ensure the accuracy for the dimension of machine side spigot-joint as shown below so as not to degrade the detection accuracy.

Confirm the gap between the magnetic drum and the sensor head is secured by 0.29mm or more with clearance gauge etc. after the installation.

**CAUTION**

1. Do not contact to the magnetic drum when installing the installation ring as it may result in damages of magnetic drum or sensor head.

2. The sensor head is joined after adjusting the positional relationship with the installation ring beforehand, so do not remove the sensor head fixing screw.

3. Create a spigot-joint as close to the machine side and fit the installation ring on the spigot-joint to install. Do not center the core by striking on the installation ring outer diameter, etc.

4. Adherence of foreign materials to the element part of the sensor head (metallic thin film part) could lead to incorrect detections. Remove with an air blow when foreign materials are adhered so as not to damage them.

---

<table>
<thead>
<tr>
<th>Type</th>
<th>Installation ring outer diameter</th>
<th>Spigot-joint inner diameter (φD)</th>
<th>Spigot-joint height (E)</th>
<th>Height from installation ring bottom surface to magnetic drum bottom surface (F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBA405W-BE082</td>
<td>φ140 0 -0.015</td>
<td>φ140 +0.015 0</td>
<td>3.0 to 5.5</td>
<td>9.5±0.2</td>
</tr>
<tr>
<td>MBA405W-BF125</td>
<td>φ190 0 -0.015</td>
<td>φ190 +0.015 0</td>
<td>3.0 to 7.5</td>
<td>11.5±0.2</td>
</tr>
<tr>
<td>MBA405W-BG160</td>
<td>φ242 0 -0.015</td>
<td>φ242 +0.015 0</td>
<td>3.0 to 9.5</td>
<td>13.5±0.2</td>
</tr>
</tbody>
</table>
(3) For Z-phase signal detection
After turning the encoder power ON, Z-phase signal is required to be detected by the main head (Z-phase signal position mark is required to pass the main head). For the device configuration which the magnetic drum cannot drive more than one rotation, install the encoder so that Z-phase can pass the main head in the shaft stroke.

(4) For the rotation direction of the encoder
Seeing an encoder from the upper surface as shown below, when the magnetic drum rotates clockwise is the forward run. Confirm the rotation direction of the encoder and motor by reference to each motor specifications.

(5) For MBA405W (absolute encoder)
The initial setup operation is required after the operation is enabled for NC system to connect MBA405W to the servo drive unit. Refer to "7.3 Initial setup for the direct-drive motor system when using MBA405W" for details. The initial setup is required only for the first time after installing the encoder to the machine.
Setup
7.1 Setting the Initial Parameters for the Direct-drive Motor

The servo parameters must be set before the direct-drive motor can be started up. The servo parameters are input from the NC. The input method differs according to the NC being used, so refer to each NC Instruction Manual. When setting the initial setting parameters, perform the following settings.

<For direct-drive motor system>

1. Set the standard parameters in the section "7.1.2 List of standard parameters for each direct-drive motor".
2. "7.1.1 Setting of encoder related parameter"

**CAUTION**

Do not release the emergency stop even after setting the above initial parameters. The initial setup (refer to the section "7.2 Initial setup for the direct-drive motor system") is always required to enable the test operation for the direct-drive motor (Ex. manual pulse feed, low-speed JOG feed).

### 7.1.1 Setting of Encoder Related Parameters

Set the encoder related parameters below depending on the encoder connected.

#2219(SV019), #2220(SV020), #2317(SV117), #2318(SV118)

#### Mitsubishi serial signal output encoder (Absolute position)

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Encoder type</th>
<th>Interface unit type</th>
<th>Control resolution</th>
<th>#2219 (SV019)</th>
<th>#2220 (SV020)</th>
<th>#2317 (SV117)</th>
<th>#2318 (SV118)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mitsubishi Electric</td>
<td>MBA405W</td>
<td>Provided</td>
<td>4,000,000p/rev</td>
<td>4000</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnescale</td>
<td>RU77</td>
<td>Not required</td>
<td>8,000,000p/rev</td>
<td>8000</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HEIDENHAIN</td>
<td>RCN223M</td>
<td>Not required</td>
<td>8,000,000p/rev</td>
<td>8000</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RCN723M</td>
<td>Not required</td>
<td>134,217,728p/rev</td>
<td>0</td>
<td>2048</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mitsubishi Heavy Industries</td>
<td></td>
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</tr>
<tr>
<td>Machine Tool Co., Ltd.</td>
<td>MPRZ Series</td>
<td>ADB-20J71</td>
<td>6,000,000p/rev</td>
<td>8000</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FAGOR</td>
<td>HAM Series</td>
<td>Not required</td>
<td>8,000,000p/rev</td>
<td>8000</td>
<td>0</td>
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<td>RA Series</td>
<td>Not required</td>
<td>8,000,000p/rev</td>
<td>8000</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>134,217,728p/rev</td>
<td>0</td>
<td>2048</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **【#2219(PR)】 SV019 RNG1 Sub side encoder resolution**
  - Set the number of pulses per revolution in one "kp" increments.
  - Note that the value must be input in increments of 10K pulses (the 1st digit of the setting value is "0"). If any restriction is imposed due to the above condition, also set SV117 in one pulse increments.

- **【#2220(PR)】 SV020 RNG2 Main side encoder resolution**
  - Set the same value as SV019.

- **【#2317(PR)】 SV117 RNG1ex Expansion sub side encoder resolution**
  - To set the resolution of the motor side encoder in one pulse increments, set the number of pulses of the encoder by 4-byte data in total to SV117 (high-order 16bit) and SV019 (low-order 16bit). SV117= Quotient of the number of pulses divided by 65536 (If the quotient is 0, set SV117 to -1). SV019= Remainder of the number of pulses divided by 65536 (SV019 can be set in one pulse increments).
  - If the NC is C70 and SV019 is greater than 32767, enter the (negative) value obtained by subtracting 65536 from the above remainder in SV019.

- **【#2318(PR)】 SV118 RNG2ex Expansion main side encoder resolution**
  - Set the same value as SV117.
7.1.2 List of Standard Parameters for Each Direct-drive Motor

(1) Direct-drive motor TM-RB Series (MDS-E-V<sub>□</sub>, MDS-D2-V<sub>□</sub>):

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Motor</th>
<th>Direct-drive motor TM-RB Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td>Abbrev.</td>
<td>Details</td>
</tr>
<tr>
<td>0001</td>
<td>P1C</td>
<td>Motor side gear ratio</td>
</tr>
<tr>
<td>0002</td>
<td>P2C</td>
<td>Machine side gear ratio</td>
</tr>
<tr>
<td>0003</td>
<td>PGN1</td>
<td>Position loop gain 1</td>
</tr>
<tr>
<td>0004</td>
<td>PGN2</td>
<td>Position loop gain 2</td>
</tr>
<tr>
<td>0005</td>
<td>VGN1</td>
<td>Speed loop gain 1</td>
</tr>
<tr>
<td>0006</td>
<td>VGN2</td>
<td>Speed loop gain 2</td>
</tr>
<tr>
<td>0007</td>
<td>VIL</td>
<td>Speed loop delay compensation</td>
</tr>
<tr>
<td>0008</td>
<td>VIA</td>
<td>Speed loop lead compensation</td>
</tr>
<tr>
<td>0009</td>
<td>VQA</td>
<td>Current loop q axis gain</td>
</tr>
<tr>
<td>0010</td>
<td>VQA1</td>
<td>Current limit value in special control</td>
</tr>
<tr>
<td>0011</td>
<td>VIA1</td>
<td>Current loop d axis gain</td>
</tr>
<tr>
<td>0012</td>
<td>IDG</td>
<td>Current loop d axis lead compensation</td>
</tr>
<tr>
<td>0013</td>
<td>ILMT</td>
<td>Current limit value</td>
</tr>
<tr>
<td>0014</td>
<td>ILMTsp</td>
<td>Current limit value in special control</td>
</tr>
<tr>
<td>0015</td>
<td>FFC</td>
<td>Acceleration rate feed forward gain</td>
</tr>
<tr>
<td>0016</td>
<td>LMC1</td>
<td>Lost motion compensation 1</td>
</tr>
<tr>
<td>0017</td>
<td>SPEC1</td>
<td>Servo specification 1</td>
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<tr>
<td>0065</td>
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</table>
When using a motor for which SV025 is set to 22FF, the motor name displayed by selecting [Servo unit] on the drive monitor screen will be "ROTmotor".
## Direct-drive motor TM-RB Series (MDS-EJ-V1, MDS-DJ-V1)

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<td>SV010 IDA</td>
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<td>SV057 SHGC</td>
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<td>Collision detection torque estimated gain</td>
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</table>
### 7 Setup

#### Motor Parameter Details

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<th>No.</th>
<th>Abbrev.</th>
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<tbody>
<tr>
<td>012C20</td>
<td>036E20</td>
<td>048020</td>
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</tbody>
</table>

- **SV073** FEEDout Specified speed output speed 0 0 0 0
- **SV081** SPEC2 Servo specification 2 0000 0000 0000 0000
- **SV082** SSF5 Servo function 5 0000 0000 0000 0000
- **SV083** SSF6 Servo function 6 0000 0000 0000 0000
- **SV084** SSF7 Servo function 7 0000 0000 0000 0000
- **SV085** LMCa Lost motion compensation 3 spring constant 0 0 0 0
- **SV086** LMCc Lost motion compensation 3 viscous coefficient 0 0 0 0
- **SV087** FH24 Notch filter frequency 4 0 0 0 0
- **SV088** FH25 Notch filter frequency 5 0 0 0 0
- **SV099** 0 0 0 0
- **SV098** 0 0 0 0
- **SV097** 0 0 0 0
- **SV096** 0 0 0 0
- **SV095** 0 0 0 0
- **SV094** MPV Magnetic pole position error detection speed 10 10 10 10
- **SV093** 0 0 0 0
- **SV092** 0 0 0 0
- **SV091** LMC4G Lost motion compensation 4 gain 0 0 0 0
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- **SV089** 0 0 0 0
- **SV088** 0 0 0 0
- **SV087** 0 0 0 0
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- **SV081** 0 0 0 0
- **SV080** 0 0 0 0
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- **SV076** 0 0 0 0
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- **SV074** 0 0 0 0
- **SV073** 0 0 0 0
- **SV072** 0 0 0 0
- **SV071** POLE Motor unique constants 20 0 30 0
- **SV070** IS Motor unique constants -6102 0 -1211 -2101
- **SV069** IP Motor unique constants -1831 0 -3631 -5201
- **SV068** NK Motor unique constants -2201 0 -4402 -5201
- **SV067** JM Motor unique constants -2000 0 -3875 -5201
- **SV066** LQ Motor unique constants 0 0 0 0
- **SV065** LD Motor unique constants 0 0 0 0
- **SV064** KE Motor unique constants -3462 0 -1493 -1813
- **SV063** 0 0 0 0
- **SV062** 0 0 0 0
- **SV061** 0 0 0 0
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- **SV030** 0 0 0 0
- **SV029** 0 0 0 0
- **SV028** 0 0 0 0
- **SV027** 0 0 0 0
- **SV026** 0 0 0 0

(Note) When using a motor for which SV025 is set to 22FF, the motor name displayed by selecting [Servo unit] on the drive monitor screen will be "ROTmotor".
7.2 Initial Setup for the Direct-drive Motor System

This section explains the initial setup procedures for direct-drive motor.

⚠️ CAUTION

1. Perform the initial setup after the operation is enabled for NC system.
2. The initial setup is required for each direct-drive motor.
3. Perform the initial setup again after replacing the encoder.
4. For a system with multiple direct-drive motor axes, the initial setup (DC excitation function) must be performed for each axis. Set #2213(SV013) to 0 and #2228(SV028) to 1 for the direct-drive motor axis for which the DC excitation function is not enabled. If the emergency stop is released in the state of #2228(SV028) is 0, magnetic pole position detection error (16) will occur.
5. The initial setup method differs when using MBA405W. Refer to "7.3 Initial setup for the direct-drive motor system when using MBA405W".

7.2.1 Adjustment Procedure

For the direct-drive motor system, the initial setup must be performed for each machine because the position relation between the motor coil and encoder differs among machines. Be sure to set up according to the following procedures. The motor may not work properly unless the initial setup for the magnetic pole (DC excitation function) is performed correctly.

DC excitation function detects the position relation (magnetic pole shift amount) between the motor coil and encoder. The magnetic pole shift amount can be seen at [AFLT gain] on the NC's servo diagnosis screen by moving the direct-drive motor with DC excitation function. The motor will be driven according to the magnetic pole shift amount from next time the NC power is turned ON.

With the DC excitation function, once the servo parameter (SV028) is set, resetting is not required unless the encoder is replaced.

<DC excitation function>

1. Turn ON the servo drive unit and NC. Confirm that there is no error such as Initial parameter error (37).
2. Set the servo parameter #2213(SV013) to 100.
3. Set the parameters related to the DC excitation function (#2261(SV061) to 10, #2262(SV062) to 10, and #2263(SV063) to 1000).
4. Set the servo parameter #2234/bit4(SV034/bit4) to "1" to enable the DC excitation mode.
5. Release the emergency stop.
6. Confirm that the direct-drive motor carries out a reciprocation operation between about ±10° and 20° once (start DC excitation).
7. Confirm that the direct-drive motor stops after the reciprocation operation.
8. Switch to the [Servo diagn] menu on the NC maintenance screen, select [Servo unit] and monitor [AFLT gain].
9. Turn the NC power ON again (terminate DC excitation).
10. Repeat (5) to (9) times, and monitor the ALFT gain value (magnetic pole shift amount) each time.

If difference of the magnetic pole shift amounts is 1000 data or bigger, reset the related parameter settings (#2261(SV061)=+10, #2262(SV062)=+10) and perform (5) to (9) again.

11. Calculate the average of the magnetic pole shift amounts, and set it to #2228(SV028).
12. Return the servo parameter #2234/bit4(SV034/bit4) back to the original setting, "0".
13. Turn the NC power ON again.
7 Setup

<Confirmation of encoder installation polarity>

(14) Release the emergency stop.

(15) Drive the direct-drive motor about ±20° with handle feed (select the minimum pulse magnification).

(16) Switch to the [Servo diagn] menu on the NC maintenance screen, select [Servo unit] and check [Load current]. Also check if any alarm is occurring.

  -> The encoder installation polarity may be reverse if the current value reaches to the current limit or any alarm occurs. Set the servo parameter #2217/bit0(SV017/bit0) to "1" and perform (14) to (16) again after turning the NC power ON again.

(17) Turn ON the emergency stop.

(18) Return the servo parameter #2213(SV013) back to the original setting after confirming the initial setup.

⚠️ CAUTION

1. Never operate the direct-drive motor before DC excitation function is enabled.

2. The motor carries out a reciprocation operation at about the magnetic pole pitch while DC excitation function is enabled.

3. The magnetic pole shift amount cannot be calculated correctly with incorrect wiring in the motor power line or encoder cable.
Initial setup procedures for direct-drive motor (DC excitation function)
Perform the initial setup for the direct-drive motor by following the steps in the flow diagram below.

1. NC power ON
2. Set the current limit
   - SV013[ILMT] = 100
3. Set the DC excitation-related parameters
   - SV061[DA1NO] = +10\%
   - SV062[DA2NO] = +10\%
   - SV063[DA1MPY] = 100[ms]
4. Set DC excitation mode
   - SV034[SSF3][bit4][dcd] = 1
5. Set DC excitation mode
   - SV061[DA1NO] = +10\%
   - SV062[DA2NO] = +10\%
6. Release the emergency stop
5. Release the emergency stop
   (start DC excitation mode)
7. Emergency stop (terminate DC excitation mode)
8. The axis (direct-drive motor) reciprocates one time?
   (about ±10° and 20°)
10. The variation in the AFLT gain (magnetic pole shift amount) is “1000” or less?
11. Note down the AFLT gain (magnetic pole shift amount) on the drive monitor screen
12. The axis (direct-drive motor) reciprocates one time?
   (about ±10° and 20°)
13. Set the current limit
   - SV013[ILMT] = Current limit value for each motor
14. Drive the axis (direct-drive motor) with handle feed for one rotation
   Magnification: minimum pulse
15. Any alarm occurs?
16. Release the current limit
   - SV013[ILMT] = Current limit value for each motor
17. Initial setup completed
7.2.2 Related Parameters

As DC excitation is a function used for initial setup for the direct-drive motor, use the servo parameters #2261(SV061) and #2262(SV062) that have another function (D/A output) used for adjustment. Note, however, that these parameters are enabled as the DC excitation function parameters when the servo parameter #2234/bit4(SV034/bit4) is set to "1".

【#2217(PR)】 SV017  SPEC1  Servo specification 1

bit 0 : mdir  Main side encoder feedback (for direct-drive motor)
Set the encoder installation polarity in the direct-drive motor control.
0: Forward polarity   1: Reverse polarity

【#2228(PR)】 SV028  MSFT  Magnetic pole shift amount (for direct-drive motor)
Set this parameter to adjust the motor magnetic pole position and encoder's installation phase when using direct-drive motors.
During the DC excitation of the initial setup (SV034/bit4=1), set the same value displayed in "AFLT gain" on the NC monitor screen.
Related parameters: SV034/bit4, SV061, SV062, SV063

---Setting range---
-18000 to 18000 (Mechanical angle 0.01°)

【#2234】 SV034  SSF3  Servo function 3

bit 4 : dcd  (direct-drive motor)
0: Normal setting   1: DC excitation mode
Related parameters: SV061, SV062, SV063

【#2261】 SV061  DA1NO  D/A output ch1 data No. / Initial DC excitation level
Input the data number you wish to output to the D/A output channel 1. When using the multi-axis drive unit, set "+1" to the axis that the data will not be output.

When the DC excitation is running (SV034/bit4=1):
Use this when the DC excitation is running (SV034/bit4=1) to adjust the initial setup (when measuring the magnetic pole shift amount) for direct-drive motor.
Set the initial excitation level in DC excitation control.
Set 10% as standard.
Related parameters: SV034/bit4, SV062, SV063

---Setting range---
-1 to 127
When the DC excitation is running (SV034/bit4=1): 0 to 100 (Stall current %)

【#2262】 SV062  DA2NO  D/A output ch2 data No. / Final DC excitation level
Input the data number you wish to output to the D/A output channel 2. When using the multi-axis drive unit, set "+1" to the axis that the data will not be output.

When the DC excitation is running (SV034/bit4=1):
Use this when the DC excitation is running (SV034/bit4=1) to adjust the initial setup (when measuring the magnetic pole shift amount) for direct-drive motor.
Set the final excitation level in DC excitation control.
Set 10% as standard.
Related parameters: SV034/bit4, SV061, SV063

---Setting range---
-1 to 127
When the DC excitation is running (SV034/bit4=1): 0 to 100 (Stall current %)
7 Setup

7.3 Initial Setup for Direct-drive Motor System When Using MBA405W

This section explains the initial setup procedures when using MBA405W.

⚠️ CAUTION

1. Perform the initial setup after the operation is enabled for NC system.
2. The initial setup is required for each direct-drive motor.
3. Perform the initial setup again after replacing the encoder.
4. For the initial setup, the main head of MBA405W is required to detect Z-phase signal (Z-phase signal position mark needs to pass the main head). If the structure does not allow the magnetic drum to turn move than one revolution, reinstall it so that Z-phase passes the main head within the shaft stroke.

7.3.1 Adjustment Procedure

Although MBA405W is an absolute position encoder, it needs to pass Z-phase at the initial power ON before the initial setup (DC excitation) is carried out.

Therefore, when using it with a direct-drive motor, drive the motor until the encoder passes the Z-phase by initial magnetic pole estimate. After the Z-phase has been passed, turn the NC power ON again to decide the absolute position within one revolution.

After deciding the absolute position, execute the DC excitation function in the same manner as for the other absolute encoders to decide the magnetic pole shift amount.

<Initial magnetic pole estimate function>

1. Set the incremental control (#2049 type to 0).
2. Set the parameters related to the initial magnetic pole estimate function (#2321(SV121) to 33, #2322(SV122) to Standard VGN1, and #2323(SV123) to 1364).
   -> Standard VGN1 is set depending on the load inertia scale for #2322(SV122). (Refer to "8.1.1 Speed loop gain").
3. Turn the NC power ON again.
   -> Confirm that the warning during initial setup for the absolute position (A3) occurs.
   -> Select the [Servo diag] and [Servo unit] menus on the NC maintenance screen, and confirm that [Motor end encoder] displays "MB*405W".
4. Release the emergency stop.
5. The LED on the drive unit changes to "Cx" and the direct-drive motor moves by little and little for about five seconds (start initial magnetic pole estimate).
6. Confirm that the LED on the drive unit changes to "dx" and the motor stops (terminate initial magnetic pole estimate).


<Confirmation of encoder installation polarity>
(7) Drive the direct-drive motor until the Z-phase has been detected with handle feed (select the minimum pulse magnification).
  -> Switch to the [Servo diagn] menu on the NC maintenance screen, select [Servo unit] and confirm [Control output 2/bit0(ZCN) *Z-phase passed] is "1".
(8) Switch to the [Servo diagn] menu on the NC maintenance screen, select [Servo unit] and check [Load current]. Also check if any alarm is occurring.
  -> The encoder installation polarity may be reverse if the current value reaches to the current limit or any alarm occurs. Set the servo parameter #2217/bit0(SV017/bit0) to "1" and perform (4) to (8) again after turning the NC power ON again.
(9) Turn ON the emergency stop.
(10) Set the parameter (NC system side) for enabling the absolute position control (#2049(type) = the absolute position zero point alignment method to be used).
(11) Release the parameters related to the initial magnetic pole estimate function (#2321(SV121) to 0, #2322(SV122) to 0, and #2323(SV123) to 0).
(12) Turn the NC power ON again.
(13) Confirm that the warning during initial setup for the absolute position (A3) is released and [Motor end encoder] displays "MBA405W".

<DC excitation function>
(14) Set the servo parameter #2213(SV013) to 100.
(15) Set the parameters related to the DC excitation (#2261(SV061) to 10, #2262(SV062) to 10, and #2263(SV063) to 1000).
(16) Set the servo parameter #2234/bit4(SV034/bit4) to "1" to enable the DC excitation mode.
(17) Release the emergency stop.
(18) Confirm that the direct-drive motor carries out a reciprocation operation between about ±10° and 20° once (start DC excitation).
(19) Confirm that the direct-drive motor stops after the reciprocation operation.
(20) Switch to the [Servo diagn] menu on the NC maintenance screen, select [Servo unit] and monitor [AFLT gain].
(21) Turn ON the emergency stop (terminate DC excitation).
(22) Repeat (17) to (21) 5 times, and monitor the ALFT gain value (magnetic pole shift amount) each time.
  If difference of the magnetic pole shift amounts is 1000 data or bigger, reset the related parameter settings (#2261(SV061)=+10, #2262(SV062)=+10) and perform (17) to (21) again.
(23) Calculate the average of the magnetic pole shift amounts, and set it to #2228(SV028).
(24) Return the servo parameter #2234/bit4(SV034/bit4) back to the original setting, "0".
(25) Turn the NC power ON again.
(26) Return the servo parameter #2213(SV013) back to the original setting after confirming the initial setup.

⚠️ CAUTION

1. Alarm 37 / error number 2454 is detected before the initial setup operation, but this is not a fault. The alarm will be cleared after the initial setup is completed and by turning the NC power ON again.
2. The NC monitor displays "MB*405W" before the initial setup is completed. It will be correctly displayed as "MBA405W" after the initial setup is completed.
Initial setup procedures for direct-drive motor (when using MBA405W)

When using MBA405W, perform the initial setup for the direct-drive motor by following the steps in the flow diagram below.

1. **Connect the battery.**
2. **Perform under an emergency stop state.**
3. **Start the initial setup.**
4. **[1] NC power ON.**
5. **[2] Set the incremental control.**
   - NC system side parameter “#2049 type = 0”.
6. **[3] Set the parameters related to the initial magnetic pole estimate.**
   - SV121(Kyp) = 33
   - SV122(Kvp) = Standard VGN1
   - SV123(Kvi) = 136
7. **[4] Drive LED displays “MB*405W” at initial setup.**
8. **[5] Release the emergency stop (start initial magnetic pole estimate).**
9. **[6] NC power ON again.**
10. **[7] Drive the direct-drive motor with handle feed, etc.**
    - Check the AFLT gain (magnetic pole shift amount) on the drive monitor screen.
11. **[8] Emergency stop.**
    - NC monitor displays “MB*405W” at initial setup.
12. **[9] Set the parameter for enabling the absolute position control.**
    - NC system side parameter “#2049 type = 0”.
    - Release the parameters related to the initial magnetic pole estimate.
    - SV121(Kyp) to SV124(ILMTmp) = 0
13. **[10] NC power ON again.**
14. **[11] Encoder type is MBA405W, and A3 on the drive LED is OFF?**
    - “Diagn” → “Drv mon” → “Drive unit display”
    - “Diagn” → “Drv mon” → “Motor end encoder”
15. **[12] Set the current limit.**
    - SV013(ILMT) = 100%
16. **[13] Set the magnetic pole adjustment (DC excitation) mode.**
    - SV034(SF3)/bit0(dcd) = 1
17. **[14] Set the DC excitation-related parameters.**
    - SV063(DA1MPY) = 100[ms]
18. **[15] Release the emergency stop (start DC excitation mode).**
19. **[16] Does the axis (direct-drive motor) carry out a reciprocation operation once?**
    - “Control output2/bit0” changes from “0” to “1” on NC monitor display.
20. **[17] Check the AFLT gain (magnetic pole shift amount) on the drive monitor screen.**
21. **[18] Turn ON the emergency stop (terminate DC excitation).**
22. **[19] Check the setting for encoder installation polarity if an alarm occurs.**
    - “Diagn” → “Drv mon” → “Drive unit display”
    - “Diagn” → “Drv mon” → “Motor end encoder”
23. **[20] Set the current limit.**
    - SV013(ILMT) = 100%
24. **[21] NC power ON again.**
25. **[22] Release the magnetic pole adjustment (DC excitation) mode.**
    - SV063(DA1MPY) = 0
26. **[23] Drive LED displays “Cx” during initial magnetic pole estimate.**
27. **[24] Check the NC monitor display for encoder type = “MB405W” display.**
    - Check whether Z-phase is passed.
28. **[25] NC power ON again.**
29. **[26] Change the parameter setting value for SV122(Kvp) to “+300” and NC power ON again (Alarm 16 is released).**
30. **[27] Check the setting for encoder installation polarity if an alarm occurs.**
    - “Diagn” → “Drv mon” → “Drive unit display”
    - “Diagn” → “Drv mon” → “Motor end encoder”
31. **[28] Drive LED displays “dx”? (terminate initial magnetic pole estimate).**
    - “Diagn” → “Drv mon” → “Drive unit display”
    - “Diagn” → “Drv mon” → “Motor end encoder”
32. **[29] Set the average of magnetic pole shift amounts to SV028(MSFT).**
33. **[30] Connect the battery.**
34. **[31] Do not leave the emergency stop state for a long time.**
35. **[32] Turn the drive unit and NC power ON again if the alarm 25 occurs.**
36. **[33] Check the parameter setting value for SV122(Kvp) to “+300” and NC power ON again (Alarm 16 is released).**
37. **[34] Drive LED displays “dx”? (terminate initial magnetic pole estimate).**
38. **[35] Emergency stop.**
39. **[36] Drive LED displays “Cx” during initial magnetic pole estimate.**
40. **[37] Initial setup completed.**
7.3.2 Related Parameters

For the initial setup when using MBA405W, the following parameters are required to be set in addition to those related to the DC excitation function. If the initial setup for MBA405W is performed before setting these parameters, an alarm for Initial parameter error (37) occurs.

### [#2321] SV121 Kpp Magnetic pole detection position loop gain

Set this parameter to adjust the motor magnetic pole position and encoder's installation phase at using MBA405W.
Set the position loop gain in the magnetic polar detection loop at the initial magnetic polar detection.

The initial magnetic polar detection is performed for the direct-drive motor which uses MBA405W as the motor side encoder.

Related parameters : SV122,SV123,SV124

--- Setting range---
0 to 32767

### [#2322] SV122 Kvp Magnetic pole detection speed loop gain

Set this parameter to adjust the motor magnetic pole position and encoder's installation phase at initial setup when using MBA405W.
Set the speed loop gain in the magnetic polar detection loop at the initial magnetic polar detection.

The initial magnetic polar detection is performed for the direct-drive motor which uses MBA405W as the motor side encoder.

Related parameters : SV121,SV123,SV124

--- Setting range---
0 to 32767

### [#2323] SV123 Kvi Magnetic pole detection speed loop lead compensation

Set this parameter to adjust the motor magnetic pole position and encoder's installation phase at initial setup when using MBA405W.
Set the speed loop lead compensation in the magnetic polar detection loop at the initial magnetic polar detection.

The initial magnetic polar detection is performed for the direct-drive motor which uses MBA405W as the motor side encoder.

Related parameters : SV121,SV122,SV124

--- Setting range---
0 to 32767

### [#2324] SV124 ILMTmp Initial magnetic polar estimate/current limit value

Set this parameter to adjust the motor magnetic pole position and encoder's installation phase at initial setup when using MBA405W.
Set the current (torque) limit value in the magnetic polar detection loop at the initial magnetic polar detection.

The initial magnetic polar detection is performed for the direct-drive motor which uses MBA405W as the motor side encoder.
When set to "0", use SV014(ILMTsp) for the current limit at the initial magnetic polar estimate.

Related parameters : SV121,SV122,SV123

--- Setting range---
0 to 200
(Stall current %)
7.4 Protective Functions List of Units

The protective functions related to the direct-drive motor system are shown below.

7.4.1 Drive Unit Alarm

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Details</th>
<th>Reset method</th>
<th>Stop method</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>Initial magnetic pole position detection error</td>
<td>- In the direct-drive motor which uses the absolute position encoder, the servo ON has been set before the magnetic pole shift amount (SV028) is set. - The magnetic pole position, detected in the initial magnetic pole estimate function at initial setup when using MBA405W, is not correctly estimated.</td>
<td>PR</td>
<td>Dynamic stop</td>
</tr>
<tr>
<td>25</td>
<td>Absolute position data tool</td>
<td>- An incorrect set value was detected among the parameters sent from the NC at the power ON.</td>
<td>AR</td>
<td>Initial error</td>
</tr>
<tr>
<td>37</td>
<td>Initial parameter error</td>
<td>- The absolute position data was lost in the encoder.</td>
<td>PR</td>
<td>Initial error</td>
</tr>
<tr>
<td>3E</td>
<td>Magnetic pole position detection error</td>
<td>- The magnetic pole position, detected in the magnetic pole position detection control, is not correctly detected. The setting of magnetic pole shift amount (SV028) is not reliable.</td>
<td>AR</td>
<td>Dynamic stop</td>
</tr>
<tr>
<td>46</td>
<td>Motor overheat / Thermal error</td>
<td>- An overheat is detected on the motor. - The thermistor signal receiving circuit of the linear motor or direct-drive motor was disconnected. - The thermistor signal receiving circuit was short-circuited.</td>
<td>NR</td>
<td>Deceleration stop</td>
</tr>
<tr>
<td>51</td>
<td>Overload 2</td>
<td>- Current command of 95% or more of the unit's max. current was given continuously for 1 second or longer. - The encoder installation polarity (SV17/bit0) may be reverse.</td>
<td>NR</td>
<td>Deceleration stop</td>
</tr>
<tr>
<td>52</td>
<td>Excessive error 1</td>
<td>- A position tracking error during servo ON was excessive.</td>
<td>NR</td>
<td>Deceleration stop</td>
</tr>
</tbody>
</table>

(Note) Resetting methods

NR : Reset with the NC RESET button. This alarm can also be reset with the PR and AR resetting conditions.
PR : Reset by turning the NC power ON again. This alarm can also be reset with the AR resetting conditions.
When the control axis is removed, this alarm can be reset with the NC RESET button. (Excluding alarms 32 and 37.)
AR : Reset by turning the NC and servo drive unit power ON again.

Encoder alarm (Servo drive unit)

<table>
<thead>
<tr>
<th>Alarm number when the encoder is connected to CN2 side</th>
<th>2B</th>
<th>2C</th>
<th>2D</th>
<th>2E</th>
<th>4B</th>
<th>49</th>
<th>4A</th>
<th>4B</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBA405W</td>
<td>CPU error</td>
<td>Waveform error</td>
<td>Data error</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Count error</td>
</tr>
<tr>
<td>RCN223M, RCN723M, RCN272M, RCN827M, RCN827M</td>
<td>HEIDENHAIN</td>
<td>Initialization error</td>
<td>EEPROM error</td>
<td>Relative/absolute position data mismatch</td>
<td>ROM-RAM error</td>
<td>CPU error</td>
<td>Overspeed</td>
<td>Absolute position data error</td>
</tr>
<tr>
<td>MPRZ scale</td>
<td>Mitsubishi Heavy Industries Machine Tool</td>
<td>Installation accuracy fault</td>
<td>-</td>
<td>Detection position deviation</td>
<td>Scale breaking</td>
<td>Absolute value detection fault</td>
<td>-</td>
<td>Gain fault</td>
</tr>
<tr>
<td>RU77</td>
<td>Magnescale</td>
<td>Laser diode error</td>
<td>System memory error</td>
<td>Encoder mismatch error</td>
<td>-</td>
<td>-</td>
<td>Overspeed</td>
<td>Absolute position data error</td>
</tr>
<tr>
<td>HAM Series</td>
<td>FAGOR</td>
<td>-</td>
<td>-</td>
<td>Absolute value detection error</td>
<td>HW error</td>
<td>CPU error</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>RA Series</td>
<td>Renishaw</td>
<td>Initialization error</td>
<td>-</td>
<td>Absolute position data error</td>
<td>-</td>
<td>-</td>
<td>Over speed</td>
<td>-</td>
</tr>
</tbody>
</table>

(Note) A drive unit processes all reset types of alarms as “PR”. However, “AR” will be applied according to the encoder.
7.4.2 Drive Unit Warning

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Details</th>
<th>Reset method</th>
<th>Stop method</th>
</tr>
</thead>
<tbody>
<tr>
<td>A3</td>
<td>Distance-coded reference check / initial setup warning</td>
<td>This warning is detected during the initial setup of MBA405W. This warning turns OFF after the initial setup is completed when the axis has passed the Z-phase of MBA405W and the NC power has been turned again.</td>
<td>PR</td>
<td>-</td>
</tr>
<tr>
<td>E4</td>
<td>Parameter warning</td>
<td>An incorrect set value was detected among the parameters send from the NC in the normal operation.</td>
<td>*</td>
<td>-</td>
</tr>
</tbody>
</table>

(Note 1) A drive unit processes all reset types of alarms as "PR". However, "AR" will be applied according to the encoder.

(Note 2) Resetting methods:
* : Automatically reset once the cause of the warning is removed.
PR : Reset with the NC RESET button. This warning can also be reset with the PR and AR resetting conditions.
AR : Reset by turning the NC and servo drive unit power ON again.

(Note 3) Direct-drive motor does not stop when the warning occurs.

(Note 4) When an emergency stop is input, direct-drive motor decelerates to a stop. (When SV048, SV055 or SV056 is set.)
7.4.3 Parameter Numbers During Initial Parameter Error

If an initial parameter error (alarm 37) or set parameter warning (warning E4) occurs, the axis name and the No. of the error parameter that exceeds the setting range will appear on the NC Diagnosis screen as shown below:

<table>
<thead>
<tr>
<th>Error parameter No.</th>
<th>Details</th>
<th>Related parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>2454</td>
<td>The parameter for enabling the absolute position control (#2049 type) is set before the initial setup is completed when MBA405W is connected.</td>
<td>#2049</td>
</tr>
<tr>
<td>2217</td>
<td>The motor selected is of a motor series different from the drive unit's input voltage (200V/400V). Or a motor of an incompatible motor series is selected.</td>
<td>SV017</td>
</tr>
<tr>
<td>2219</td>
<td>In a semi-closed loop control system, the setting value of SV019 is different from that of SV020. Set them to the same value. -SV019 is set to a value outside the setting range.</td>
<td>SV019</td>
</tr>
<tr>
<td>2220</td>
<td>The resolution of the motor side encoder actually connected is not consistent with the setting value for SV020. -SV020 is set to a value outside the setting range.</td>
<td>SV020</td>
</tr>
<tr>
<td>2225</td>
<td>Incompatible motor type is selected. The machine side encoder type or the motor side encoder type is incorrectly set.</td>
<td>SV017, SV025</td>
</tr>
<tr>
<td>2228</td>
<td>The DC excitation mode (SV034/bit4) is set in the following conditions: -when the NC is powered ON -when a general servo motor (not a built-in motor) is used.</td>
<td>SV028</td>
</tr>
<tr>
<td>2234</td>
<td>The DC excitation mode (SV034/bit4) is set in the following conditions: -when the NC is powered ON -when a general servo motor (not a built-in motor) is used.</td>
<td>SV034</td>
</tr>
<tr>
<td>2261</td>
<td>When the DC excitation mode (SV034/bit4) is set, the initial DC excitation level (SV061) is set to a value outside the setting range.</td>
<td>SV034, SV061</td>
</tr>
<tr>
<td>2262</td>
<td>When the DC excitation mode (SV034/bit4) is set, the final DC excitation level (SV062) is set to a value outside the setting range.</td>
<td>SV034, SV062</td>
</tr>
<tr>
<td>2263</td>
<td>When the DC excitation mode (SV034/bit4) is set, the initial DC excitation time (SV063) is set to a value outside the setting range.</td>
<td>SV034, SV063</td>
</tr>
<tr>
<td>2317</td>
<td>• The expansion sub side encoder resolution (SV117) is set to “0” for an encoder that requires the resolution expansion setting. If the upper 16 bits for the encoder resolution are 0, this should be set to “-1”. • The expansion sub side encoder resolution (SV117) is set to a value other than “0” for an encoder that does not support the resolution expansion setting.</td>
<td>SV019,SV025,SV117</td>
</tr>
<tr>
<td>2318</td>
<td>• The expansion main side encoder resolution (SV118) is set to “0” for an encoder that requires the resolution expansion setting. If the upper 16 bits for the encoder resolution are 0, this should be set to “-1”. • The expansion main side encoder resolution (SV118) is set to a value other than “0” for an encoder that does not support the resolution expansion setting.</td>
<td>SV020,SV025,SV118</td>
</tr>
<tr>
<td>2321</td>
<td>Magnetic pole detection position loop gain (SV121) is not set at initial setup when MBA405W is connected.</td>
<td>SV121</td>
</tr>
<tr>
<td>2322</td>
<td>Magnetic pole detection speed loop gain (SV122) is not set at initial setup when MBA405W is connected.</td>
<td>SV122</td>
</tr>
<tr>
<td>2323</td>
<td>Magnetic pole detection speed loop lead compensation (SV123) is not set at initial setup when MBA405W is connected.</td>
<td>SV123</td>
</tr>
</tbody>
</table>
8.1 Servo Adjustment Procedure

The servo parameters must be set before the direct-drive motor can be started up. The servo parameters are input from the NC. The input method differs according to the NC being used, so refer to each NC Instruction Manual.

When setting the initial setting parameters, perform the following settings.

![Diagram of Servo Adjustment Procedure]

- **CAUTION**
  Perform adjusting the servo in the factory configuration of the machine. When the servo is adjusted without having an enough running-in or a cover, friction force, machine resonance frequency or resonance gain may be different, resulting in an incorrect adjustment.

Refer to the Instruction Manual of each drive unit for details on the adjustment method required for each setting.
8.1.1 Speed Loop Gain

1. Setting the speed loop gain

The speed loop gain 1 (SV005: VGN1) is an important parameter for determining the responsiveness of the servo control. During servo adjustment, the highest extent that this value can be set to becomes important. The setting value has a large influence on the machine cutting precision and cycle time.

[1] Refer to the following standard VGN1 graphs and set the standard VGN1 according to the size of the entire load inertia (motor and machine load inertia).

[2] If the standard VGN1 setting value is exceeded, the current command fluctuation will increase even if the speed feedback fluctuates by one pulse. This can cause the machine to vibrate easily, so set a lower value to increase the machine stability.

< When machine resonance does not occur at the standard VGN1 >

Set the standard VGN1. Use the standard value if no problem (such as machine resonance) occurs. If sufficient cutting precision cannot be obtained at the standard VGN1, VGN1 can be raised above the standard value as long as a 70 percent margin in respect to the machine resonance occurrence limit is maintained. The cutting accuracy can also be improved by adjusting with the disturbance observer.

< When machine resonance occurs at the standard VGN1 >

Machine resonance is occurring if the shaft makes abnormal sounds when operating or stopping, and a fine vibration can be felt when the machine is touched while stopped. Machine resonance occurs because the servo control responsiveness includes the machine resonance points. (Speed control resonance points occur, for example, at parts close to the motor such as ball screws.) Machine resonance can be suppressed by lowering VGN1 and the servo control responsiveness, but the cutting precision and cycle time are sacrificed. Thus, set a vibration suppression filter and suppress the machine resonance (Refer to section "4-4-2 Vibration suppression measures"), and set a value as close as possible to the standard VGN1. If the machine resonance cannot be sufficiently eliminated even by using a vibration suppression filter, then lower the VGN1.

【#2205】SV005 VGN1 Speed loop gain 1

Set the speed loop gain.
The higher the setting value is, the more accurate the control will be, however, vibration tends to occur.
If vibration occurs, adjust by lowering by 20 to 30%.
The value should be determined to the 70 to 80% of the value at which the vibration stops.
The value differs depending on servo motors.
Aim at the standard value determined by the servo motor type and load inertia ratio to adjust.

---Setting range---
1 to 30000

POINT

1. Suppressing the resonance with the vibration suppression function and increasing the VGN1 setting is effective for adjusting the servo later.

2. When performing "Velocity loop gain adjustment" automatically with NC Analyzer for direct-drive motor system, select "Linear/DD motor (normal)" for "Velocity loop gain adjustment level" -> "Upper limit" in the Selection of adjustment item screen. If the adjusted VGN1 reaches the upper limit (=1000), select "Linear/DD motor (special)" and adjust it again.

3. If "Gain Margin" or "Cross Frequency", the result of "Frequency response measurement" with NC Analyzer, displays "N/ A" for the direct-drive motor system, the setting for VGN1 may be too small. Raise the setting value until the "N/A" display switches to a numerical value.
Load inertia ratio display
Perform the measurement referring to the section "(1) Measuring unbalance torque and frictional torque" of "Improvement of protrusion at quadrant changeover" in Instruction Manual of each drive unit, and set a torque offset (SV032) and frictional torque (SV045). When an acceleration/deceleration operation is executed with the setting of SV035/bitF=1, an estimated load inertia ratio will be displayed in "load inertia ratio " on the drive monitor screen.

Standard VGN1 graph (direct-drive motor TM-RB Series)
< MDS-E and MDS-D2 Series >
< MDS-EJ and MDS-DJ Series >

[TM-RBP012C20]

Isolated motor

Load inertia magnification (%)

Standard VGN1

[TM-RBP036E20]

Isolated motor

Load inertia magnification (%)

Standard VGN1

[TM-RBP048G20]

Isolated motor

Load inertia magnification (%)

Standard VGN1

[TM-RBP105G10]

Isolated motor

Load inertia magnification (%)

Standard VGN1
8 Servo Adjustment
## Revision History

<table>
<thead>
<tr>
<th>Date of revision</th>
<th>Manual No.</th>
<th>Revision details</th>
</tr>
</thead>
</table>
| Aug. 2013        | IB(NA)1501068-B | - "WARRANTY" was revised.  
- The explanation for CN3 was added to "Twin-head magnetic encoder (MBA Series)".  
- MBA405W was added to "System configuration" and "Cable connection diagram".  
- The motor thermistor cable connection diagram was added to "List of cables and connectors".  
- "Grobal Service Network" was revised. |
| Aug. 2016        | IB(NA)1501068-C | - Descriptions for MDS-E/EH Series and MDS-EJ Series were added.  
- The words "detector" were replaced by "encoder".  
- "Precautions for Safety" was revised.  
- "System Configuration" was revised.  
- "Specifications List" and "Outline Dimension Drawings" were revised.  
- "Overload Protection Characteristics" and "Dynamic Brake Characteristics" were revised.  
- "Encoder system options" and "Cables and Connectors" were revised.  
- "Selection of the Power Supply Unit" was revised.  
- "Installing Twin-head Magnetic Encoder (MBA405W Series)" was revised.  
- "Setting the Initial Parameters for the Direct-drive Motor" was revised.  
- "Initial Setup for Direct-drive Motor System When Using MBA405W" was revised.  
- "Protective Functions List of Units" was revised.  
- "Speed Loop Gain" was revised.  
- "Grobal Service Network" was revised.  
- Miswrite is corrected. |
Global Service Network

AMERICA

MITSUBISHI ELECTRIC AUTOMATION INC. (AMERICA FA CENTER)

Central Region Service Center (Chicago)
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**Notice**

Every effort has been made to keep up with software and hardware revisions in the contents described in this manual. However, please understand that in some unavoidable cases simultaneous revision is not possible. Please contact your Mitsubishi Electric dealer with any questions or comments regarding the use of this product.

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Specifications are subject to change without notice.