MITSUBISHI ELECTRIC
Changes for the Better

Numerical Control (CNC)

Specifications Manual

MDS-E/EH Series

IB-1501226(ENG)-L

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.
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 tool builders. The "restrictions" and "available functions" described in the manuals issued by the machine tool builders 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.
(3) The characteristic values and numerical values without tolerances mentioned in this manual are representative values.

In this manual, the following abbreviations might be used.
MTB: Machine tool builder

Precautions for Safety

Please read this manual and auxiliary documents before starting installation, operation, maintenance or inspection to ensure correct usage. Thoroughly understand the device, safety information and precautions before starting operation.
The safety precautions in this instruction manual are ranked as "WARNING" and "CAUTION".

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

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

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

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

The signs indicating prohibited and mandatory matters are explained below.

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

The meaning of each pictorial sign is as follows.

CAUTION	**CAUTION rotated object**	**CAUTION HOT**	**Danger Electric shock risk**	**Danger explosive**
Prohibited	**Disassembly is prohibited**	**KEEP FIRE AWAY**	**General instruction**	**Earth ground**

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

POINT

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

⚠ WARNING

1. Electric shock prevention

- **Make sure the power is shut OFF before connecting a unit and a motor to the power.**
- **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/SPM spindle motor, if the rotor is rotated by hand etc., voltage occurs between the terminals of lead. Take care not to get electric shocks.**

⚠ WARNING

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/SPM 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/SPM 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.

⚠ **Incorrect wiring could lead to smoke or fire in the unit and the reactor, resulting in faults. Be careful when wiring.**

⚠ CAUTION

1. Fire prevention

- ⚠ **Install the units, motors and regenerative resistor on non-combustible material. Direct installation on combustible material or near combustible materials could lead to fires.**
- ⚠ **Always install a circuit protector and contactor on the servo drive unit power input as explained in this manual. Refer to this manual and select the correct circuit protector and contactor. An incorrect selection could result in fire.**
- ⚠ **Shut off the power on the unit side if a fault occurs in the units. Fires could be caused if a large current continues to flow.**
- ⚠ **When using a regenerative resistor, provide a sequence that shuts off the power with the regenerative resistor's error signal. The regenerative resistor could abnormally overheat and cause a fire due to a fault in the regenerative transistor, etc.**
- ⚠ **The battery unit could heat up, ignite or rupture if submerged in water, or if the poles are incorrectly wired.**
- ⚠ **Cut off the main circuit power with the contactor when an alarm or emergency stop occurs.**

2. Injury prevention

- ⚠ **Do not apply a voltage other than that specified in this manual, on each terminal. Failure to observe this item could lead to ruptures or damage, etc.**
- ⚠ **Do not mistake the terminal connections. Failure to observe this item could lead to ruptures or damage, etc.**
- ⚠ **Do not mistake the polarity (+,-). 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.**

⚠ CAUTION

3. Various precautions

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

(1) Transportation and installation

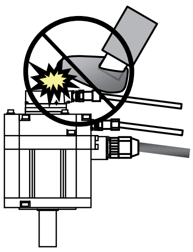
⚠ **Correctly transport the product according to its weight.**

❗ **Use the motor's hanging bolts only when transporting the motor itself. Do not use the motor's hanging bolts to transport a motor with other parts installed, or to transport a machine with a motor installed.**

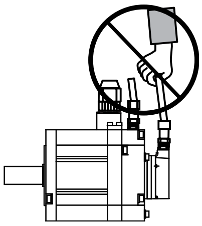
⚠ **Do not stack the products above the tolerable number.**

⚠ **Follow this manual and install the unit or motor securely in a place where it can be borne and noncombustible. Insufficient fixing could lead to the unit or the motor slipping off during operation.**

⚠ **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.**

⚠ **Always operate the motor, which has a shaft with keyway, with the key attached.**

⚠ CAUTION

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

Environment	Unit	Servo motor	Spindle motor
Ambient temperature	Operation: 0 to +55°C (with no freezing), Storage / Transportation: -15°C to +70°C (with no freezing)	Operation: 0 to +40°C (with no freezing), Storage: -15°C to +70°C (with no freezing)	Operation: 0 to +40°C (with no freezing), Storage: -20°C to +65°C (with no freezing)
Ambient humidity	Operation: 90%RH or less (with no dew condensation) Storage / Transportation: 90%RH or less (with no dew condensation)	Operation: 80%RH or less (with no dew condensation), HK(-H) Series: 10 to 90%RH or less (with no dew condensation) Storage: 90%RH or less (with no dew condensation) HK(-H) Series: 10 to 90%RH or less (with no dew condensation)	Operation: 90%RH or less (with no dew condensation) Storage: 90%RH or less (with no dew condensation)
Atmosphere	Indoors (no direct sunlight) With no corrosive gas, inflammable gas, oil mist, dust or conductive fine particles No object generating a strong magnetic field External magnetic field: 10 mT or less		
Altitude	Operation/Storage: 1000 meters or less above sea level, Transportation: 13000 meters or less above sea level	Operation/Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level	
Vibration/impact	According to each unit or motor specification		

(Note) For details, confirm each unit or motor specifications in addition.

⚠ CAUTION

⚠ 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/SPM 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/SPM 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, Sales Office or dealer.

⚠ Install the heavy peripheral devices to the lower part in the panel and securely fix it not to be moved due to vibration.

⚠ CAUTION

(2) Wiring

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

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

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

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

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

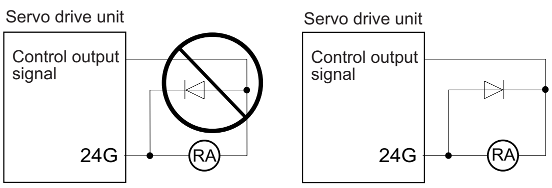
⚠ **Always connect the motor to the drive unit's output terminals (U, V, W).**

⚠ **Do not directly connect a commercial power supply to the 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 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.**

CAUTION

(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, 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.
- This unit is not intended for use in low voltage public networks that supply power to households. Using this unit in such networks may cause radio frequency interference.
- Do not use this unit in residential areas.

(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.
- 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.

⚠ CAUTION

(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.**

⚠ **Never perform a megger test (measure the insulation resistance) of the drive unit. Failure to observe this could lead to faults.**

⚠ **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 tool builders.**

⚠ **For maintenance, part replacement, and services in case of failures in the built-in motor (including the encoder), take necessary actions at the machine tool builders. 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 industrial wastes.**

⚠ **Do not disassemble the unit or motor.**

⚠ **Dispose of the battery according to local laws.**

⚠ **Dispose of the primary side of the linear servo motor as industrial waste. For the secondary side, dispose of it as industrial waste after demagnetizing it by heating it to 300°C or higher.**

⚠ **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 Electric recommends sorting the product and selling the members to appropriate contractors.

(2) Requirements for "Law for Treatment of Waste and Cleaning"
   (a) Mitsubishi Electric 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

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 지역에 서 사용하는 것을 목적으로 합니다 .

WARRANTY

Please confirm the following product warranty details before using Mitsubishi Electric 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, repair services shall be provided at no cost through the distributor from which the product was purchased or through a Mitsubishi Electric service provider. Note, however, that this does not apply if the customer was informed prior to purchasing 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 the product to the end user, provided the product purchased from Mitsubishi Electric or a distributor in Japan is installed in Japan (but in no event longer than thirty (30) months, including distribution time after shipment from Mitsubishi Electric or a distributor).
Note that, in the case where the product purchased from Mitsubishi Electric or a distributor 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" below.

[Limitations]
(1) The machine tool builder is requested to conduct an initial failure diagnosis, as a general rule. The diagnosis may also be carried out by Mitsubishi Electric or our service provider for a fee at the machine tool builder's request.
(2) This warranty applies only when the conditions, method, environment, etc., of use are in compliance with the terms, 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 will 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 a problem with the customer's hardware or software
  (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 could have been avoided if consumable parts designated in the instruction manual, etc. had been duly maintained and replaced
  (e) any replacement of consumable parts (including the 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 earthquakes, lightning, and natural disasters
  (g) a failure which could not have been foreseen under technologies available at the time of shipment of this product from Mitsubishi Electric
  (h) any other failures which are not attributable to Mitsubishi Electric or which the customer acknowledges are not attributable to Mitsubishi Electric

2. Service in Overseas Countries

If the customer installs a product purchased from Mitsubishi Electric in a machine or equipment and exports it to any country other than where it was purchased, the customer may sign a paid warranty contract with our local FA center.
This applies in 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 product was purchased.

3. Exclusion of Responsibility for Compensation against Loss of Opportunity, Secondary Loss, etc.

Regardless of the gratis warranty term, Mitsubishi Electric shall not be liable for compensation for:
(1) Damage arising from any cause found not to be the responsibility of Mitsubishi Electric.
(2) Lost opportunity or lost profit incurred by the user due to a failure of a Mitsubishi Electric product.
(3) Special damage or secondary damage, whether foreseeable or not, compensation for accidents, and compensation for damages to products other than Mitsubishi Electric 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 use of this product, applications should be those that will not result in a serious damage even if a failure or malfunction occurs in the product, and a backup or failsafe function should operate on an external system when any failure or malfunction occurs to the product.
(2) Mitsubishi Electric CNC is designed and manufactured solely for applications to machine tools for industrial purposes.
Do not use this product in applications other than those specified above, especially those which have substantial influence on public interest or which are expected to have significant influence on human lives or properties.

Contents

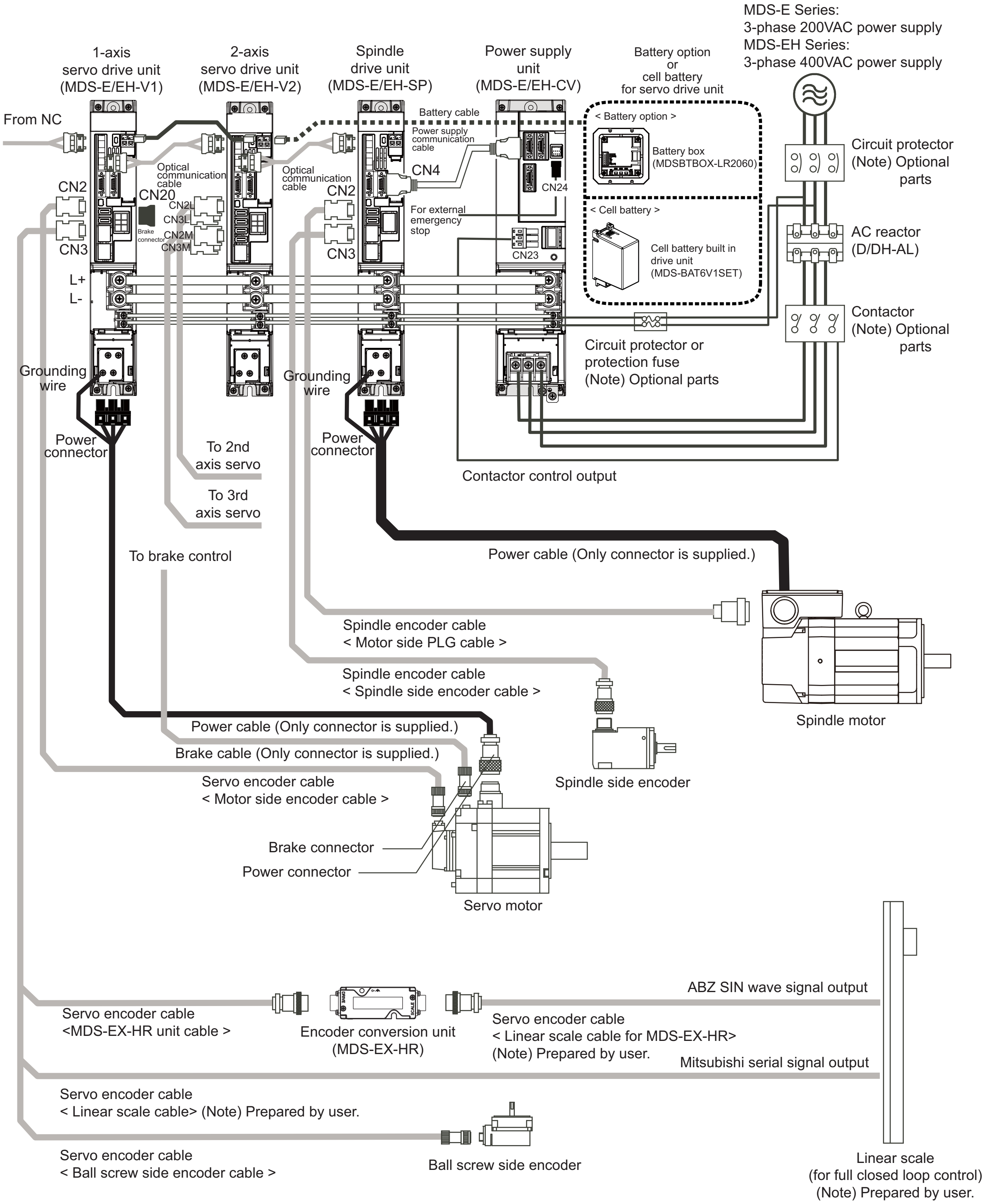
Outline for MDS-E/EH Series Instruction Manual (IB-1501229(ENG)-K)

1

Introduction

1.1 Servo/Spindle Drive System Configuration

1.1.1 System Configuration

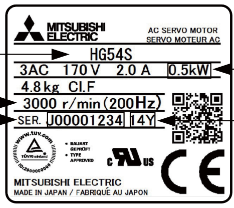


(Note) For details of cables and connectors, refer to "List of Cables and Connectors" later in this manual.

1.2 Explanation of Type

1.2.1 Servo Motor Type

Motor type
Rated rotation speed
Serial No.



Rated output
Date of manufacture
•109:September, 2010
•13Y:November, 2013
(X:October,Y:November,Z:December)

Motor rating nameplate

(1) 200V series

< HG Series >

HG (1) (2) (3) - (4) - (5)

(1) Rated output · Maximum rotation speed

Symbol	Rated output	Maximum rotation speed	Flange size (mm)
46	0.2 kW	6000 r/min	60 SQ.
56	0.4 kW	6000 r/min	60 SQ.
96	0.75 kW	6000 r/min	80 SQ.
75	0.75 kW	5000 r/min	90 SQ.
105	1.0 kW	5000 r/min	90 SQ.
54	0.5 kW	4000 r/min	130 SQ.
104	1.0 kW	4000 r/min	130 SQ.
154	1.5 kW	4000 r/min	130 SQ.
224	2.2 kW	4000 r/min	130 SQ.
204	2.0 kW	4000 r/min	176 SQ.
354	3.5 kW	4000 r/min	176 SQ.
123	1.2 kW	3000 r/min	130 SQ.
223	2.2 kW	3000 r/min	130 SQ.
303	3.0 kW	3000 r/min	176 SQ.
453	4.5 kW	3500 r/min	176 SQ.
603	6.0 kW	3000 r/min	176 SQ.
702	7.0 kW	2000 r/min	176 SQ.
703	7.0 kW	3000 r/min	176 SQ.
903	9.0 kW	3000 r/min	204 SQ.
1103	11.0 kW	3000 r/min	220 SQ.
142	1.4 kW	2000 r/min	130 SQ.
302	3.0 kW	2000 r/min	176 SQ.

(3) Shaft end structure

Symbol	Shaft end structure
K	With keyway (with key)
S	Straight
T	Taper

(Note 1) "Taper" is available for the motor whose flange size is 90 SQ. mm or 130 SQ. mm.
(Note 2) "K: With keyway (with key)" is only available for HG46/56/96.

(2) Magnetic brake

Symbol	Magnetic brake
None	None
B	With magnetic brakes

(5) Encoder

Symbol	Type	Detection method	Resolution
D47	OSA24RS-120	Absolute position	1,048,576 p/rev
D48	OSA24RS		1,048,576 p/rev
D51	OSA405S5AS		4,194,304 p/rev
D74	OSA676S5AS		67,108,864 p/rev

(Note) Encoder D47 can only be used with HG46/56/96.

(4) Power connector

Symbol	Connector
None	Normal
S105010	Compact (horizontal direction)

(Note) S105010 can only be used with HG75/105.

< HK Series >

HK (1) (2) (3) - (4)

(1) Rated output · Maximum rotation speed

Symbol	Rated output	Maximum rotation speed	Flange size (mm)
76	0.75 kW	6700 r/min	90 SQ.
105	1.0 kW	5000 r/min	90 SQ.
55	0.5 kW	5000 r/min	130 SQ.
104	1.0 kW	4500 r/min	130 SQ.
123	1.2 kW	3500 r/min	130 SQ.
142	1.4 kW	2000 r/min	130 SQ.
154	1.5 kW	4500 r/min 4000 r/min (MDS-E-V3-40)	130 SQ.
223	2.2 kW	3000 r/min	130 SQ.
224	2.2 kW	4500 r/min	130 SQ.
204	2.0 kW	4000 r/min	176 SQ.
302	3.0 kW	2000 r/min	176 SQ.
303	3.0 kW	3000 r/min	176 SQ.
354	3.5 kW	4000 r/min	176 SQ.
453	4.5 kW	3500 r/min	176 SQ.
603	6.0 kW	3000 r/min	176 SQ.
702	7.0 kW	2000 r/min	176 SQ.
703	7.0 kW	3000 r/min	176 SQ.

(2) Magnetic brake

Symbol	Magnetic brake
None	None
B	With magnetic brakes

(3) Shaft end structure

Symbol	Shaft end structure
K	With keyway (with key)
S	Straight
T	Taper

(Note 1) "Taper" is available for the motor whose flange size is 90 SQ. mm or 130 SQ. mm.

(4) Encoder

Symbol	Type	Detection method	Resolution
G48	CSW26KS	Batteryless absolute position	1,048,576 p/rev

(2) 400V series

< HG-H Series>

HG-H (1) (2) (3) − (4) − (5)

(1) Rated output · Maximum rotation speed

Symbol	Rated output	Maximum rotation speed	Flange size (mm)
75	0.75 kW	5000r/min	90 SQ.
105	1.0 kW	5000r/min	90 SQ.
54	0.5kW	4000r/min	130 SQ.
104	1.0kW	4000r/min	130 SQ.
154	1.5kW	4000r/min	130 SQ.
224	2.2kW	4000r/min	130 SQ.
204	2.0kW	4000r/min	176 SQ.
354	3.5kW	4000r/min	176 SQ.
453	4.5kW	3500r/min	176 SQ.
703	7.0kW	3000r/min	176 SQ.
903	9.0kW	3000r/min	204 SQ.
1502	15.0kW	2500r/min	250 SQ.

(3) Shaft end structure

Symbol	Shaft end structure
S	Straight
T	Taper

(Note) "Taper" is available for the motor whose flange size is 90 SQ. mm or 130 SQ. mm.

(2) Magnetic brakes

Symbol	Magnetic brakes
None	None
B	With magnetic brakes

(Note) Magnetic brakes cannot be used for HG-H1502.

(5) Encoder

Symbol	Type	Detection method	Resolution
D48	OSA24RS	Absolute position	1,048,576 p/rev
D51	OSA405S5AS		4,194,304 p/rev
D74	OSA676S5AS		67,108,864 p/rev

(4) Power connector

Symbol	Connector
None	Normal
S105010	Compact (horizontal direction)

(Note) S105010 can only be used with HG-H75/105.

< HQ-H Series >

HQ-H (1) (2) S− (3)

(1) Rated output · Maximum rotation speed

Symbol	Rated output	Maximum rotation speed	Flange size (mm)
903	9.0kW	3000r/min	220 SQ.
1103	11.0kW	3000r/min	220 SQ.

(3) Encoder

Symbol	Type	Detection method	Resolution
D48	OSA24RS	Absolute position	1,048,576 p/rev
D51	OSA405S5AS		4,194,304 p/rev
D74	OSA676S5AS		67,108,864 p/rev

(2) Magnetic brakes

Symbol	Magnetic brakes
None	None
B	With magnetic brakes

< HK-H Series >

HK-H (1) (2) (3) - (4)

(1) Rated output · Maximum rotation speed

Symbol	Rated output	Maximum rotation speed	Flange size (mm)
76	0.75 kW	6700 r/min	90 SQ.
105	1.0 kW	5000 r/min	90 SQ.
55	0.5 kW	5000 r/min	130 SQ.
104	1.0 kW	4500 r/min	130 SQ.
123	1.2 kW	3500 r/min	130 SQ.
154	1.5 kW	4500 r/min	130 SQ.
223	2.2 kW	3000 r/min	130 SQ.
224	2.2 kW	4500 r/min	130 SQ.
204	2.0 kW	4000 r/min	176 SQ.
302	3.0 kW	2000 r/min	176 SQ.
303	3.0 kW	3000 r/min	176 SQ.
354	3.5 kW	4000 r/min	176 SQ.
453	4.5 kW	3500 r/min	176 SQ.
603	6.0 kW	3000 r/min	176 SQ.
702	7.0 kW	2000 r/min	176 SQ.
703	7.0 kW	3000 r/min	176 SQ.

(3) Shaft end structure

Symbol	Shaft end structure
K	With keyway (with key)
S	Straight
T	Taper

(Note 1) "Taper" is available for the motor whose flange size is 90 SQ. mm or 130 SQ. mm.

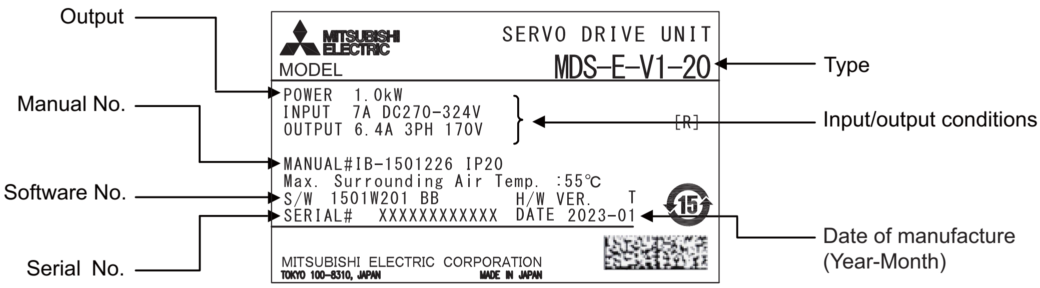
(2) Magnetic brake

Symbol	Magnetic brake
None	None
B	With magnetic brakes

(4) Encoder

Symbol	Type	Detection method	Resolution
G48	CSW26KS	Batteryless absolute position	1,048,576 p/rev

1.2.2 Servo Drive Unit Type



Rating nameplate

(1) 200V series

< MDS-E Series >

(a) 1-axis servo drive unit

MDS-E-V1- (1)

(1) Unit Type MDS-E-V1-	Unit width	Compatible motor type / Unit nominal maximum current \ Stall torque (N·m)	HG□ 46	56	96	75	105	54	104	154	224	204	354	123	223	303	453	603	702	703	903	1103	142	302
			0.64	1.3	2.4	2.0	3.0	2.9	5.9	9.0	12.0	13.7	22.5	7.0	12.0	22.5	30.0	45.0	41.0	49.0	58.8	95.5	11.0	20.0
20	60mm	20A	●	●	●	●	●							●									●	
40	60mm	40A						●	●						●									●
80	60mm	80A								●	●	●				●								
160	60mm	160A											●				●	●	●					
160W	90mm	160A																		●				
320	120mm	320A																			●			
320W	150mm	320A																				●		

● Indicates the compatible motor for each servo drive unit.

MDS-E-V1- (1)

(1) Unit Type MDS-E-V1-	Unit width	Compatible motor type / Unit nominal maximum current \ Stall torque (N·m)	HK□ 76	105	55	104	123	142	154	223	224	204	302	303	354	453	603	702	703
			3.0	4.8	3.5	8.6	7.5	11.0	12.0	15.0	14.0	15.0	20.0	22.5	27.0	33.5	45.5	57.0	51.0
20	60mm	20A	●	●			●	●											
40	60mm	40A			●	●				●			●						
80	60mm	80A							●		●	●		●					
160	60mm	160A									●				●	●	●	●	
160W	90mm	160A																	●
320	120mm	320A																	
320W	150mm	320A																	

● Indicates the compatible motor for each servo drive unit.

> ⚠ **CAUTION**
>
> The dynamic brake unit (MDS-D-DBU) is required for the MDS-E-V1-320W.

(b) 2-axis servo drive unit

MDS-E-V2- (1)

(1) Unit Type MDS-E-V2-	Unit width	Compatible motor type / Unit nominal maximum current	HG□ 46	56	96	75	105	54	104	154	224	204	354	123	223	303	453	603	702	703	903	142	302
		Stall torque (N·m)	0.64	1.3	2.4	2.0	3.0	2.9	5.9	9.0	12.0	13.7	22.5	7.0	12.0	22.5	30.0	45.0	41.0	49.0	58.8	11.0	20.0
20	60mm	20A+20A (L+M axis)	●	●	●	●	●							●								●	
40	60mm	40A+40A (L+M axis)			●	●	●	●	●					●	●							●	●
80	60mm	80A+80A (L+M axis)						●	●	●	●	●			●	●							●
160	90mm	160A+160A (L+M axis)								●	●	●	●			●	●	●	●				
160W	120mm	160A+160A (L+M axis)											●				●			●			

● Indicates the compatible motor for each servo drive unit.

MDS-E-V2- (1)

(1) Unit Type MDS-E-V2-	Unit width	Compatible motor type / Unit nominal maximum current	HK□ 76	105	55	104	123	142	154	223	224	204	302	303	354	453	603	702	703
		Stall torque (N·m)	3.0	4.8	3.5	8.6	7.5	11.0	12.0	15.0	14.0	15.0	20.0	22.5	27.0	33.5	45.5	57.0	51.0
20	60mm	20A+20A (L+M axis)	●	●			●	●											
40	60mm	40A+40A (L+M axis)	●	●	●	●	●	●		●			●						
80	60mm	80A+80A (L+M axis)			●	●			●	●	●	●	●	●					
160	90mm	160A+160A (L+M axis)							●		●	●		●	●	●	●	●	
160W	120mm	160A+160A (L+M axis)													●	●			●

● Indicates the compatible motor for each servo drive unit.

(c) 3-axis servo drive unit

MDS-E-V3- (1)

(1) Unit Type MDS-E-V3-	Unit width	Compatible motor type / Unit nominal maximum current \ Stall torque (N·m)	HG□ 46	56	96	75	105	54	104	154	224	204	123	223	303	142	302
			0.64	1.3	2.4	2.0	3.0	2.9	5.9	9.0	12.0	13.7	7.0	12.0	22.5	11.0	20.0
20	60mm	20A+20A+20A (L+M+S axis)	●	●	●	●	●						●			●	
40	60mm	40A+40A+40A (L+M+S axis)			●	●	●	●	●	□			●	●		●	●
80	90mm	80A+80A+80A (L+M+S axis)						●	●	●	●	●		●	●		●

● Indicates the compatible motor for each servo drive unit.
□ Indicates the motor that can be combined with the drive unit although the stall torque and maximum torque are limited.
When combining MDS-E-V3-40 with HG154, stall torque is 7.0N･m.

MDS-E-V3- (1)

(1) Unit Type MDS-E-V3-	Unit width	Compatible motor type / Unit nominal maximum current \ Stall torque (N·m)	HK□ 76	105	55	104	123	142	154	223	224	204	302	303
			3.0	4.8	3.5	8.6	7.5	11.0	9.5	15.0	14.0	15.0	20.0	22.5
20	60mm	20A+20A+20A (L+M+S axis)	●	●			●	●						
40	60mm	40A+40A+40A (L+M+S axis)	●	●	●	●	●	●	●	●			●	
80	90mm	80A+80A+80A (L+M+S axis)			●	●			□	●	●	●	●	●

● Indicates the compatible motor for each servo drive unit.
□ Indicates the motor that can be combined with the drive unit although the stall torque and maximum torque are limited.
When combining MDS-E-V3-80 with HK154, stall torque is 9.0N･m.

(2) 400V series

< MDS-EH Series >

(a) 1-axis servo drive unit

MDS-EH-V1- (1)

(1) Unit type MDS-EH-V1-	Unit width	Compatible motor type	HG-H□												HQ-H□	
			75	105	54	104	154	224	204	354	453	703	903	1502	903	1103
		Stall torque (N･m) / Unit nominal maximum current	2.0	3.0	2.9	5.9	9.0	12.0	13.7	22.5	30.0	49.0	58.8	152.1	70.0	110.0
10	60mm	10A	●	●												
20	60mm	20A			●	●										
40	60mm	40A					●	●	●							
80	60mm	80A								●	●					
80W	90mm	80A										●				
160	120mm	160A											●		●	
160W	150mm	160A														●
200 (Note)	240mm	200A												●		

● Indicates the compatible motor for each servo drive unit.

(Note) DC connection bar is required. Always install a large capacity drive unit (MDS-EH-V1-200) in the left side of power supply unit, and connect with DC connection bar.

MDS-EH-V1- (1)

(1) Unit type MDS-EH-V1-	Unit width	Compatible motor type	HK-H□															
			76	105	55	104	123	154	223	224	204	302	303	354	453	603	702	703
		Stall torque (N･m) / Unit nominal maximum current	2.8	3.8	3.5	8.6	5.7	12.0	13.5	14.0	15.0	28.0	21.5	27.0	39.0	45.0	57.0	51.0
10	60mm	10A	●	●			●											
20	60mm	20A			●	●			●									
40	60mm	40A						●		□	●	●	●					
80	60mm	80A								●				●	●	●	●	
80W	90mm	80A																●
160	120mm	160A																
160W	150mm	160A																
200 (Note)	240mm	200A																

● Indicates the compatible motor for each servo drive unit.
□ Indicates the motor that can be combined with the drive unit although the stall torque and maximum torque are limited.
When combining MDS-EH-V1-40 with HK-H224, stall torque is 13.5N･m.
(Note) DC connection bar is required. Always install a large capacity drive unit (MDS-EH-V1-200) in the left side of power supply unit, and connect with DC connection bar.

> ⚠ **CAUTION**
>
> The dynamic brake unit (MDS-D-DBU) is required for the MDS-EH-V1-160W and MDS-EH-V1-200.

(b) 2-axis servo drive unit

MDS-EH-V2- (1)

(1) Unit type MDS-EH-V2-		Compatible motor type	HG-H□											HQ-H□
			75	105	54	104	154	224	204	354	453	703	903	903
	Unit width	Unit nominal maximum current / Stall torque (N･m)	2.0	3.0	2.9	5.9	9.0	12.0	13.7	22.5	30.0	49.0	58.8	70.0
10	60mm	10A+10A (L+M axis)	●	●										
20		20A+20A (L+M axis)	●	●	●	●								
40		40A+40A (L+M axis)			●	●	●	●	●					
80	90mm	80A+80A (L+M axis)					●	●	●	●	●			
80W	120mm	80A+80A (L+M axis)								●	●	●		
160		160A+160A (L+M axis)										●	●	●

● Indicates the compatible motor for each servo drive unit.

MDS-EH-V2- (1)

(1) Unit type MDS-EH-V2-		Compatible motor type	HK-H□															
			76	105	55	104	123	154	223	224	204	302	303	354	453	603	702	703
	Unit width	Unit nominal maximum current / Stall torque (N･m)	2.8	3.8	3.5	8.6	5.7	12.0	13.5	14.0	15.0	28.0	21.5	27.0	39.0	45.0	57.0	51.0
10	60mm	10A+10A (L+M axis)	●	●			●											
20		20A+20A (L+M axis)	●	●	●	●	●		●									
40		40A+40A (L+M axis)			●	●		●	●	□	●	●	●					
80	90mm	80A+80A (L+M axis)						●		●	●		●	●	●	●	●	
80W	120mm	80A+80A (L+M axis)												●	●	●	●	●
160		160A+160A (L+M axis)																●

● Indicates the compatible motor for each servo drive unit.

□ Indicates the motor that can be combined with the drive unit although the stall torque and maximum torque are limited.

When combining MDS-EH-V2-40 with HK-H224, stall torque is 13.5N･m.

(c) 3-axis servo drive unit

MDS-EH-V3- (1)

(1) Unit type MDS-EH-V3-		Compatible motor type	HG-H□				
			54	104	154	224	204
	Unit width	Unit nominal maximum current / Stall torque (N·m)	2.9	5.9	9.0	12.0	13.7
40	90mm	40A+40A+40A (L+M+S axis)	●	●	●	●	●

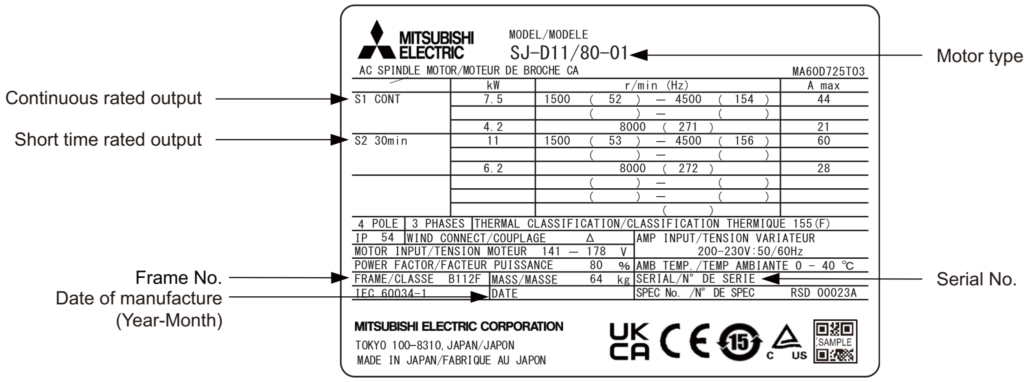
● Indicates the compatible motor for each servo drive unit.

MDS-EH-V3- (1)

(1) Unit type MDS-EH-V3-		Compatible motor type	HK-H□							
			55	104	154	223	224	204	302	303
	Unit width	Unit nominal maximum current / Stall torque (N·m)	3.5	8.6	9.0	13.5	13.5	15.0	28.0	21.5
40	90mm	40A+40A+40A (L+M+S axis)	●	●	●	●	●	●	●	●

● Indicates the compatible motor for each servo drive unit.

1.2.3 Spindle Motor Type



Rating nameplate

(1) 200V series

< SJ-D/DG/DJ/DL/DM/DN Series >

SJ-D (1)(2) / (3) - (4) (5) - (6)

(1) Series

Symbol	Series
None	Normal
G	High-output specifications
J	Compact & lightweight specifications
L	Low-inertia specifications
M	Magnet specifications
N	High-torque specifications

(2) Short time (or %ED) rated output

Symbol	Short-time rated output
0.75	0.75 kW
1.5	1.5 kW
3.7	3.7 kW
5.5	5.5 kW
7.5	7.5 kW
11	11 kW
15	15 kW
18.5	18.5 kW
22	22 kW
26	26 kW

(3) Maximum rotation speed
Indicates the hundreds place and higher order digits.

(4) Specification code
Indicates a specification code (01 to 99).

(5) Encoder

Symbol	Type
None	Type 1
T	Type 2

(6) Specification (Note)

Symbol	Specification
None	Standard
A	With leg
C	Shaft with key
J	Oil seal
K	Coil changeover
S	Hollow shaft
X	Reversed cooling air

(Note) If more than one option is included, the symbols are in alphabetical order.

(Note) This explains the model name system of spindle motors, but does not mean all the combinations are available.

< SJ-V/VL Series >

SJ- (1) (2) (3) (4) - (5) (6) T

(1) Series

Symbol	Series
V	Medium-inertia series
VL	Low -inertia series

(2) Coil changeover

Symbol	Coil changeover
None	Unavailable
K	Available

(3) Shaft configuration

Symbol	Axis configuration
None	Standard

(4) Short time rated output
(For normal specification)

Symbol	Short time rated output
0.75	0.75 kW
1.5	1.5 kW
2.2	2.2 kW
3.7	3.7 kW
5.5	5.5 kW
7.5	7.5 kW
11	11 kW
15	15 kW
18.5	18.5 kW
22	22 kW
26	26 kW
30	30 kW
37	37 kW
45	45 kW
55	55 kW

(5) Specification code
The SJ-V/VL Series is indicated with a specification code (01 to 99).

(6) Special specification

Symbol	Special specification
None	Standard
Z	High-speed bearing
FZ	High-speed bearing front-lock

T: For MDS-E/EM motor

(Note) This explains the model name system of spindle motors, but does not mean all the combinations are available.

(2) 400V series

< SJ-4-V Series >

SJ- 4 - (1) (2) (3) (4) – (5) (6) T

(1) Motor series

Symbol	Motor series
V	Medium-inertia series

(2) Coil changeover

Symbol	Coil changeover
None	Unavailable

(3) Shaft configuration

Symbol	Axis configuration
None	Standard

(4) Short time rated output
(For normal specification)

Symbol	Short time rated output
2.2	2.2 kW
3.7	3.7 kW
5.5	5.5 kW
7.5	7.5 kW
11	11 kW
15	15 kW
18.5	18.5 kW
22	22 kW
26	26 kW
37	37 kW
45	45 kW
55	55 kW

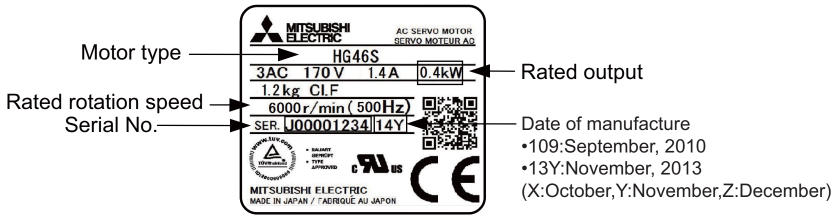
(5) Specification code
The SJ-4-V Series is indicated with a specification code (01 to 99).

(6) Special specification

Symbol	Special specification
None	Standard
Z	High-speed bearing

(Note) This explains the model name system of spindle motors, but does not mean all the combinations are available.

1.2.4 Tool Spindle Motor Type



Motor rating nameplate

Rating nameplate

(1) 200V series

< HG Series >

HG (1) (2) - (3) - (4)

(1) Rated output · Maximum rotation speed

Symbol	Rated output	Maximum rotation speed	Flange size (mm)
46	0.4 kW	6000 r/min	60 SQ.
56	0.5 kW	6000 r/min	60 SQ.
96	0.9 kW	6000 r/min	80 SQ.
75	0.75 kW	4000 r/min	90 SQ.
105	1.0 kW	4000 r/min	90 SQ.
54	0.5 kW	3000 r/min	130 SQ.
104	1.0 kW	3000 r/min	130 SQ.
154	1.5 kW	3000 r/min	130 SQ.
224	2.2 kW	3000 r/min	130 SQ.
204	2.0 kW	3000 r/min	176 SQ.
354	3.5 kW	3000 r/min	176 SQ.
453	4.5 kW	3000 r/min	176 SQ.
703	7.0 kW	3000 r/min	176 SQ.
903	9.0 kW	3000 r/min	204 SQ.

(3) Encoder

Symbol	Type	Resolution
D47	OSA24RS-120	1,048,576 p/rev
D48	OSA24RS	1,048,576 p/rev

(Note 1) Encoder D51 and D74 can not be used with the tool spindle motor.
(Note 2) Encoder D47 can only be used with HG46/56/96.

(2) Shaft end structure

Symbol	Shaft end structure
S	Straight
K	With keyway (with key)

(Note) "K: With keyway (with key)" is only available for HG46/56/96.

(4) Power connector

Symbol	Connector
None	Normal
S105010	Compact (horizontal direction)

(Note) S105010 can only be used with HG75/105.

< HG-JR Series >

HG-JR (1) E1 (2) W9C - (3)

(1) Rated output · Maximum rotation speed

Symbol	Rated output	Maximum rotation speed	Flange size (mm)
73	0.75 kW	8000 r/min	90 SQ.
153	1.5 kW	8000 r/min	90 SQ.

(2) Shaft end structure

Symbol	Shaft end structure
None	Straight
K	With keyway (without key)

(3) Power connector

Symbol	Connector
S105003	Normal (vertical direction)
S105010	Compact (horizontal direction)

(2) 400V series

< HG-JR Series >

HG-JR (1) E1 (2) W9C - (3)

(1) Rated output · Maximum rotation speed

Symbol	Rated output	Maximum rotation speed	Flange size (mm)
734	0.75 kW	8000 r/min	90 SQ.
1534	1.5 kW	8000 r/min	90 SQ.

(2) Shaft end structure

Symbol	Shaft end structure
None	Straight
K	With keyway (without key)

(3) Power connector

Symbol	Connector
S105003	Normal (vertical direction)
S105010	Compact (horizontal direction)

< Combination with spindle drive unit >

(a) 1-axis spindle drive unit

Unit Type MDS-E-SP-	Unit width	Compatible motor type / Unit nominal maximum current \ Rated torque (N·m)	HG□ 46	56	96	75	105	54	104	154	224	204	354	453	703	903
			0.64	0.8	1.43	1.8	2.4	1.6	3.2	4.8	7.0	6.4	11.1	14.3	22.3	28.7
20	60mm	20 A	●	●	●	●	●									
40		40 A						●	●							
80		80 A								●	●	●				
160	90mm	160 A											●	●	●	
200	120mm	200 A														
240	150mm	240 A														
320		320 A														●
400	240mm	400 A														
640	300mm	640 A														

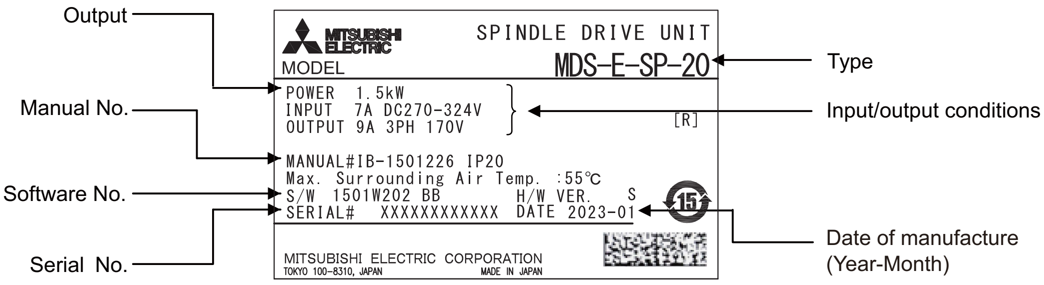
● Indicates the compatible motor for each spindle drive unit.

(b) 2-axis spindle drive unit

Unit Type MDS-E-SP2-	Unit width	Compatible motor type / Unit nominal maximum current \ Rated torque (N·m)	HG□ 46	56	96	75	105	54	104	154	224	204	354	453	703
			0.64	0.8	1.43	1.8	2.4	1.6	3.2	4.8	7.0	6.4	11.1	14.3	22.3
20	60mm	20A+20A (L+M axis)	●	●	●	●	●								
40		40A+40A (L+M axis)			●	●	●	●	●						
80	90mm	80A+80A (L+M axis)						●	●	●	●	●			
16080		160A+80A (L+M axis)								●	●	●	●	●	●

● Indicates the compatible motor for each spindle drive unit.

1.2.5 Spindle Drive Unit Type



Rating nameplate

(1) 200V series

< MDS-E Series >

(a) 1-axis spindle drive unit

MDS-E-SP- (1)

(1) Capacity

Symbol	Unit nominal maximum current	Unit width
20	20 A	60mm
40	40 A	
80	80 A	
160	160 A	90mm
200	200 A	120mm
240	240 A	150mm
320	320 A	
400	400 A	240mm (Note)
640	640 A	300mm (Note)

(Note) DC connection bar is required. Always install a large capacity drive unit (MDS-E-SP-400,640) in the left side of power supply unit, and connect with DC connection bar.

(b) 2-axis spindle drive unit

MDS-E-SP2- (1)

(1) Capacity

Symbol	Unit nominal maximum current	Unit width
20	20 A+20 A (L+M axis)	60mm
40	40 A+40 A (L+M axis)	
80	80 A+80 A (L+M axis)	90mm
16080	160 A+80 A (L+M axis)	

(2) 400V series

< MDS-EH Series >

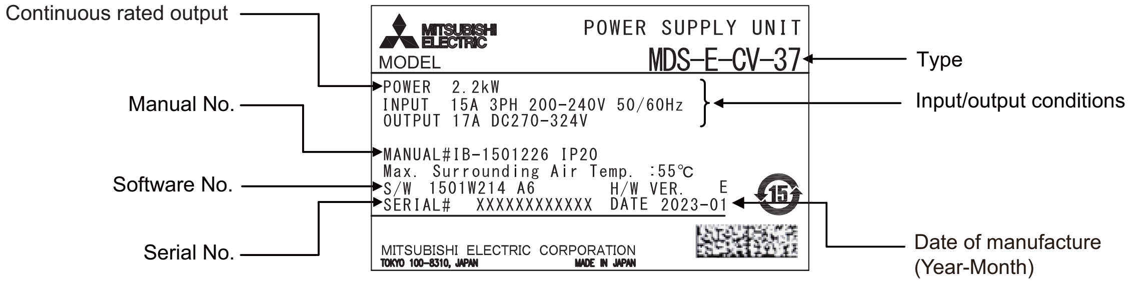
MDS-EH-SP- (1)

(1) Capacity

Symbol	Unit nominal maximum current	Unit width
20	20A	60mm
40	40A	
80	80A	90mm
100	100A	120mm
160	160A	150mm
200	200A	240mm (Note)
320	320A	
480	480A	300mm (Note)
600	600A	

(Note) DC connection bar is required. Always install a large capacity drive unit (MDS-EH-SP-200,320,480,600) in the left side of power supply unit, and connect with DC connection bar.

1.2.6 Power Supply Unit Type



Rating nameplate

(1) 200V series

< MDS-E Series >

MDS-E-CV- (1)

Power supply unit				Compatible AC reactor	Compatible contactor (Mitsubishi) (Note 1)	Compatible circuit protector (Mitsubishi) (Note 1)
(1) Type MDS-E-CV-	30-minute rated output	Continuous rated output	Unit width			
37	3.7kW	2.2kW	60mm	D-AL-7.5K	S-T12-AC200V	NF63-CW3P-20A
75	7.5kW	5.5kW			S-T35-AC200V	NF63-CW3P-40A
110	11.0kW	7.5kW	90mm	D-AL-11K		NF63-CW3P-50A
185	18.5kW	15.0kW		D-AL-18.5K	S-T65-AC200V	NF125-CW3P-100A
300	30.0kW	26.0kW	150mm (Note 2)	D-AL-30K	S-T80-AC200V	NF250-CW3P-125A
370	37.0kW	30.0kW		D-AL-37K	S-N150-AC200V	NF250-CW3P-175A
450	45.0kW	37.0kW		D-AL-45K		NF250-CW3P-200A
550	55.0kW	45.0kW	300mm (Note 2)	D-AL-55K	S-N180-AC200V	NF250-CW3P-225A

(Note 1) This is an optional part that is not included with the parts provided in the NC system.
(Note 2) When connecting with a large capacity drive unit, DC connection bar is required.
Always install a large capacity drive unit in the left side of power supply unit, and connect with DC connection bar.

(2) 400V series

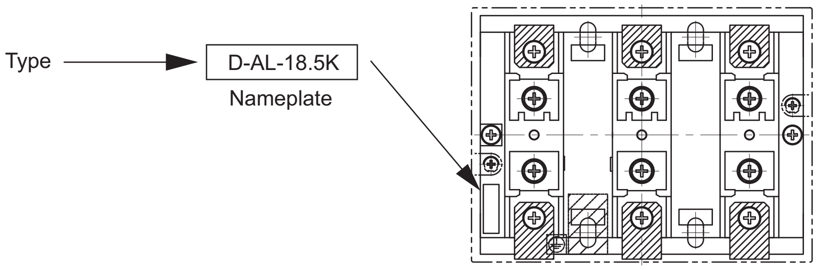
< MDS-EH Series >

MDS-EH-CV- (1)

Power supply unit				Compatible AC reactor	Compatible contactor (Mitsubishi) (Note 1)	Compatible circuit protector (Mitsubishi) (Note 1)
(1) Type MDS-EH-CV-	30-minute rated output	Continuous rated output	Unit width			
37	3.7kW	2.2kW	90mm	DH-AL-7.5K	S-T12-AC400V	NF63-CW3P-10A
75	7.5kW	5.5kW				NF63-CW3P-20A
110	11.0kW	7.5kW		DH-AL-11K	S-T21-AC400V	NF63-CW3P-30A
185	18.5kW	15.0kW		DH-AL-18.5K	S-T35-AC400V	NF63-CW3P-40A
300	30.0kW	26.0kW	150mm (Note 2)	DH-AL-30K	S-T50-AC400V	NF125-CW3P-75A
370	37.0kW	30.0kW		DH-AL-37K	S-T65-AC400V	NF125-CW3P-100A
450	45.0kW	37.0kW		DH-AL-45K		NF125-CW3P-100A
550	55.0kW	45.0kW	300mm (Note 2)	DH-AL-55K	S-T80-AC400V	NF250-CW3P-125A
750	75.0kW	55.0kW		DH-AL-75K	S-N150-AC400V	NF250-CW3P-200A

(Note 1) This is an optional part that is not included with the parts provided in the NC system.
(Note 2) When connecting with a large capacity drive unit, DC connection bar is required.
Always install a large capacity drive unit in the left side of power supply unit, and connect with DC connection bar.

1.2.7 AC Reactor Type



Top surface of AC reactor

(1) 200V series

< MDS-E Series >

D-AL- (1)

AC reactor (1) Type D-AL-	AC reactor Capacity	Compatible power supply unit
7.5K	7.5kW	MDS-E-CV-37
		MDS-E-CV-75
11K	11.0kW	MDS-E-CV-110
18.5K	18.5kW	MDS-E-CV-185
30K	30.0kW	MDS-E-CV-300
37K	37.0kW	MDS-E-CV-370
45K	45.0kW	MDS-E-CV-450
55K	55.0kW	MDS-E-CV-550

(2) 400V series

< MDS-EH Series >

DH-AL- (1)

AC reactor (1) Type DH-AL-	AC reactor Capacity	Compatible power supply unit
7.5K	7.5kW	MDS-EH-CV-37
		MDS-EH-CV-75
11K	11.0kW	MDS-EH-CV-110
18.5K	18.5kW	MDS-EH-CV-185
30K	30.0kW	MDS-EH-CV-300
37K	37.0kW	MDS-EH-CV-370
45K	45.0kW	MDS-EH-CV-450
55K	55.0kW	MDS-EH-CV-550
75K	75.0kW	MDS-EH-CV-750

2

Specifications

2.1 Servo Motor

2.1.1 Specifications List

(1) 200V series

< HG Series >

Servo motor type		HG Series		
		ABS specifications: HG ☐ -D47		
		HG46	HG56	HG96
Compatible servo drive unit type	MDS-E-V1-	20	20	20
	MDS-E-V2-	20	20	20 40
	MDS-E-V3-	20	20	20 40
Continuous characteristics	Rated output [kW]	0.2	0.4	0.75
	Rated current [A]	1.3	2.6	4.8
	Rated torque [N•m]	0.64	1.3	2.4
	Stall current [A]	1.4	2.6	4.8
	Stall torque [N•m] (Note 3)	0.64	1.3	2.4
Rated rotation speed [r/min]		3000		
Maximum rotation speed [r/min]		6000		
Maximum current [A]		5.3	11.2	15.0
Maximum torque [N•m]		2.5	5.0	7.2
Power rate at continuous rated torque [kW/s]		17.6	42.7	45.2
Motor inertia [$\times 10^{-4}$kg•m^2]		0.234	0.379	1.27
Motor inertia with brake [$\times 10^{-4}$kg•m^2]		0.261	0.407	1.37
Maximum motor shaft conversion load inertia [$\times 10^{-4}$kg•m^2] (Note 4)		3.45	5.64	18.9
Motor side encoder		Resolution per motor revolution D47: 1,048,576 pulse/rev		
Degree of protection		IP67 (The shaft-through portion is excluded.)		
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -15°C to 70°C (with no freezing)		
	Ambient humidity	Operation: 80%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)		
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust		
	Altitude	Operation/Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level		
	Vibration	X,Y: 49m/s^2 (5G)		
Flange size [mm]		60 SQ.	60 SQ.	80 SQ.
Total length (excluding shaft) [mm]		117.2	138.9	147.8
Flange fitting diameter [mm]		Φ50	Φ50	Φ70
Shaft diameter [mm]		Φ14	Φ14	Φ19
Mass Without / with brake [kg]		1.2/1.6	1.6/2.0	2.9/3.7
Heat-resistant class		130 (B)		

(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) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.
(Note 3) Stall torque is the maximum torque that can be output continuously when the motor rotation is stopped.
(Note 4) Using on a non-interpolation axis is recommended.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< HG Series >

Servo motor type		HG Series								
		ABS specifications: HG □ -D74 / -D51 / -D48								
		HG75	HG105	HG54	HG104	HG154		HG224	HG204	HG354
Compatible servo drive unit type	MDS-E-V1-	20	20	40	40	80	-	80	80	160
	MDS-E-V2-	20 40	20 40	40 80	40 80	80 160	-	80 160	80 160	160 160W
	MDS-E-V3-	20 40	20 40	40 80	40 80	80	40	80	80	-
Continuous characteristics	Rated output [kW]	0.75	1.0	0.5	1.0	1.5	1.5	2.2	2.0	3.5
	Rated current [A]	3.1	3.7	2.0	3.9	5.6	5.6	8.6	6.8	12
	Rated torque [N•m]	1.8	2.4	1.6	3.2	4.8	4.8	7.0	6.4	11.1
	Stall current [A]	3.2	4.6	3.2	6.6	11	8.5	15	15	22
	Stall torque [N•m] (Note 4)	2.0	3.0	2.9	5.9	9.0	7.0	12.0	13.7	22.5
Rated rotation speed [r/min]		4000		3000						
Maximum rotation speed [r/min]		5000		4000						
Maximum current [A]		14.0	15.5	17.0	29.0	52.0	29.0	57.0	57.0	116.0
Maximum torque [N•m]		8.0	11.0	13.0	23.3	42.0	23.7	46.5	47.0	90.0
Power rate at continuous rated torque [kW/s]		12.3	11.2	4.1	8.4	12.7	12.7	20.7	10.6	16.5
Motor inertia [$\times 10^{-4}$kg•m^2]		2.62	5.12	6.13	11.9	17.8	17.8	23.7	38.3	75.0
Motor inertia with brake [$\times 10^{-4}$kg•m^2]		2.70	5.20	8.26	14.0	20.0	20.0	25.9	47.9	84.7
Maximum motor shaft conversion load inertia [$\times 10^{-4}$kg•m^2] (Note 5)		18.3	35.7	42.7	83.3	125	125	166	268	525
Motor side encoder		Resolution per motor revolution D74: 67,108,864 pulse/rev, D51: 4,194,304 pulse/rev, D48: 1,048,576 pulse/rev								
Degree of protection		IP67 (The shaft-through portion is excluded.)								
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -15°C to 70°C (with no freezing)								
	Ambient humidity	Operation: 80%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)								
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust								
	Altitude	Operation/Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level								
	Vibration	X,Y:24.5m/s^2 (2.5G)								X:24.5m/s^2 (2.5G) Y:29.4m/s^2 (3G)
Flange size [mm]		90 SQ.	90 SQ.	130 SQ.	130 SQ.	130 SQ.		130 SQ.	176 SQ.	176 SQ.
Total length (excluding shaft) [mm]		127.5	163.5	118.5	140.5	162.5		184.5	143.5	183.5
Flange fitting diameter [mm]		Φ80	Φ80	Φ110	Φ110	Φ110		Φ110	Φ114.3	Φ114.3
Shaft diameter [mm]		Φ14	Φ14	Φ24	Φ24	Φ24		Φ24	Φ35	Φ35
Mass Without / with brake [kg]		2.6/3.6	4.4/5.3	4.8/6.7	6.5/8.5	8.3/11		10.0/12.0	12.0/18.0	19.0/25.0
Heat-resistant class		155 (F)								

(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 total length will be 3.5mm longer when using a D51 or D74 encoder.
(Note 3) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.
(Note 4) Stall torque is the maximum torque that can be output continuously when the motor rotation is stopped.
(Note 5) 3 times or less the motor inertia is recommended for a high-speed, high-accuracy machine, and 5 times or less the motor inertia is recommended for a general machine tool interpolation axis.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< HG Series >

Servo motor type		HG Series ABS specifications: HG □ -D74/-D51/-D48 HG123	HG223	HG303	HG453	HG603	HG702
Compatible servo drive unit type	MDS-E-V1-	20	40	80	160	160	160
	MDS-E-V2-	20 40	40 80	80 160	160 160W	160	160
	MDS-E-V3-	20 40	40 80	80	-	-	-
Continuous characteristics	Rated output [kW]	1.2	2.2	3.0	4.5	6.0	7.0
	Rated current [A]	5.2	9.0	11	19	33	24
	Rated torque [N•m]	5.7	10.5	14.3	14.3	19.1	33.4
	Stall current [A]	6.4	11	16	28	33	24
	Stall torque [N•m] (Note 4)	7.0	12.0	22.5	30.0	45.0	41.0
Rated rotation speed [r/min]		2000			3000		2000
Maximum rotation speed [r/min]		3000			3500	3000	2000
Maximum current [A]		16.0	29.0	48.0	105.0	109.0	79.5
Maximum torque [N•m]		17.0	32.0	64.0	122.0	152.0	130
Power rate at continuous rated torque [kW/s]		27.3	46.5	27.3	18.3	23.7	72.5
Motor inertia [$\times 10^{-4}$kg•m^2]		11.9	23.7	75.0	112.0	154.0	154.0
Motor inertia with brake [$\times 10^{-4}$kg•m^2]		14.0	25.9	84.7	122.0	164.0	164.0
Maximum motor shaft conversion load inertia [$\times 10^{-4}$kg•m^2] (Note 5)		83.3	166	525	784	1078	1078
Motor side encoder		Resolution per motor revolution D74: 67,108,864 pulse/rev, D51: 4,194,304 pulse/rev, D48: 1,048,576 pulse/rev					
Degree of protection		IP67 (The shaft-through portion is excluded.)					
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -15°C to 70°C (with no freezing)					
	Ambient humidity	Operation: 80%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)					
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust					
	Altitude	Operation/Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level					
	Vibration	X,Y:24.5m/s^2 (2.5G)		X:24.5m/s^2 (2.5G) Y:29.4m/s^2 (3G)			
Flange size [mm]		130 SQ.	130 SQ.	176 SQ.	176 SQ.	176 SQ.	176 SQ.
Total length (excluding shaft) [mm]		140.5	184.5	183.5	223.5	263.5	263.5
Flange fitting diameter [mm]		Φ110	Φ110	Φ114.3	Φ114.3	Φ114.3	Φ114.3
Shaft diameter [mm]		Φ24	Φ24	Φ35	Φ35	Φ35	Φ35
Mass Without / with brake [kg]		6.5/8.5	10.0/12.0	19.0/25.0	25/31	32/38	32/38
Heat-resistant class		155 (F)					

(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 total length will be 3.5mm longer when using a D51 or D74 encoder.
(Note 3) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.
(Note 4) Stall torque is the maximum torque that can be output continuously when the motor rotation is stopped.
(Note 5) 3 times or less the motor inertia is recommended for a high-speed, high-accuracy machine, and 5 times or less the motor inertia is recommended for a general machine tool interpolation axis.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< HG Series >

Servo motor type		HG Series				
		ABS specifications: HG □ -D74/-D51/-D48				
		HG703	HG903	HG1103	HG142	HG302
Compatible servo drive unit type	MDS-E-V1-	160W	320	320W	20	40
	MDS-E-V2-	160W	-	-	20 40	40 80
	MDS-E-V3-	-	-	-	20 40	40 80
Continuous characteristics	Rated output [kW]	7.0	9.0	11.0	1.4	3.0
	Rated current [A]	34	30	43	5.2	11
	Rated torque [N•m]	22.3	28.6	35.0	6.7	14.3
	Stall current [A]	37	56	76	6.4	11
	Stall torque [N•m] (Note 4)	49.0	58.8	95.5	11.0	20.0
Rated rotation speed [r/min]		3000			2000	
Maximum rotation speed [r/min]		3000			2000	
Maximum current [A]		109.0	204.0	212	16.0	29.0
Maximum torque [N•m]		152.0	208.0	225	26.5	50.0
Power rate at continuous rated torque [kW/s]		32.2	42.1	38.9	25.2	27.3
Motor inertia [$\times 10^{-4}$kg•m^2]		154.0	196.0	315	17.8	75.0
Motor inertia with brake [$\times 10^{-4}$kg•m^2]		164.0	206.0	336	20.0	84.7
Maximum motor shaft conversion load inertia [$\times 10^{-4}$kg•m^2] (Note 5)		1078	1372	2205	125	525
Motor side encoder		Resolution per motor revolution D74: 67,108,864 pulse/rev, D51: 4,194,304 pulse/rev, D48: 1,048,576 pulse/rev				
Degree of protection		IP67 (The shaft-through portion is excluded.)				
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -15°C to 70°C (with no freezing)				
	Ambient humidity	Operation: 80%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)				
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust				
	Altitude	Operation/Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level				
	Vibration	X: 24.5m/s^2 (2.5G) Y: 29.4m/s^2 (3G)	X,Y: 9.8m/s^2 (1G)	X,Y: 24.5m/s^2 (2.5G)		X: 24.5m/s^2 (2.5G) Y: 29.4m/s^2 (3G)
Flange size [mm]		176 SQ.	204 SQ.	220 SQ.	130 SQ.	176 SQ.
Total length (excluding shaft) [mm]		263.5	330	438	162.5	183.5
Flange fitting diameter [mm]		Φ114.3	Φ180	Φ200	Φ110	Φ114.3
Shaft diameter [mm]		Φ35	Φ42	Φ55	Φ24	Φ35
Mass Without / with brake [kg]		32.0/38.0	43/49	86/97	8.3/11	19.0/25.0
Heat-resistant class		155 (F)				

(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 total length will be 3.5mm longer when using a D51 or D74 encoder.

(Note 3) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 4) Stall torque is the maximum torque that can be output continuously when the motor rotation is stopped.

(Note 5) 3 times or less the motor inertia is recommended for a high-speed, high-accuracy machine, and 5 times or less the motor inertia is recommended for a general machine tool interpolation axis.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< HK Series >

Servo motor type		HK Series				
		ABS specifications: HK □ -G48				
		HK76	HK105	HK55	HK104	HK123
Compatible servo drive unit type	MDS-E-V1-	20	20	40	40	20
	MDS-E-V2-	20 40	20 40	40 80	40 80	20 40
	MDS-E-V3-	20 40	20 40	40 80	40 80	20 40
Continuous characteristics	Rated output [kW]	0.75	1.0	0.5	1.0	1.2
	Rated current [A]	3.0	3.3	2.1	3.7	4.6
	Rated torque [N•m]	1.8	2.7	1.6	3.2	5.7
	Stall current [A]	4.9	5.6	4.4	9.5	6.0
	Stall torque [N•m] (Note 3)	3.0	4.8	3.5	8.6	7.5
Rated rotation speed [r/min]		4000	3500	3000	3000	2000
Maximum rotation speed [r/min]		6700	5000	5000	4500	3500
Maximum current [A]		16	16	21	29	16
Maximum torque [N•m]		8.1	12.5	14.8	24.0	18.0
Power rate at continuous rated torque [kW/s]		15.4	17.1	4.3	8.9	28.8
Motor inertia [$\times10^{-4}$kg•m^2]		2.08	4.36	5.90	11.4	11.4
Motor inertia with brake [$\times10^{-4}$kg•m^2]		2.23	4.51	7.75	13.3	13.3
Maximum motor shaft conversion load inertia [$\times10^{-4}$kg•m^2] (Note 4)		18.3	35.7	42.7	83.3	83.3
Motor side encoder		Resolution per motor revolution G48:1,048,576 pulse/rev				
Degree of protection		IP67 (The shaft-through portion is excluded.)				
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -15°C to 70°C (with no freezing)				
	Ambient humidity	Operation: 10 to 90%RH or less (with no dew condensation), Storage: 10 to 90%RH or less (with no dew condensation)				
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust No object generating a strong magnetic field External magnetic field: 10 mT or less				
	Altitude	Operation/Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level				
	Vibration	X: 24.5m/s^2 (2.5G) Y: 49m/s^2 (5G)	X,Y: 24.5m/s^2 (2.5G)	X: 24.5m/s^2 (2.5G) Y: 49m/s^2 (5G)		
Flange size [mm]		90 SQ.	90 SQ.	130 SQ.	130 SQ.	130 SQ.
Total length (excluding shaft) [mm]		114.1	149.5	115.5	137.5	137.5
Flange fitting diameter [mm]		Φ80	Φ80	Φ110	Φ110	Φ110
Shaft diameter [mm]		Φ14	Φ14	Φ24	Φ24	Φ24
Mass Without / with brake [kg]		2.7/3.6	4.1/5.0	5.0/6.8	7.1/8.8	7.1/8.8
Heat-resistant class		155 (F)				

(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) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 3) Stall torque is the maximum torque that can be output continuously when the motor rotation is stopped.

(Note 4) 3 times or less the motor inertia is recommended for a high-speed, high-accuracy machine, and 5 times or less the motor inertia is recommended for a general machine tool interpolation axis.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< HK Series >

Servo motor type		HK Series				
		ABS specifications: HK ☐ -G48				
		HK142	HK154			HK223
Compatible servo drive unit type	MDS-E-V1-	20	80	-	-	40
	MDS-E-V2-	20 40	80 160	-	-	40 80
	MDS-E-V3-	20 40	-	40	80	40 80
Continuous characteristics	Rated output [kW]	1.4	1.5			2.2
	Rated current [A]	4.9	5.4			7.6
	Rated torque [N•m]	8.9	4.8			10.5
	Stall current [A]	6.0	13	11	9.8	11
	Stall torque [N•m] (Note 3)	11.0	12.0	9.5	9.0	15.0
Rated rotation speed [r/min]		1500	3000			2000
Maximum rotation speed [r/min]		2000	4500	4000	4500	3000
Maximum current [A]		16	58	29	58	29
Maximum torque [N•m]		27.0	48.0	25.0	48.0	39.0
Power rate at continuous rated torque [kW/s]		47.0	13.5			49.3
Motor inertia [$\times 10^{-4}$kg•m^2]		16.9	16.9			22.4
Motor inertia with brake [$\times 10^{-4}$kg•m^2]		18.8	18.8			24.2
Maximum motor shaft conversion load inertia [$\times 10^{-4}$kg•m^2] (Note 4)		125	125	120	125	166
Motor side encoder		Resolution per motor revolution G48:1,048,576 pulse/rev				
Degree of protection		IP67 (The shaft-through portion is excluded.)				
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -15°C to 70°C (with no freezing)				
	Ambient humidity	Operation: 10 to 90%RH or less (with no dew condensation), Storage: 10 to 90%RH or less (with no dew condensation)				
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust No object generating a strong magnetic field External magnetic field: 10 mT or less				
	Altitude	Operation/Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level				
	Vibration	X: 24.5m/s^2 (2.5G), Y: 49m/s^2 (5G)				
Flange size [mm]		130 SQ.	130 SQ.			130 SQ.
Total length (excluding shaft) [mm]		159.5	159.5			181.5
Flange fitting diameter [mm]		Φ110	Φ110			Φ110
Shaft diameter [mm]		Φ24	Φ24			Φ24
Mass Without / with brake [kg]		9.1/11	9.1/11			11/13
Heat-resistant class		155 (F)				

(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) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 3) Stall torque is the maximum torque that can be output continuously when the motor rotation is stopped.

(Note 4) 3 times or less the motor inertia is recommended for a high-speed, high-accuracy machine, and 5 times or less the motor inertia is recommended for a general machine tool interpolation axis.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< HK Series >

Servo motor type		HK Series	
		ABS specifications: HK □ -G48	
		HK224	
Compatible servo drive unit type	MDS-E-V1-	80	160
	MDS-E-V2-	80	160
	MDS-E-V3-	80	-
Continuous characteristics	Rated output [kW]	2.2	
	Rated current [A]	8.0	
	Rated torque [N•m]	7.0	
	Stall current [A]	16	
	Stall torque [N•m] (Note 3)	14.0	
Rated rotation speed [r/min]		3000	
Maximum rotation speed [r/min]		4500	
Maximum current [A]		58	82
Maximum torque [N•m]		49.0	70.0
Power rate at continuous rated torque [kW/s]		21.9	
Motor inertia [$\times 10^{-4}$kg•m^2]		22.4	
Motor inertia with brake [$\times 10^{-4}$kg•m^2]		24.2	
Maximum motor shaft conversion load inertia [$\times 10^{-4}$kg•m^2] (Note 4)		166	
Motor side encoder		Resolution per motor revolution G48:1,048,576 pulse/rev	
Degree of protection		IP67 (The shaft-through portion is excluded.)	
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -15°C to 70°C (with no freezing)	
	Ambient humidity	Operation: 10 to 90%RH or less (with no dew condensation), Storage: 10 to 90%RH or less (with no dew condensation)	
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust No object generating a strong magnetic field External magnetic field: 10 mT or less	
	Altitude	Operation/Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level	
	Vibration	X: 24.5m/s^2 (2.5G), Y: 49m/s^2 (5G)	
Flange size [mm]		130 SQ.	
Total length (excluding shaft) [mm]		181.5	
Flange fitting diameter [mm]		Φ110	
Shaft diameter [mm]		Φ24	
Mass Without / with brake [kg]		11/13	
Heat-resistant class		155 (F)	

(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) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.
(Note 3) Stall torque is the maximum torque that can be output continuously when the motor rotation is stopped.
(Note 4) 3 times or less the motor inertia is recommended for a high-speed, high-accuracy machine, and 5 times or less the motor inertia is recommended for a general machine tool interpolation axis.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< HK Series >

Servo motor type		HK Series			
		ABS specifications: HK □ -G48			
		HK204	HK302	HK303	HK354
Compatible servo drive unit type	MDS-E-V1-	80	40	80	160
	MDS-E-V2-	80 160	40 80	80 160	160 160W
	MDS-E-V3-	80	40 80	80	-
Continuous characteristics	Rated output [kW]	2.0	3.0	3.0	3.5
	Rated current [A]	7.8	11	11	13
	Rated torque [N•m]	7.6	19.1	14.3	13.4
	Stall current [A]	16	11	16	25
	Stall torque [N•m] (Note 3)	15.0	20.0	22.5	27.0
Rated rotation speed [r/min]		2500	1500	2000	2500
Maximum rotation speed [r/min]		4000	2000	3000	4000
Maximum current [A]		57	29	58	100
Maximum torque [N•m]		49.7	50.0	75.0	98.0
Power rate at continuous rated torque [kW/s]		16.0	51.5	29.0	25.2
Motor inertia [$\times 10^{-4}$kg•m^2]		36.4	70.8	70.8	70.8
Motor inertia with brake [$\times 10^{-4}$kg•m^2]		41.4	75.8	75.8	75.8
Maximum motor shaft conversion load inertia [$\times 10^{-4}$kg•m^2] (Note 4)		268	422	372	525
Motor side encoder		Resolution per motor revolution G48:1,048,576 pulse/rev			
Degree of protection		IP67 (The shaft-through portion is excluded.)			
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -15°C to 70°C (with no freezing)			
	Ambient humidity	Operation: 10 to 90%RH or less (with no dew condensation), Storage: 10 to 90%RH or less (with no dew condensation)			
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust No object generating a strong magnetic field External magnetic field: 10 mT or less			
	Altitude	Operation/Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level			
	Vibration	X: 24.5m/s^2 (2.5G) Y: 49m/s^2 (5G)	X: 24.5m/s^2 (2.5G) Y: 29.4m/s^2 (3G)		
Flange size [mm]		176 SQ.	176 SQ.	176 SQ.	176 SQ.
Total length (excluding shaft) [mm]		138.5	178.5	178.5	178.5
Flange fitting diameter [mm]		Φ114.3	Φ114.3	Φ114.3	Φ114.3
Shaft diameter [mm]		Φ35	Φ35	Φ35	Φ35
Mass Without / with brake [kg]		13/18	20/25	20/25	20/25
Heat-resistant class		155 (F)			

(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) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 3) Stall torque is the maximum torque that can be output continuously when the motor rotation is stopped.

(Note 4) 3 times or less the motor inertia is recommended for a high-speed, high-accuracy machine, and 5 times or less the motor inertia is recommended for a general machine tool interpolation axis.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< HK Series >

Servo motor type		HK Series			
		ABS specifications: HK □ -G48			
		HK453	HK603	HK702	HK703
Compatible servo drive unit type	MDS-E-V1-	160	160	160	160W
	MDS-E-V2-	160 160W	160	160	160W
	MDS-E-V3-	-	-	-	-
Continuous characteristics	Rated output [kW]	4.5	6.0	7.0	7.0
	Rated current [A]	19	21	25	25
	Rated torque [N•m]	21.5	28.6	44.6	33.4
	Stall current [A]	28	33	31	37
	Stall torque [N•m] (Note 3)	33.5	45.5	57.0	51.0
Rated rotation speed [r/min]		2000	2000	1500	2000
Maximum rotation speed [r/min]		3500	3000	2000	3000
Maximum current [A]		116	116	116	116
Maximum torque [N•m]		126	152	190	152
Power rate at continuous rated torque [kW/s]		44.0	58.6	142.0	79.8
Motor inertia [$\times 10^{-4}$kg•m^2]		105	140	140	140
Motor inertia with brake [$\times 10^{-4}$kg•m^2]		110	145	145	145
Maximum motor shaft conversion load inertia [$\times 10^{-4}$kg•m^2] (Note 4)		672	858	1078	858
Motor side encoder		Resolution per motor revolution G48:1,048,576 pulse/rev			
Degree of protection		IP67 (The shaft-through portion is excluded.)			
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -15°C to 70°C (with no freezing)			
	Ambient humidity	Operation: 10 to 90%RH or less (with no dew condensation), Storage: 10 to 90%RH or less (with no dew condensation)			
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust No object generating a strong magnetic field External magnetic field: 10 mT or less			
	Altitude	Operation/Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level			
	Vibration	X: 24.5m/s^2 (2.5G), Y: 29.4m/s^2 (3G)			
Flange size [mm]		176 SQ.	176 SQ.	176 SQ.	176 SQ.
Total length (excluding shaft) [mm]		218.5	258.5	258.5	258.5
Flange fitting diameter [mm]		Φ114.3	Φ114.3	Φ114.3	Φ114.3
Shaft diameter [mm]		Φ35	Φ35	Φ35	Φ35
Mass Without / with brake [kg]		27/31	33/38	33/38	33/38
Heat-resistant class		155 (F)			

(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) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.
(Note 3) Stall torque is the maximum torque that can be output continuously when the motor rotation is stopped.
(Note 4) 3 times or less the motor inertia is recommended for a high-speed, high-accuracy machine, and 5 times or less the motor inertia is recommended for a general machine tool interpolation axis.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

(2) 400V series

< HG-H Series >

Servo motor type		HG-H Series				
		ABS specifications: HG-H □ -D74/-D51/-D48				
		HG-H75	HG-H105	HG-H54	HG-H104	HG-H154
Compatible servo drive unit type	MDS-EH-V1-	10	10	20	20	40
	MDS-EH-V2-	10 20	10 20	20 40	20 40	40 80
	MDS-EH-V3-	-	-	40	40	40
Continuous characteristics	Rated output [kW]	0.75	1.0	0.5	1.0	1.5
	Rated current [A]	1.5	1.8	1.1	2.0	2.7
	Rated torque [N•m]	1.8	2.4	1.6	3.2	4.8
	Stall current [A]	1.6	2.3	1.6	3.3	5.5
	Stall torque [N•m] (Note 4)	2.0	3.0	2.9	5.9	9.0
Rated rotation speed [r/min]		4000		3000		
Maximum rotation speed [r/min]		5000		4000		
Maximum current [A]		7.0	7.8	8.4	15.0	26.0
Maximum torque [N•m]		8.0	11.0	13.0	23.3	42.0
Power rate at continuous rated torque [kW/s]		12.3	11.2	4.1	8.4	12.7
Motor inertia [$\times10^{-4}$kg•m^2]		2.62	5.12	6.13	11.9	17.8
Motor inertia with brake [$\times10^{-4}$kg•m^2]		2.70	5.20	8.26	14.0	20.0
Maximum motor shaft conversion load inertia [$\times10^{-4}$kg•m^2] (Note 5)		18.3	35.8	42.7	83.3	125
Motor side encoder		Resolution per motor revolution D74:67,108,864 pulse/rev, D51:4,194,304 pulse/rev, D48:1,048,576 pulse/rev				
Degree of protection		IP67 (The shaft-through portion is excluded.)				
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -15°C to 70°C (with no freezing)				
	Ambient humidity	Operation: 80%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)				
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust				
	Altitude	Operation/Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level				
	Vibration	X,Y:24.5m/s^2 (2.5G)				
Flange size [mm]		90 SQ.	90 SQ.	130 SQ.	130 SQ.	130 SQ.
Total length (excluding shaft) [mm] (Note 2)		127.5	163.5	118.5	140.5	162.5
Flange fitting diameter [mm]		Φ80	Φ80	Φ110	Φ110	Φ110
Shaft diameter [mm]		Φ14	Φ14	Φ24	Φ24	Φ24
Mass Without / with brake [kg]		2.6/3.6	4.4/5.3	4.8/6.7	6.5/8.5	8.3/11
Heat-resistant class		155 (F)				

(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 total length will be 3.5mm longer when using a D51 or D74 encoder.

(Note 3) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 4) Stall torque is the maximum torque that can be output continuously when the motor rotation is stopped.

(Note 5) 3 times or less the motor inertia is recommended for a high-speed, high-accuracy machine, and 5 times or less the motor inertia is recommended for a general machine tool interpolation axis.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< HG-H Series >

Servo motor type		HG-H Series					
		ABS specifications: HG-H □ -D74 / -D51 / -D48					
		HG-H224	HG-H204	HG-H354	HG-H453	HG-H703	HG-H903
Compatible servo drive unit type	MDS-EH-V1-	40	40	80	80	80W	160
	MDS-EH-V2-	40 80	40 80	80 80W	80 80W	80W 160	160
	MDS-EH-V3-	40	40	-	-	-	-
Continuous characteristics	Rated output [kW]	2.2	2.0	3.5	4.5	7.0	9.0
	Rated current [A]	4.3	3.5	7.8	9.3	16	17
	Rated torque [N•m]	7.0	6.4	11.1	14.3	22.3	28.6
	Stall current [A]	7.4	7.3	14	14	19	28
	Stall torque [N•m] (Note 4)	12.0	13.7	22.5	30.0	49.0	58.8
Rated rotation speed [r/min]		3000					
Maximum rotation speed [r/min]		4000			3500	3000	
Maximum current [A]		28.5	29.0	58.0	53.0	55.0	102.0
Maximum torque [N•m]		46.5	47.0	90.0	122.0	152.0	208.0
Power rate at continuous rated torque [kW/s]		20.7	10.6	16.5	18.3	32.2	42.1
Motor inertia [$\times 10^{-4}$kg•m^2]		23.7	38.3	75.0	112.0	154.0	196.0
Motor inertia with brake [$\times 10^{-4}$kg•m^2]		25.9	47.9	84.7	122.0	164.0	206.0
Maximum motor shaft conversion load inertia [$\times 10^{-4}$kg•m^2] (Note 5)		166	268	525	784	1078	1372
Motor side encoder		Resolution per motor revolution D74: 67,108,864 pulse/rev, D51: 4,194,304 pulse/rev, D48: 1,048,576 pulse/rev					
Degree of protection		IP67 (The shaft-through portion is excluded.)					
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -15°C to 70°C (with no freezing)					
	Ambient humidity	Operation: 80%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)					
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust					
	Altitude	Operation/Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level					
	Vibration	X:24.5m/s^2 (2.5G) Y:29.4m/s^2 (3G)					X,Y:9.8m/s^2 (1G)
Flange size [mm]		130 SQ.	176 SQ.	176 SQ.	176 SQ.	176 SQ.	204 SQ.
Total length (excluding shaft) [mm] (Note 2)		184.5	143.5	183.5	223.5	263.5	330
Flange fitting diameter [mm]		Φ110	Φ114.3	Φ114.3	Φ114.3	Φ114.3	Φ180
Shaft diameter [mm]		Φ24	Φ35	Φ35	Φ35	Φ35	Φ42
Mass Without / with brake [kg]		10.0/12.0	12.0/18.0	19.0/25.0	25/31	32.0/38.0	43/49
Heat-resistant class		155 (F)					

(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 total length will be 3.5mm longer when using a D51 or D74 encoder.

(Note 3) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 4) Stall torque is the maximum torque that can be output continuously when the motor rotation is stopped.

(Note 5) 3 times or less the motor inertia is recommended for a high-speed, high-accuracy machine, and 5 times or less the motor inertia is recommended for a general machine tool interpolation axis.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< HG-H Series >

Servo motor type		HG-H Series
		ABS specifications: HG-H □ -D74/-D51/-D48
		HG-H1502
Compatible servo drive unit type	MDS-EH-V1-	200
	MDS-EH-V2-	-
	MDS-EH-V3-	-
Continuous characteristics	Rated output [kW]	15.0
	Rated current [A]	24
	Rated torque [N•m]	71.6
	Stall current [A]	48
	Stall torque [N•m] (Note 3)	152.1
Rated rotation speed [r/min]		2000
Maximum rotation speed [r/min]		2500
Maximum current [A]		111.0
Maximum torque [N•m]		320.0
Power rate at continuous rated torque [kW/s]		105.0
Motor inertia [$\times 10^{-4}$kg•m^2]		489
Motor inertia with brake [$\times 10^{-4}$kg•m^2]		-
Maximum motor shaft conversion load inertia [$\times 10^{-4}$kg•m^2] (Note 4)		4890
Motor side encoder		Resolution per motor revolution D74: 67,108,864 pulse/rev, D51: 4,194,304 pulse/rev, D48: 1,048,576 pulse/rev
Degree of protection		IP44 (The shaft-through portion is excluded.)
Cooling fan	Input voltage	3-phase 380 to 480VAC 50Hz/60Hz
	Maximum power consumption	65W(50Hz)/85W(60Hz)
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -15°C to 70°C (with no freezing)
	Ambient humidity	Operation: 80%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust
	Altitude	Operation/Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level
	Vibration	X,Y: 24.5m/s^2 (2.5G)
Flange size [mm]		250 SQ.
Total length (excluding shaft) [mm]		476
Flange fitting diameter [mm]		Φ230
Shaft diameter [mm]		Φ65
Mass Without / with brake [kg]		120
Heat-resistance class		155 (F)

(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) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.
(Note 3) Stall torque is the maximum torque that can be output continuously when the motor rotation is stopped.
(Note 4) 3 times or less the motor inertia is recommended for a high-speed, high-accuracy machine, and 5 times or less the motor inertia is recommended for a general machine tool interpolation axis.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< HQ-H Series >

Servo motor type		HQ-H Series	
		ABS specifications: HQ-H □ -D74 / -D51 / -D48	
		HQ-H903	HQ-H1103
Compatible servo drive unit type	MDS-EH-V1-	160	160W
	MDS-EH-V2-	160	-
	MDS-EH-V3-	-	-
Continuous characteristics	Rated output [kW]	9.0	11.0
	Rated current [A]	14.7	18.5
	Rated torque [N•m]	28.7	35.0
	Stall current [A]	32.0	46.0
	Stall torque [N•m] (Note 4)	70.0	110.0
Rated rotation speed [r/min]		3000	
Maximum rotation speed [r/min]		3000	
Maximum current [A]		92.7	114.6
Maximum torque [N•m]		170.0	260.0
Power rate at continuous rated torque [kW/s]		36.0	35.0
Motor inertia [$\times 10^{-4}$kg•m^2]		230.0	350.0
Motor inertia with brake [$\times 10^{-4}$kg•m^2]		254.0	374.0
Maximum motor shaft conversion load inertia [$\times 10^{-4}$kg•m^2] (Note 5)		2250	3000
Motor side encoder		Resolution per motor revolution D74: 67,108,864 pulse/rev, D51: 4,194,304 pulse/rev, D48: 1,048,576 pulse/rev	
Degree of protection		IP67 (The shaft-through portion is excluded.)	
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -15°C to 70°C (with no freezing)	
	Ambient humidity	Operation: 80%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)	
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust	
	Altitude	Operation/Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level	
	Vibration	X,Y:9.8m/s^2 (1G)	
Flange size [mm]		220 SQ.	220 SQ.
Total length (excluding shaft) [mm] (Note 2)		346.5	419.5
Flange fitting diameter [mm]		Φ200	Φ200
Shaft diameter [mm]		Φ55	Φ55
Mass Without / with brake [kg]		51.0/61.4	74.0/84.4
Heat-resistant class		155 (F)	

(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 total length will be 3.5mm longer when using a D51 or D74 encoder.
(Note 3) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.
(Note 4) Stall torque is the maximum torque that can be output continuously when the motor rotation is stopped.
(Note 5) 3 times or less the motor inertia is recommended for a high-speed, high-accuracy machine, and 5 times or less the motor inertia is recommended for a general machine tool interpolation axis.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< HK-H Series >

Servo motor type		HK-H Series				
		ABS specifications: HK-H □ -G48				
		HK-H76	HK-H105	HK-H55	HK-H104	HK-H123
Compatible servo drive unit type	MDS-EH-V1-	10	10	20	20	10
	MDS-EH-V2-	10 20	10 20	20 40	20 40	10 20
	MDS-EH-V3-	-	-	40	40	-
Continuous characteristics	Rated output [kW]	0.75	1.0	0.5	1.0	1.2
	Rated current [A]	1.5	1.7	1.1	1.9	2.3
	Rated torque [N•m]	1.8	2.7	1.6	3.2	5.7
	Stall current [A]	2.3	2.3	2.2	4.8	2.3
	Stall torque [N•m] (Note 3)	2.8	3.8	3.5	8.6	5.7
Rated rotation speed [r/min]		4000	3500	3000	3000	2000
Maximum rotation speed [r/min]		6700	5000	5000	4500	3500
Maximum current [A]		7.8	7.8	11	15	7.8
Maximum torque [N•m]		8.1	12.5	14.8	24.0	18.0
Power rate at continuous rated torque [kW/s]		15.4	17.1	4.3	8.9	28.8
Motor inertia [$\times10^{-4}$kg•m^2]		2.08	4.36	5.90	11.4	11.4
Motor inertia with brake [$\times10^{-4}$kg•m^2]		2.23	4.51	7.75	13.3	13.3
Maximum motor shaft conversion load inertia [$\times10^{-4}$kg•m^2] (Note 4)		18.3	35.7	42.7	83.3	83.3
Motor side encoder		Resolution per motor revolution G48:1,048,576 pulse/rev				
Degree of protection		IP67 (The shaft-through portion is excluded.)				
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -15°C to 70°C (with no freezing)				
	Ambient humidity	Operation: 10 to 90%RH or less (with no dew condensation), Storage: 10 to 90%RH or less (with no dew condensation)				
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust No object generating a strong magnetic field External magnetic field: 10 mT or less				
	Altitude	Operation/Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level				
	Vibration	X: 24.5m/s^2 (2.5G) Y: 49m/s^2 (5G)	X,Y: 24.5m/s^2 (2.5G)	X: 24.5m/s^2 (2.5G) Y: 49m/s^2 (5G)		
Flange size [mm]		90 SQ.	90 SQ.	130 SQ.	130 SQ.	130 SQ.
Total length (excluding shaft) [mm]		114.1	149.5	115.5	137.5	137.5
Flange fitting diameter [mm]		Φ80	Φ80	Φ110	Φ110	Φ110
Shaft diameter [mm]		Φ14	Φ14	Φ24	Φ24	Φ24
Mass Without / with brake [kg]		2.7/3.6	4.1/5.0	5.0/6.8	7.1/8.8	7.1/8.8
Heat-resistant class		155 (F)				

(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) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 3) Stall torque is the maximum torque that can be output continuously when the motor rotation is stopped.

(Note 4) 3 times or less the motor inertia is recommended for a high-speed, high-accuracy machine, and 5 times or less the motor inertia is recommended for a general machine tool interpolation axis.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< HK-H Series >

Servo motor type		HK-H Series				
		ABS specifications: HK-H □ -G48				
		HK-H154		HK-H223	HK-H224	
Compatible servo drive unit type	MDS-EH-V1-	-	40	20	40	80
	MDS-EH-V2-	-	40 80	20 40	40	80
	MDS-EH-V3-	40	-	40	40	-
Continuous characteristics	Rated output [kW]	1.5		2.2	2.2	
	Rated current [A]	2.7		3.8	4.0	
	Rated torque [N•m]	4.8		10.5	7.0	
	Stall current [A]	4.9	6.5	4.9	7.6	7.9
	Stall torque [N•m] (Note 3)	9.0	12.0	13.5	13.5	14.0
Rated rotation speed [r/min]		3000		2000	3000	
Maximum rotation speed [r/min]		4500		3000	4500	
Maximum current [A]		25	29	15	29	41
Maximum torque [N•m]		42.0	48.0	39.0	49.0	70.0
Power rate at continuous rated torque [kW/s]		13.5		49.3	21.9	
Motor inertia [$\times10^{-4}$kg•m^2]		16.9		22.4	22.4	
Motor inertia with brake [$\times10^{-4}$kg•m^2]		18.8		24.2	24.2	
Maximum motor shaft conversion load inertia [$\times10^{-4}$kg•m^2] (Note 4)		125		166	166	
Motor side encoder		Resolution per motor revolution G48:1,048,576 pulse/rev				
Degree of protection		IP67 (The shaft-through portion is excluded.)				
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -15°C to 70°C (with no freezing)				
	Ambient humidity	Operation: 10 to 90%RH or less (with no dew condensation), Storage: 10 to 90%RH or less (with no dew condensation)				
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust No object generating a strong magnetic field External magnetic field: 10 mT or less				
	Altitude	Operation/Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level				
	Vibration	X: 24.5m/s^2 (2.5G), Y: 49m/s^2 (5G)				
Flange size [mm]		130 SQ.		130 SQ.	130 SQ.	
Total length (excluding shaft) [mm]		159.5		181.5	181.5	
Flange fitting diameter [mm]		Φ110		Φ110	Φ110	
Shaft diameter [mm]		Φ24		Φ24	Φ24	
Mass Without / with brake [kg]		9.1/11		11/13	11/13	
Heat-resistant class		155 (F)				

(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) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.
(Note 3) Stall torque is the maximum torque that can be output continuously when the motor rotation is stopped.
(Note 4) 3 times or less the motor inertia is recommended for a high-speed, high-accuracy machine, and 5 times or less the motor inertia is recommended for a general machine tool interpolation axis.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< HK-H Series >

Servo motor type		HK-H Series			
		ABS specifications: HK-H □ -G48			
		HK-H204	HK-H302	HK-H303	HK-H354
Compatible servo drive unit type	MDS-EH-V1-	40	40	40	80
	MDS-EH-V2-	40 80	40	40 80	80 80W
	MDS-EH-V3-	40	40	40	-
Continuous characteristics	Rated output [kW]	2.0	3.0	3.0	3.5
	Rated current [A]	3.9	5.3	5.2	6.2
	Rated torque [N•m]	7.6	19.1	14.3	13.4
	Stall current [A]	7.6	7.7	7.7	13
	Stall torque [N•m] (Note 3)	15.0	28.0	21.5	27.0
Rated rotation speed [r/min]		2500	1500	2000	2500
Maximum rotation speed [r/min]		4000	2000	3000	4000
Maximum current [A]		29	29	29	50
Maximum torque [N•m]		49.7	95.0	75.0	98.0
Power rate at continuous rated torque [kW/s]		16.0	51.5	29.0	25.2
Motor inertia [$\times 10^{-4}$kg•m^2]		36.4	70.8	70.8	70.8
Motor inertia with brake [$\times 10^{-4}$kg•m^2]		41.4	75.8	75.8	75.8
Maximum motor shaft conversion load inertia [$\times 10^{-4}$kg•m^2] (Note 4)		198	525	232	525
Motor side encoder		Resolution per motor revolution G48:1,048,576 pulse/rev			
Degree of protection		IP67 (The shaft-through portion is excluded.)			
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -15°C to 70°C (with no freezing)			
	Ambient humidity	Operation: 10 to 90%RH or less (with no dew condensation), Storage: 10 to 90%RH or less (with no dew condensation)			
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust No object generating a strong magnetic field External magnetic field: 10 mT or less			
	Altitude	Operation/Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level			
	Vibration	X: 24.5m/s^2 (2.5G) Y: 49m/s^2 (5G)	X: 24.5m/s^2 (2.5G) Y: 29.4m/s^2 (3G)		
Flange size [mm]		176 SQ.	176 SQ.	176 SQ.	176 SQ.
Total length (excluding shaft) [mm]		138.5	178.5	178.5	178.5
Flange fitting diameter [mm]		Φ114.3	Φ114.3	Φ114.3	Φ114.3
Shaft diameter [mm]		Φ35	Φ35	Φ35	Φ35
Mass Without / with brake [kg]		13/18	20/25	20/25	20/25
Heat-resistant class		155 (F)			

(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) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 3) Stall torque is the maximum torque that can be output continuously when the motor rotation is stopped.

(Note 4) 3 times or less the motor inertia is recommended for a high-speed, high-accuracy machine, and 5 times or less the motor inertia is recommended for a general machine tool interpolation axis.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< HK-H Series >

Servo motor type		HK-H Series			
		ABS specifications: HK-H □ -G48			
		HK-H453	HK-H603	HK-H702	HK-H703
Compatible servo drive unit type	MDS-EH-V1-	80	80	80	80W
	MDS-EH-V2-	80 80W	80 80W	80 80W	80W 160
	MDS-EH-V3-	-	-	-	-
Continuous characteristics	Rated output [kW]	4.5	6.0	7.0	7.0
	Rated current [A]	9.1	11	13	13
	Rated torque [N•m]	21.5	28.6	44.6	33.4
	Stall current [A]	17	17	16	19
	Stall torque [N•m] (Note 3)	39.0	45.0	57.0	51.0
Rated rotation speed [r/min]		2000	2000	1500	2000
Maximum rotation speed [r/min]		3500	3000	2000	3000
Maximum current [A]		58	58	58	58
Maximum torque [N•m]		126	152	190	152
Power rate at continuous rated torque [kW/s]		44.0	58.6	142	79.8
Motor inertia [$\times 10^{-4}$kg•m^2]		105	140	140	140
Motor inertia with brake [$\times 10^{-4}$kg•m^2]		110	145	145	145
Maximum motor shaft conversion load inertia [$\times 10^{-4}$kg•m^2] (Note 4)		605	756	1078	899
Motor side encoder		Resolution per motor revolution G48:1,048,576 pulse/rev			
Degree of protection		IP67 (The shaft-through portion is excluded.)			
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -15°C to 70°C (with no freezing)			
	Ambient humidity	Operation: 10 to 90%RH or less (with no dew condensation), Storage: 10 to 90%RH or less (with no dew condensation)			
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust No object generating a strong magnetic field External magnetic field: 10 mT or less			
	Altitude	Operation/Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level			
	Vibration	X: 24.5m/s^2 (2.5G), Y: 29.4m/s^2 (3G)			
Flange size [mm]		176 SQ.	176 SQ.	176 SQ.	176 SQ.
Total length (excluding shaft) [mm]		218.5	258.5	258.5	258.5
Flange fitting diameter [mm]		Φ114.3	Φ114.3	Φ114.3	Φ114.3
Shaft diameter [mm]		Φ35	Φ35	Φ35	Φ35
Mass Without / with brake [kg]		27/31	33/38	33/38	33/38
Heat-resistant class		155 (F)			

(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) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 3) Stall torque is the maximum torque that can be output continuously when the motor rotation is stopped.

(Note 4) 3 times or less the motor inertia is recommended for a high-speed, high-accuracy machine, and 5 times or less the motor inertia is recommended for a general machine tool interpolation axis.

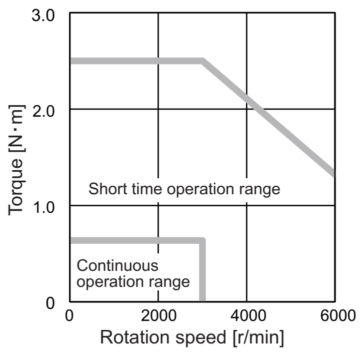
For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

2.1.2 Torque Characteristics

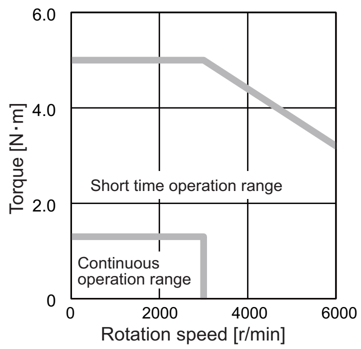
(1) 200V series

< HG Series >

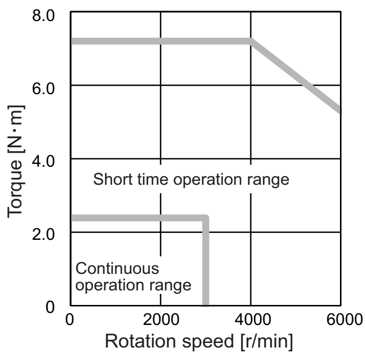
[HG46]



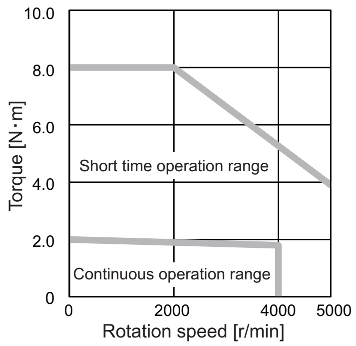
[HG56]



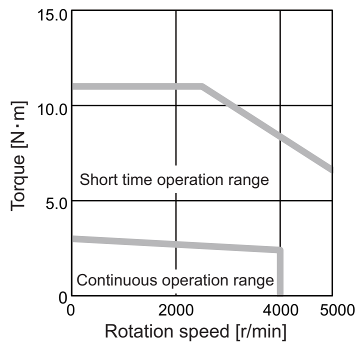
[HG96]



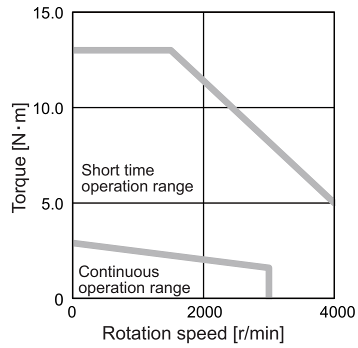
[HG75]



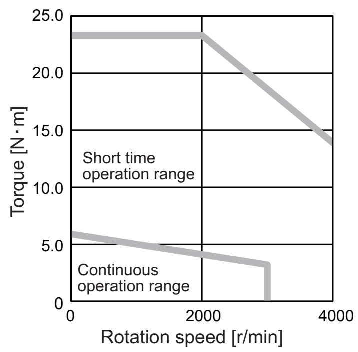
[HG105]



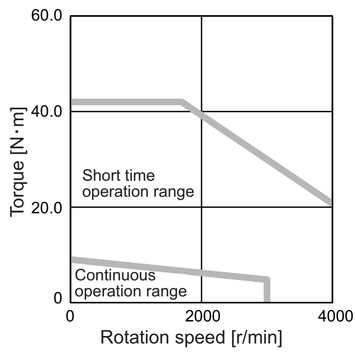
[HG54]



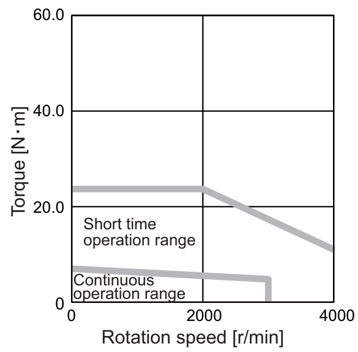
[HG104]



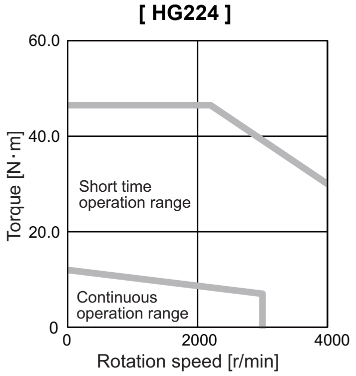
[HG154]



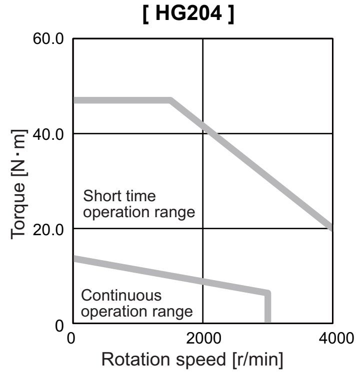
[HG154] (E-V3-40)



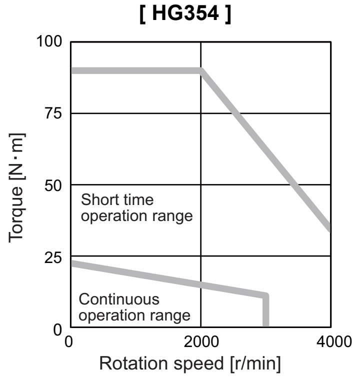
[HG224]



[HG204]



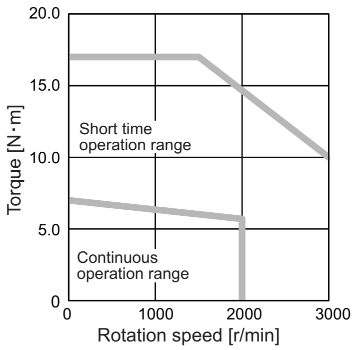
[HG354]



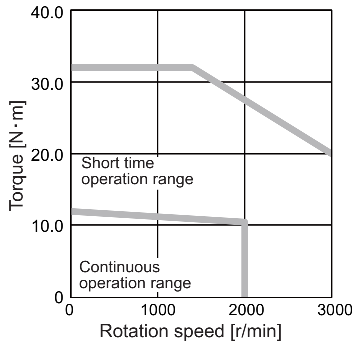
(Note 1) The above graphs show the data when applied the input voltage of 200VAC. When the input voltage is 200VAC or less, the short time operation range is limited.

< HG Series >

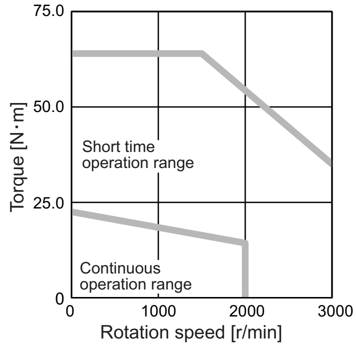
[HG123]



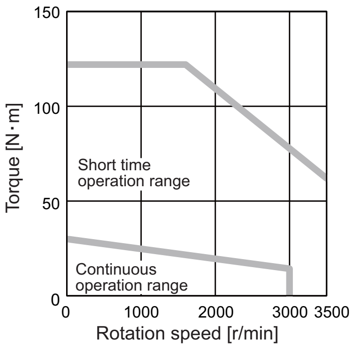
[HG223]



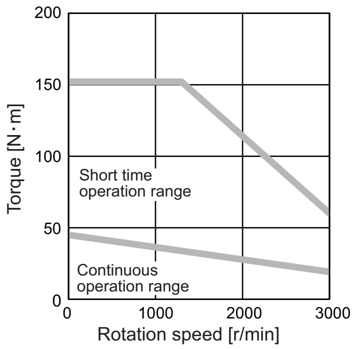
[HG303]



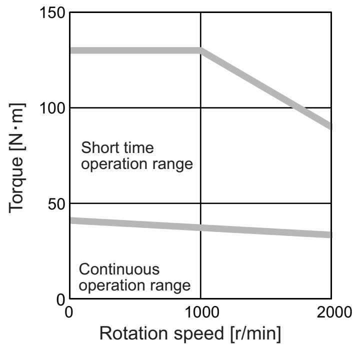
[HG453]



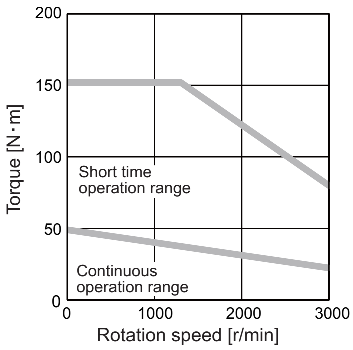
[HG603]



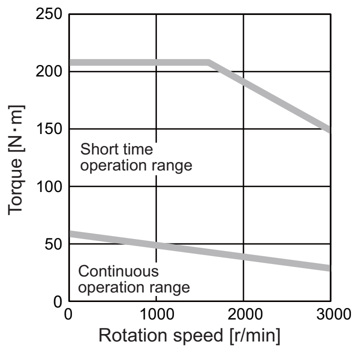
[HG702]



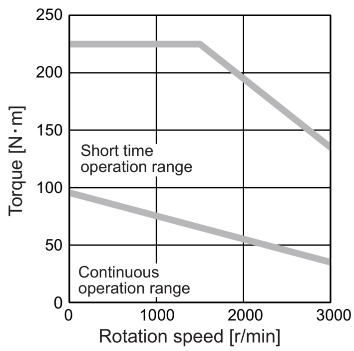
[HG703]



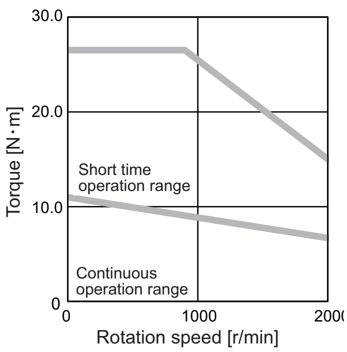
[HG903]



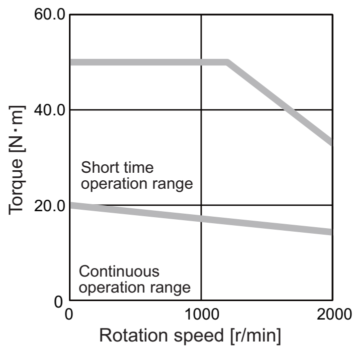
[HG1103]



[HG142]



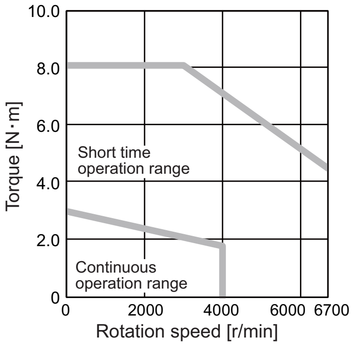
[HG302]



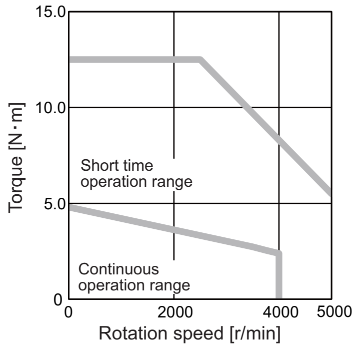
(Note 1) The above graphs show the data when applied the input voltage of 200VAC. When the input voltage is 200VAC or less, the short time operation range is limited.

< HK Series >

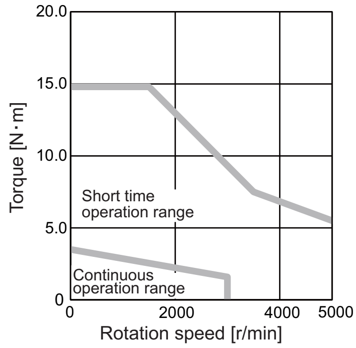
[HK76]



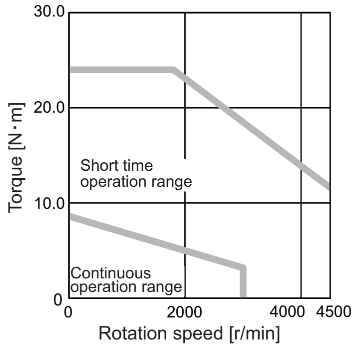
[HK105]



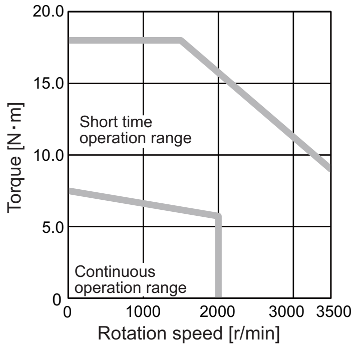
[HK55]



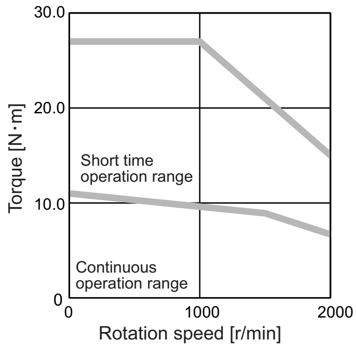
[HK104]



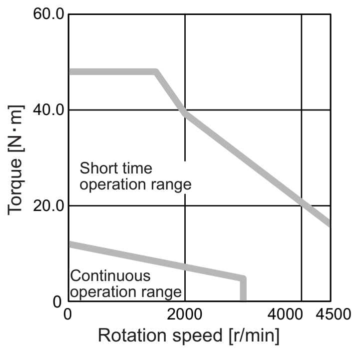
[HK123]



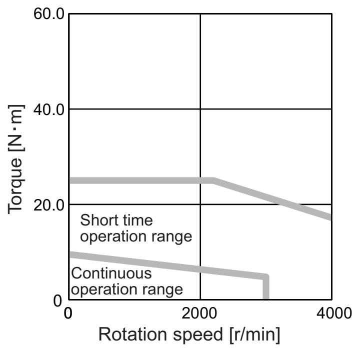
[HK142]



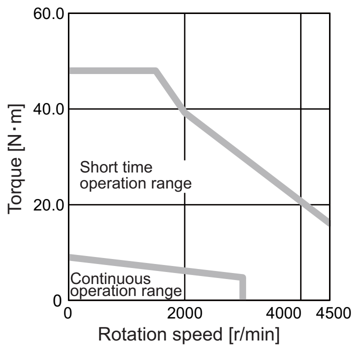
[HK154]
(E-V1/V2)



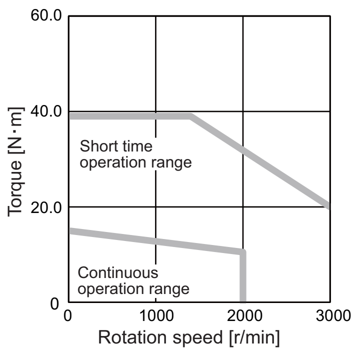
[HK154]
(E-V3-40)



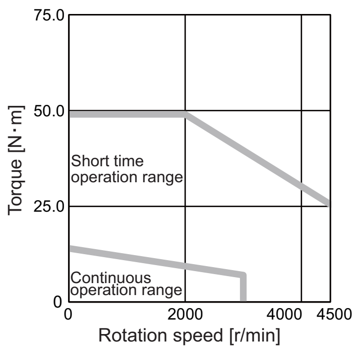
[HK154]
(E-V3-80)



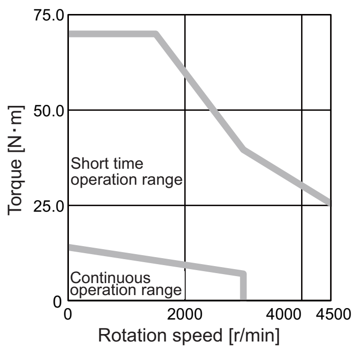
[HK223]



[HK224]
(E-V1/V2/V3-80)



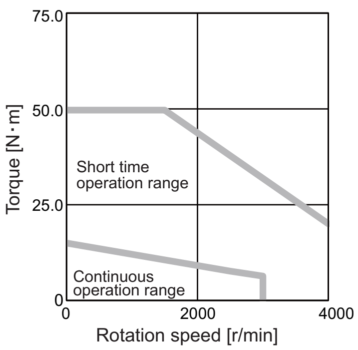
[HK224]
(E-V1/V2-160)



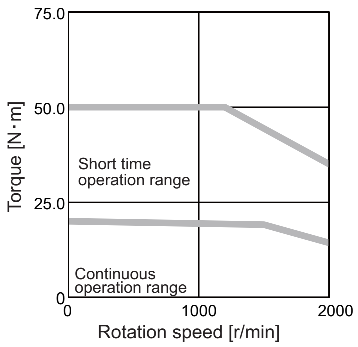
(Note 1) The above graphs show the data when applied the input voltage of 200VAC. When the input voltage is 200VAC or less, the short time operation range is limited.

< HK Series >

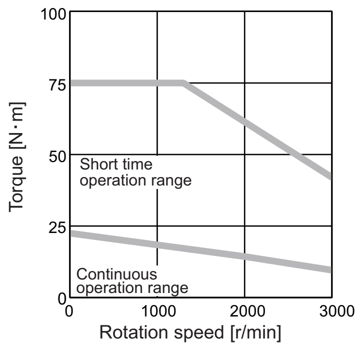
[HK204]



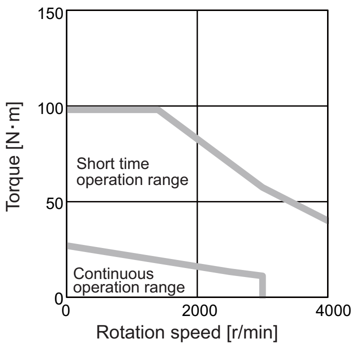
[HK302]



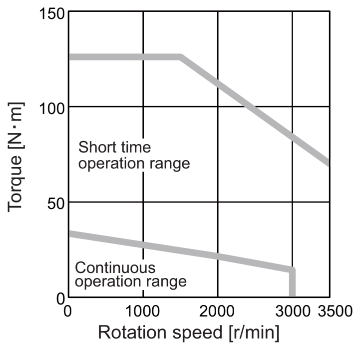
[HK303]



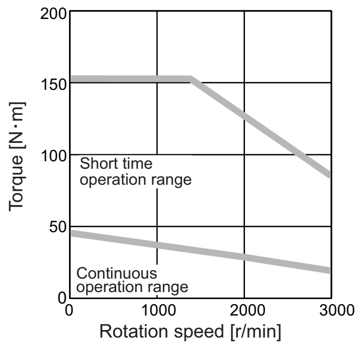
[HK354]



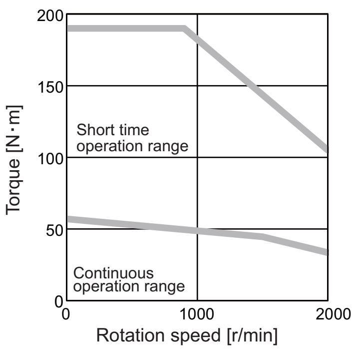
[HK453]



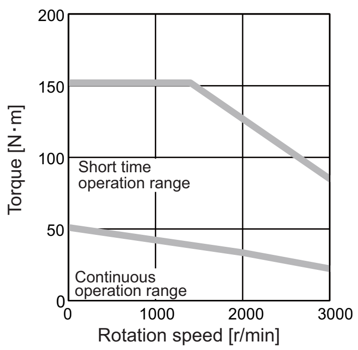
[HK603]



[HK702]



[HK703]

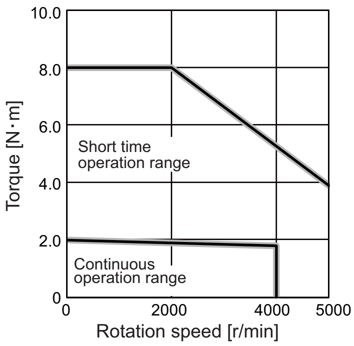


(Note 1) The above graphs show the data when applied the input voltage of 200VAC. When the input voltage is 200VAC or less, the short time operation range is limited.

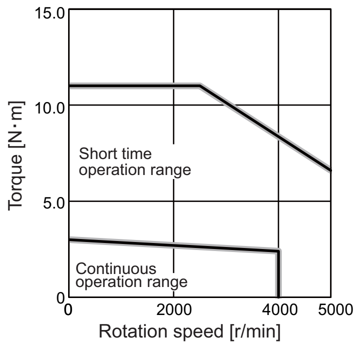
(2) 400V series

< HG-H Series >

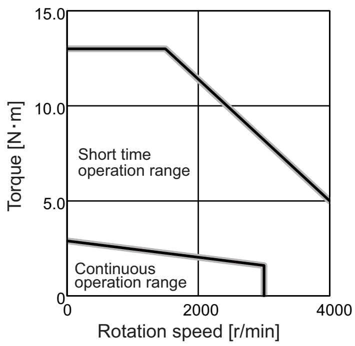
[HG-H75]



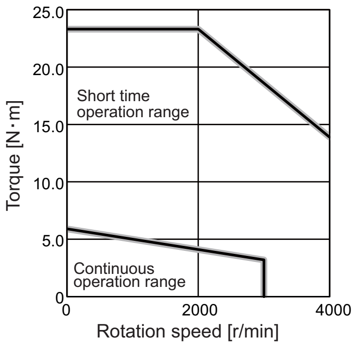
[HG-H105]



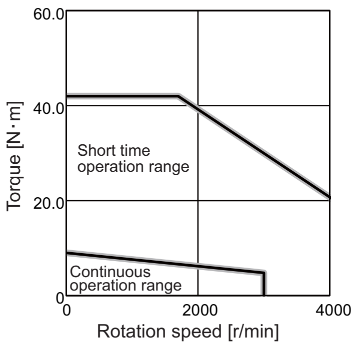
[HG-H54]



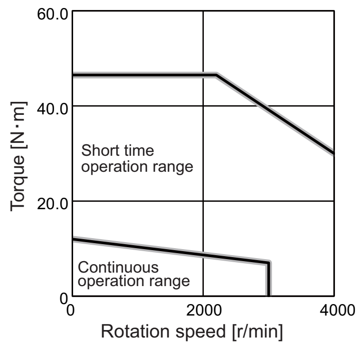
[HG-H104]



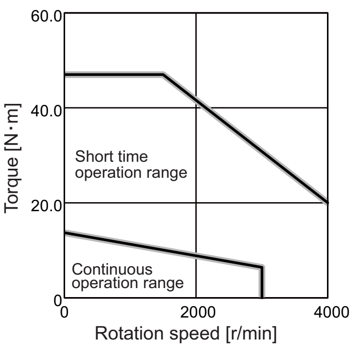
[HG-H154]



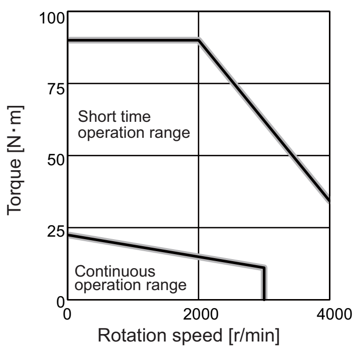
[HG-H224]



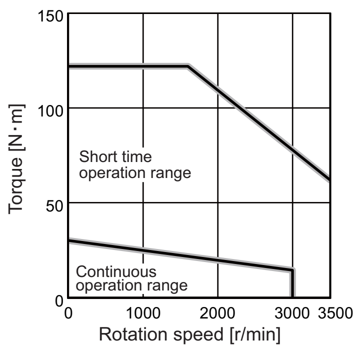
[HG-H204]



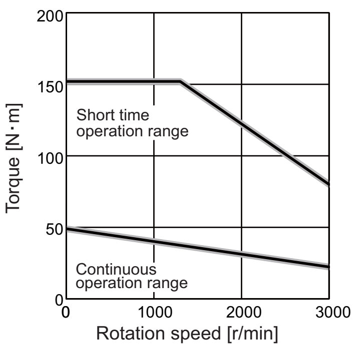
[HG-H354]



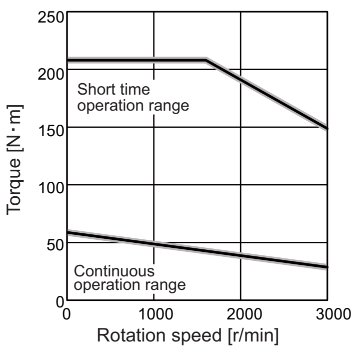
[HG-H453]



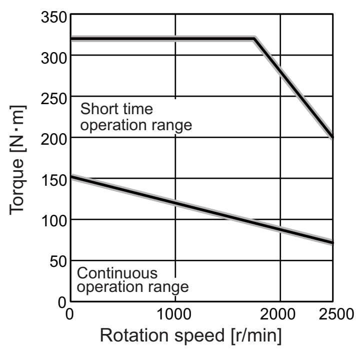
[HG-H703]



[HG-H903]



[HG-H1502]

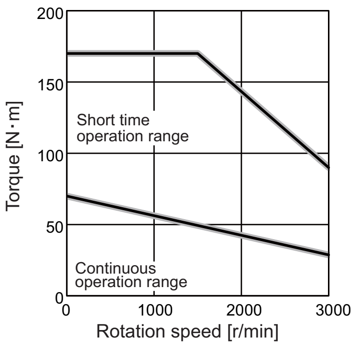


(Note 1) The line (gray) of short time operation range shows the characteristics of 3-phase 400V input.

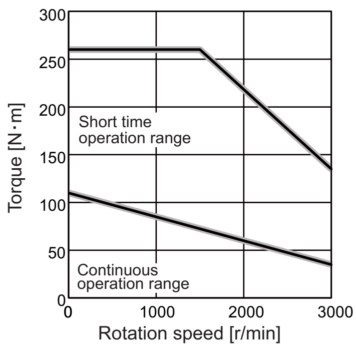
(Note 2) The line (black) of short time operation range shows the characteristics of 3-phase 380V input.

< HQ-H Series >

[HQ-H903]



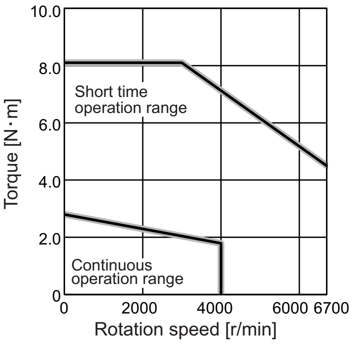
[HQ-H1103]



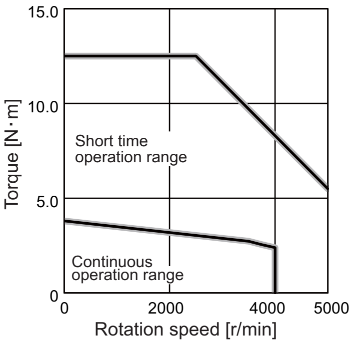
(Note 1) The line (gray) of short time operation range shows the characteristics of 3-phase 400V input.
(Note 2) The line (black) of short time operation range shows the characteristics of 3-phase 380V input.

< HK-H Series >

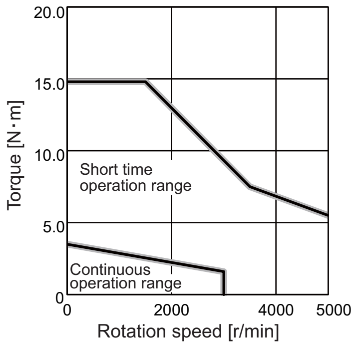
[HK-H76]



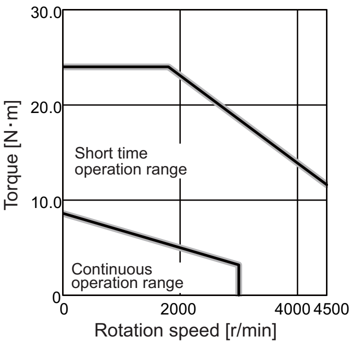
[HK-H105]



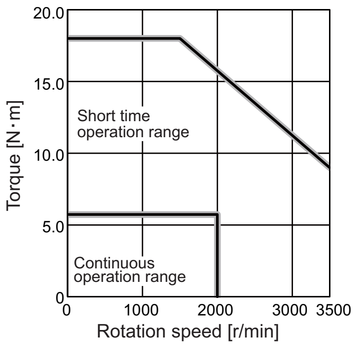
[HK-H55]



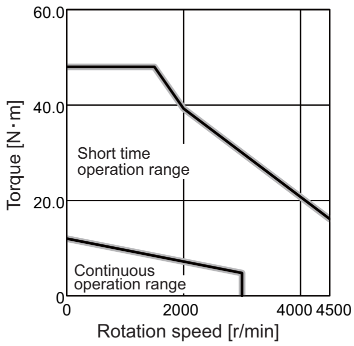
[HK-H104]



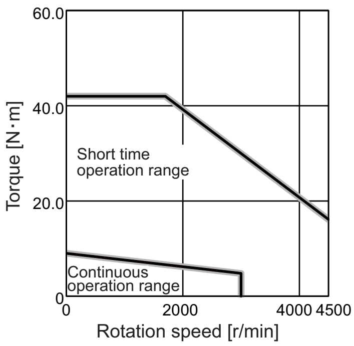
[HK-H123]



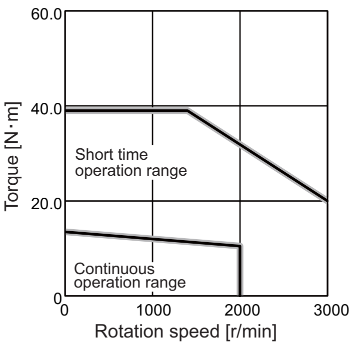
[HK-H154]
(EH-V1/V2)



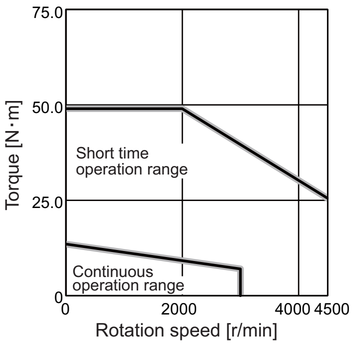
[HK-H154]
(EH-V3-40)



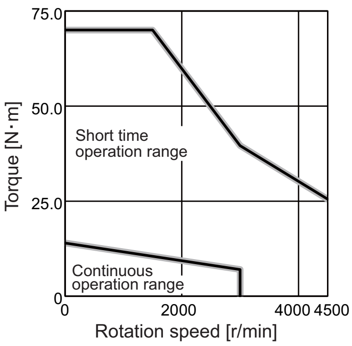
[HK-H223]



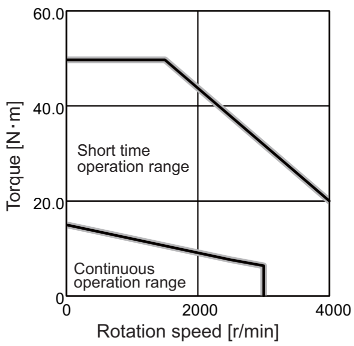
[HK-H224]
(EH-V1/V2/V3-40)



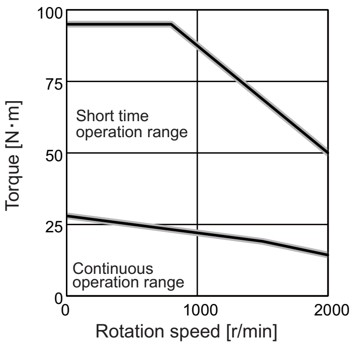
[HK-H224]
(EH-V1/V2-80)



[HK-H204]



[HK-H302]

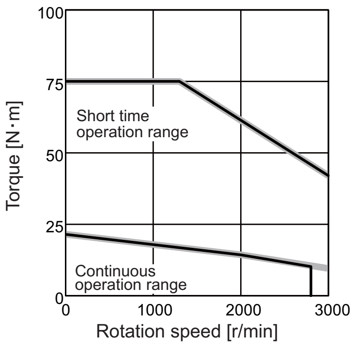


(Note 1) The line (gray) of short time operation range shows the characteristics of 3-phase 400V input.

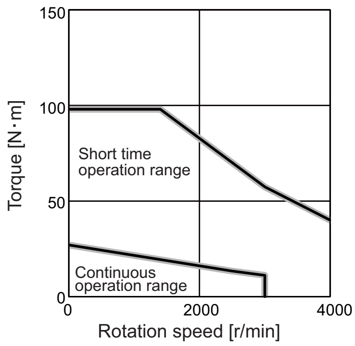
(Note 2) The line (black) of short time operation range shows the characteristics of 3-phase 380V input.

< HK-H Series >

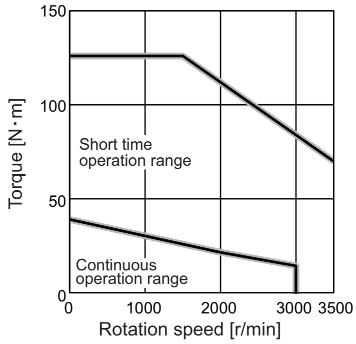
[HK-H303]



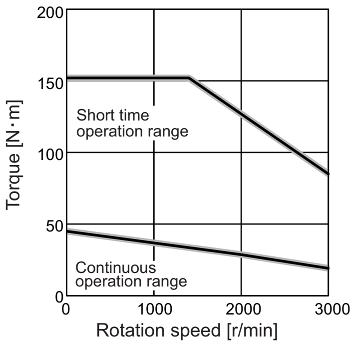
[HK-H354]



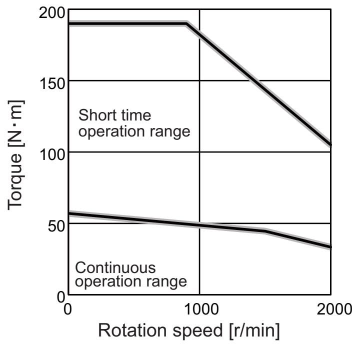
[HK-H453]



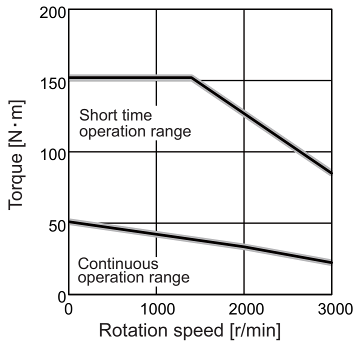
[HK-H603]



[HK-H702]



[HK-H703]



(Note 1) The line (gray) of short time operation range shows the characteristics of 3-phase 400V input.
(Note 2) The line (black) of short time operation range shows the characteristics of 3-phase 380V input.

2.2 Spindle Motor

2.2.1 Specifications

(1) 200V series

< SJ-D Series (Normal) >

Spindle motor type		SJ-D3.7/ 100-01	SJ-D5.5/ 100-01	SJ-D5.5/ 120-01	SJ-D5.5/ 120-02		SJ-D7.5/ 100-01	SJ-D7.5/ 120-01
Compatible spindle drive unit type	MDS-E-SP-	80	80	80	160	200	160	160
	MDS-E-SP2-	80 16080 (M)	80 16080 (M)	80 16080 (M)	16080 (L)	-	16080 (L)	16080 (L)
Output capacity [kW]	Continuous rated output	2.2	3.7	3.7	3.7		5.5	5.5
	Short time rated output	3.7 (15-minute rating)	5.5 (30-minute rating)	5.5 (30-minute rating)	5.5 (25%ED rating)		7.5 (30-minute rating)	7.5 (30-minute rating)
	Standard output during acceleration/deceleration	3.7	5.5	5.5	9.2	10.4	7.5	7.5
	Actual acceleration/ deceleration output (Note 3)	4.4	6.6	6.6	11.0	12.5	9	9
Base rotation speed [r/min]		1500	1500	1500	2800		1500	1500
Maximum rotation speed [r/min]		10000	10000	12000	12000		10000	12000
Frame No.		B90	D90	D90	B90		A112	A112
Continuous rated current [A]		15	24	24	24		35	35
Continuous rated torque [N•m]		14.0	23.6	23.6	12.6		35.0	35.0
GD^2 [kg•m^2]		0.030	0.053	0.053	0.030		0.094	0.094
Inertia [kg•m^2]		0.0074	0.013	0.013	0.0074		0.023	0.023
Tolerable radial load [N]		980	1470	1470	980		1960	1960
Cooling fan	Input voltage	3-phase 200V						
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -20°C to 65°C (with no freezing)						
	Ambient humidity	Operation: 90%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)						
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust						
	Altitude	Operation: 1000 meters or less above sea level, Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level						
Degree of protection		IP54 (The shaft-through portion is excluded.)						
Flange size [mm]		174 SQ.	174 SQ.	174 SQ.	174 SQ.		204 SQ.	204 SQ.
Total length (excluding shaft) [mm]		327	417	417	327		439	439
Flange fitting diameter [mm]		Φ150	Φ150	Φ150	Φ150		Φ180	Φ180
Shaft diameter [mm]		Φ28	Φ28	Φ28	Φ28		Φ32	Φ32
Mass [kg]		26	39	39	26		53	53
Heat-resistant class		155 (F)						

(Note 1) The tolerable radial load is the value calculated at the center of output shaft.

(Note 2) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 3) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

(Note 4) For SJ-D5.5/120-02, output characteristics at acceleration/deceleration vary depending on the connected drive unit. Refer to "output characteristics" for details.

(Note 5) IP code classifies the degree of protection of the motor body. It does not apply to the other electronic parts such as the cooling fan and the encoder.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< SJ-D Series (Normal) >

Spindle motor type		SJ-D11/ 100-01	SJ-D15/ 80-01	SJ-D18.5/ 80-01		SJ-D22/ 80-01		SJ-D26/ 80-01
Compatible spindle drive unit type	MDS-E-SP-	160	200	240	320	240	320	320
	MDS-E-SP2-	16080 (L)	-	-	-	-	-	-
Output capacity [kW]	Continuous rated output	7.5	11	15	15	18.5	18.5	22
	Short time rated output	11 (30-minute rating)	18.5 (25%ED rating)	18.5 (30-minute rating)	25 (25%ED rating)	22 (30-minute rating)	30 (25%ED rating)	35 (25%ED rating)
	Standard output during acceleration/deceleration	11	18.5	18.5	25.0	22.0	30.0	35.0
	Actual acceleration/ deceleration output (Note 3)	13.2	22.2	22.2	30.0	26.4	36.0	42.0
Base rotation speed [r/min]		1500	1500	1500		1500		1500
Maximum rotation speed [r/min]		10000	8000	8000		8000		8000
Frame No.		B112	A160	B160		C160		D160
Continuous rated current [A]		44	58	79		87		109
Continuous rated torque [N•m]		47.7	70.0	95.5		118		140
GD^2 [kg•m^2]		0.122	0.35	0.41		0.55		0.65
Inertia [kg•m^2]		0.031	0.086	0.10		0.14		0.16
Tolerable radial load [N]		1960	3430	3430		3920		3920
Cooling fan	Input voltage	3-phase 200V						
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -20°C to 65°C (with no freezing)						
	Ambient humidity	Operation: 90%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)						
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust						
	Altitude	Operation: 1000 meters or less above sea level, Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level						
Degree of protection		IP54 (The shaft-through portion is excluded.)						
Flange size [mm]		204 SQ.	250 SQ.	250 SQ.		250 SQ.		250 SQ.
Total length (excluding shaft) [mm]		489	438.5	468.5		538.5		583.5
Flange fitting diameter [mm]		Φ180	Φ230	Φ230		Φ230		Φ230
Shaft diameter [mm]		Φ48	Φ48	Φ48		Φ55		Φ55
Mass [kg]		64	93	103		131		147
Heat-resistant class		155 (F)						

(Note 1) The tolerable radial load is the value calculated at the center of output shaft.

(Note 2) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 3) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

(Note 4) IP code classifies the degree of protection of the motor body. It does not apply to the other electronic parts such as the cooling fan and the encoder.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< SJ-D Series (Hollow shaft) >

Spindle motor type		SJ-D5.5/120-02T-S	
Compatible spindle drive unit type	MDS-E-SP-	160	200
	MDS-E-SP2-	16080 (L)	-
Output capacity [kW]	Continuous rated output	3.7	
	Short time rated output	5.5（25%ED rating）	
	Standard output during acceleration/deceleration	9.2	10.4
	Actual acceleration/ deceleration output (Note 3)	11.0	12.5
Base rotation speed [r/min]		2800	
Maximum rotation speed [r/min]		12000	
Frame No.		B90	
Continuous rated current [A]		24	
Continuous rated torque [N•m]		12.6	
GD^2 [kg•m^2]		0.030	
Inertia [kg•m^2]		0.0075	
Tolerable radial load [N]		Not permitted (Note 4)	
Cooling fan	Input voltage	3-phase 200V	
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -20°C to 65°C (with no freezing)	
	Ambient humidity	Operation: 90%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)	
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust	
	Altitude	Operation: 1000 meters or less above sea level, Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level	
Degree of protection		IP54 (The shaft-through portion is excluded.)	
Flange size [mm]		174 SQ.	
Total length (excluding shaft) [mm]		327	
Flange fitting diameter [mm]		Φ150	
Shaft diameter [mm]		Φ28	
Mass [kg]		24	
Heat-resistant class		155 (F)	

(Note 1) The tolerable radial load is the value calculated at the center of output shaft.

(Note 2) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 3) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

(Note 4) The motor cannot be driven when a pulley or gear is directly installed on the shaft.

(Note 5) For SJ-D5.5/120-02T-S, output characteristics at acceleration/deceleration vary depending on the connected drive unit. Refer to "output characteristics" for details.

(Note 6) IP code classifies the degree of protection of the motor body. It does not apply to the other electronic parts such as the cooling fan and the encoder.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< SJ-DG Series (High-output) (Hollow shaft) >

Spindle motor type		SJ-DG3.7/ 120-03T	SJ-DG5.5/ 120-04T	SJ-DG7.5/ 120-05T	SJ-DG11/ 100-03T	SJ-DG11/120-03T(-S)	
Compatible spindle drive unit type	MDS-E-SP-	160	160	160	200	160	200
	MDS-E-SP2-	-	-	-	-	16080(L)	-
Output capacity [kW]	Continuous rated output	2.2	3.7	5.5	7.5	7.5	7.5
	Short time rated output	5.5 (25%ED rating)	7.5 (25%ED rating)	11 (25%ED rating)	15 (25%ED rating)	11 (30-minute rating)	15 (25%ED rating)
	Standard output during acceleration/deceleration	5.5	7.5	11.0	15.0	11.0	15.0
	Actual acceleration/ deceleration output (Note 3)	6.6	9.0	13.2	18.0	13.2	18.0
Base rotation speed [r/min]		1500	1500	1500	1500	(Continuous) 1500/ (Short time) 1400	1500
Maximum rotation speed [r/min]		12000	12000	12000	10000	12000	
Frame No.		B90	D90	A112	B112	B112	
Continuous rated current [A]		22	27	38	47	47	
Continuous rated torque [N•m]		14.0	23.6	35.0	47.7	47.7	
GD^2 [kg•m^2]		0.026	0.049	0.088	0.12	0.12	
Inertia [kg•m^2]		0.0066	0.012	0.022	0.029	0.029 (0.030)	
Tolerable radial load [N]		980	1470	1960	1960	1960 (Not permitted (Note 4))	
Cooling fan	Input voltage	3-phase 200V					
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -20°C to 65°C (with no freezing)					
	Ambient humidity	Operation: 90%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)					
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust					
	Altitude	Operation: 1000 meters or less above sea level, Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level					
Degree of protection		IP54 (The shaft-through portion and rotation seal portion are excluded.)					
Flange size [mm]		174 SQ.	174 SQ.	204 SQ.	204SQ.	204SQ.	
Total length (excluding shaft) [mm]		327	417	439	489	489 (488)	
Flange fitting diameter [mm]		Φ150	Φ150	Φ180	Φ180	Φ180	
Shaft diameter [mm]		Φ28	Φ28	Φ32	Φ48	Φ48 (Φ38)	
Mass [kg]		24	37	50	61	61 (58)	
Heat-resistant class		155 (F)					

(Note 1) The tolerable radial load is the value calculated at the center of output shaft.
(Note 2) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.
(Note 3) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".
(Note 4) The motor cannot be driven when a pulley or gear is directly installed on the shaft.
(Note 5) IP code classifies the degree of protection of the motor body. It does not apply to the other electronic parts such as the cooling fan and the encoder.
(Note 6) The values inside of ( ) are for the motor with "S" at the end of the type name.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< SJ-DG Series (High-output) (Hollow shaft) >

Spindle motor type		SJ-DG11/120-12T-K(S)		SJ-DG11/150-06T(-S)			SJ-DG11/150-15T-K(S)	
Compatible spindle drive unit type	MDS-E-SP-	200		160	200	200	200	
	MDS-E-SP2-	-		16080(L)	-	-	-	
Coil changeover		Low-speed coil	High-speed coil	-	-	-	Low-speed coil	High-speed coil
Output capacity [kW]	Continuous rated output	9	11	7.5	7.5	7.5	7.5	7.5
	Short time rated output	18.5 (10%ED rating)	18.5 (10%ED rating)	11 (25%ED rating)	15 (25%ED rating)	15 (10%ED rating)	18.5 (10%ED rating)	18.5 (10%ED rating)
	Standard output during acceleration/deceleration	18.5	18.5	11	15	15	18.5	18.5
	Actual acceleration/ deceleration output (Note 3)	22.2	22.2	13.2	18	18	22.2	22.2
Base rotation speed [r/min]		1500	(Continuous) 3700/ (Short time) 3000	(Continuous) 1500/ (Short time) 1400	1500	1500	1500	3000
Maximum rotation speed [r/min]		3700	12000	15000			3000	15000
Frame No.		B112						
Continuous rated current [A]		62		47			55	
Continuous rated torque [N•m]		57.3	28.4	47.7			47.7	23.9
GD^2 [kg•m^2]		0.12		0.11 (0.12)			0.11 (0.12)	
Inertia [kg•m^2]		0.029 (0.030)		0.028 (0.030)			0.028 (0.030)	
Tolerable radial load [N]		1960 (Not permitted (Note 4))		980 (Not permitted (Note 4))			980 (Not permitted (Note 4))	
Cooling fan	Input voltage	3-phase 200V						
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -20°C to 65°C (with no freezing)						
	Ambient humidity	Operation: 90%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)						
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust						
	Altitude	Operation: 1000 meters or less above sea level, Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level						
Degree of protection		IP54 (The shaft-through portion and rotation seal portion are excluded.)						
Flange size [mm]		204 SQ.		204 SQ.			204 SQ.	
Total length (excluding shaft) [mm]		489 (488)		489 (488)			489 (488)	
Flange fitting diameter [mm]		Φ180		Φ180			Φ180	
Shaft diameter [mm]		Φ48 (Φ38)		Φ38			Φ38	
Mass [kg]		61		60 (61)			60 (61)	
Heat-resistant class		155 (F)						

(Note 1) The tolerable radial load is the value calculated at the center of output shaft.

(Note 2) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 3) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

(Note 4) The motor cannot be driven when a pulley or gear is directly installed on the shaft.

(Note 5) IP code classifies the degree of protection of the motor body. It does not apply to the other electronic parts such as the cooling fan and the encoder.

(Note 6) The values inside of ( ) are for the motor with "S" at the end of the type name.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< SJ-DG Series (High-output) (Hollow shaft) >

Spindle motor type		SJ-DG15/120-02T-K(S)			
Compatible spindle drive unit type	MDS-E-SP-	200		240	
	MDS-E-SP2-	-		-	
Coil changeover		Low-speed coil	High-speed coil	Low-speed coil	High-speed coil
Output capacity [kW]	Continuous rated output	11	11	11	11
	Short time rated output	18.5 (25%ED rating)	18.5 (25%ED rating)	25 (15%ED rating)	28 (15%ED rating)
	Standard output during acceleration/deceleration	18.5	18.5	25	28
	Actual acceleration/ deceleration output (Note 3)	22.2	22.2	30	33.6
Base rotation speed [r/min]		1350	3550	1350	3550
Maximum rotation speed [r/min]		12000			
Frame No.		A160			
Continuous rated current [A]		60			
Continuous rated torque [N•m]		77.8	29.6	77.8	29.6
GD^2 [kg•m^2]		0.35			
Inertia [kg•m^2]		0.086			
Tolerable radial load [N]		1960 (Not permitted (Note 4))			
Cooling fan	Input voltage	3-phase 200V			
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -20°C to 65°C (with no freezing)			
	Ambient humidity	Operation: 90%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)			
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust			
	Altitude	Operation: 1000 meters or less above sea level, Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level			
Degree of protection		IP54 (The shaft-through portion and rotation seal portion are excluded.)			
Flange size [mm]		250 SQ.			
Total length (excluding shaft) [mm]		438.5 (437)			
Flange fitting diameter [mm]		Φ230			
Shaft diameter [mm]		Φ48			
Mass [kg]		93 (88)			
Heat-resistant class		155 (F)			

(Note 1) The tolerable radial load is the value calculated at the center of output shaft.

(Note 2) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 3) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

(Note 4) The motor cannot be driven when a pulley or gear is directly installed on the shaft.

(Note 5) IP code classifies the degree of protection of the motor body. It does not apply to the other electronic parts such as the cooling fan and the encoder.

(Note 6) The values inside of ( ) are for the motor with "S" at the end of the type name.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< SJ-DJ Series (Compact & lightweight) >

Spindle motor type		SJ-DJ5.5/ 100-01	SJ-DJ5.5/ 120-01	SJ-DJ7.5/ 100-01	SJ-DJ7.5/ 120-01	SJ-DJ11/100-01	SJ-DJ15/80-01
Compatible spindle drive unit type	MDS-E-SP-	80	80	160	160	160	200
	MDS-E-SP2-	80 16080 (M)	80 16080 (M)	16080 (L)	16080 (L)	16080 (L)	-
Output capacity [kW]	Continuous rated output	3.7	3.7	5.5	5.5	7.5	11
	Short time rated output	5.5 (25%ED rating)	5.5 (25%ED rating)	7.5 (15-minute rating)	7.5 (15-minute rating)	11 (15-minute rating)	15 (15-minute rating) (15%ED rating)
	Standard output during acceleration/deceleration	5.5	5.5	7.5	7.5	11	15
	Actual acceleration/ deceleration output (Note 3)	6.6	6.6	9	9	13.2	18
Base rotation speed [r/min]		(Continuous) 2000/ (Short time) 1500	(Continuous) 2000/ (Short time) 1500	(Continuous) 2000/ (Short time) 1500	(Continuous) 2000/ (Short time) 1500	(Continuous) 2000/ (Short time) 1500	(Continuous) 2000/ (Short time) 1500
Maximum rotation speed [r/min]		10000	12000	10000	12000	10000	8000
Frame No.		B90	B90	D90	D90	A112	B112
Continuous rated current [A]		21	21	26	26	35	51
Continuous rated torque [N•m]		17.7	17.7	26.3	26.3	35.8	52.5
GD^2 [kg•m^2]		0.030	0.030	0.053	0.053	0.094	0.122
Inertia [kg•m^2]		0.0074	0.0074	0.013	0.013	0.023	0.031
Tolerable radial load [N]		980	980	1470	1470	1960	1960
Cooling fan	Input voltage	3-phase 200V					
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -20°C to 65°C (with no freezing)					
	Ambient humidity	Operation: 90%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)					
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust					
	Altitude	Operation: 1000 meters or less above sea level, Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level					
Degree of protection		IP54 (The shaft-through portion is excluded.)					
Flange size [mm]		174 SQ.	174 SQ.	174 SQ.	174 SQ.	204 SQ.	204 SQ.
Total length (excluding shaft) [mm]		327	327	417	417	439	489
Flange fitting diameter [mm]		Φ150	Φ150	Φ150	Φ150	Φ180	Φ180
Shaft diameter [mm]		Φ28	Φ28	Φ28	Φ28	Φ32	Φ48
Mass [kg]		26	26	39	39	53	64
Heat-resistant class		155 (F)					

(Note 1) The tolerable radial load is the value calculated at the center of output shaft.

(Note 2) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 3) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

(Note 4) IP code classifies the degree of protection of the motor body. It does not apply to the other electronic parts such as the cooling fan and the encoder.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< SJ-DL Series (Low-inertia) >

Spindle motor type		SJ-DL0.75/ 100-01	SJ-DL1.5/ 100-01	SJ-DL3.7/ 240-01T	SJ-DL5.5/ 150-01T	SJ-DL5.5/ 200-01T	SJ-DL5.5/ 240-05T	SJ-DL7.5/ 150-01T
Compatible spindle drive unit type	MDS-E-SP-	20	40	200	160	160	200	160
	MDS-E-SP2-	20	40	-	16080 (L)	16080 (L)	-	16080 (L)
Output capacity [kW]	Continuous rated output	0.4	0.75	1.5	3.7	3.7	3.7	5.5
	Short time rated output	0.75 (10-minute rating)	1.5 (10-minute rating)	3.7 (10-minute rating)	5.5 (15-minute rating)	5.5 (15-minute rating)	5.5 (15-minute rating)	7.5 (30-minute rating)
	Standard output during acceleration/deceleration	0.9	1.5	15.0	11	11	22	11
	Actual acceleration/ deceleration output (Note 3)	1.1	1.8	18.0	13.2	13.2	26.4	13.2
Base rotation speed [r/min]		1500	1500	3000	2500	2500	1650	1500
Maximum rotation speed [r/min]		10000	10000	24000	15000	20000	24000	15000
Frame No.		A71	B71	C71	C90	C90	C90	B112
Continuous rated current [A]		6	9	42	42	42	57	46
Continuous rated torque [N•m]		2.55	4.8	4.8	14.1	14.1	14.1	35.0
GD^2 [kg•m^2]		0.0044	0.0077	0.0097	0.018	0.018	0.017	0.063
Inertia [kg•m^2]		0.0011	0.0019	0.0024	0.0046	0.0046	0.0042	0.016
Tolerable radial load [N]		490	490	Not permitted (Note 4)	245	245	245	980
Cooling fan	Input voltage	3-phase 200V						
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -20°C to 65°C (with no freezing)						
	Ambient humidity	Operation: 90%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)						
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust						
	Altitude	Operation: 1000 meters or less above sea level, Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level						
Degree of protection		IP54 (The shaft-through portion is excluded.)						
Flange size [mm]		130 SQ.	130 SQ.	130 SQ.	174 SQ.	174 SQ.	174 SQ.	204 SQ.
Total length (excluding shaft) [mm]		264	317	375	377	377	377	489
Flange fitting diameter [mm]		Φ110	Φ110	Φ110	Φ150	Φ150	Φ150	Φ180
Shaft diameter [mm]		Φ22	Φ22	Φ22	Φ28	Φ28	Φ22	Φ32
Mass [kg]		10	14	17	30	30	27	56
Heat-resistant class		155 (F)						

(Note 1) The tolerable radial load is the value calculated at the center of output shaft.

(Note 2) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 3) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

(Note 4) The motor cannot be driven when a pulley or gear is directly installed on the shaft.

(Note 5) IP code classifies the degree of protection of the motor body. It does not apply to the other electronic parts such as the cooling fan and the encoder.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< SJ-DL Series (Hollow shaft) >

Spindle motor type		SJ-DL5.5/200-01T-S
Compatible spindle drive unit type	MDS-E-SP-	160
	MDS-E-SP2-	16080 (L)
Output capacity [kW]	Continuous rated output	3.7
	Short time rated output	5.5 (15-minute rating) (30-minute rating)
	Standard output during acceleration/deceleration	11
	Actual acceleration/ deceleration output (Note 3)	13.2
Base rotation speed [r/min]		2500
Maximum rotation speed [r/min]		20000
Frame No.		C90
Continuous rated current [A]		42
Continuous rated torque [N•m]		14.1
GD^2 [kg•m^2]		0.019
Inertia [kg•m^2]		0.0046
Tolerable radial load [N]		Not permitted (Note 4)
Cooling fan	Input voltage	3-phase 200V
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -20°C to 65°C (with no freezing)
	Ambient humidity	Operation: 90%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust
	Altitude	Operation: 1000 meters or less above sea level, Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level
Degree of protection		IP54 (The shaft-through portion is excluded.)
Flange size [mm]		174 SQ.
Total length (excluding shaft) [mm]		377
Flange fitting diameter [mm]		Φ150
Shaft diameter [mm]		Φ22
Mass [kg]		28
Heat-resistant class		155 (F)

(Note 1) The tolerable radial load is the value calculated at the center of output shaft.

(Note 2) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 3) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

(Note 4) The motor cannot be driven when a pulley or gear is directly installed on the shaft.

(Note 5) IP code classifies the degree of protection of the motor body. It does not apply to the other electronic parts such as the cooling fan and the encoder.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< SJ-DM Series (Magnet) >

Spindle motor type		SJ-DM11/120-01T
Compatible spindle drive unit type	MDS-E-SP-	320
	MDS-E-SP2-	-
Output capacity [kW]	Continuous rated output	9
	Short time rated output	34 （1-minute rating)
	Standard output during acceleration/deceleration	34
	Actual acceleration/ deceleration output (Note 3)	40.8
Base rotation speed [r/min]		4500
Maximum rotation speed [r/min]		12000
Frame No.		C71
Continuous rated current [A]		65
Continuous rated torque [N•m]		19.1
GD^2 [kg•m^2]		0.009
Inertia [kg•m^2]		0.0022
Tolerable radial load [N]		490
Cooling fan	Input voltage	3-phase 200V
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -20°C to 65°C (with no freezing)
	Ambient humidity	Operation: 90%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust
	Altitude	Operation: 1000 meters or less above sea level, Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level
Degree of protection		IP54 (The shaft-through portion is excluded.)
Flange size [mm]		130 SQ.
Total length (excluding shaft) [mm]		375
Flange fitting diameter [mm]		Φ110
Shaft diameter [mm]		Φ22
Mass [kg]		18
Heat-resistant class		155 (F)

(Note 1) The tolerable radial load is the value calculated at the center of output shaft.

(Note 2) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 3) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

(Note 4) IP code classifies the degree of protection of the motor body. It does not apply to the other electronic parts such as the cooling fan and the encoder.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< SJ-DN Series (High-torque) >

Spindle motor type		SJ-DN7.5/80-01	SJ-DN11/80-01	SJ-DN15/80-01	SJ-DN18.5/80-01
Compatible spindle drive unit type	MDS-E-SP-	160	200	200	200
	MDS-E-SP2-	16080(L)	-	-	-
Output capacity [kW]	Continuous rated output	5.5	9	11	15
	Short time rated output	7.5 (15-minute rating) (25%ED rating)	11 (25%ED rating)	15 (25%ED rating)	18.5 (10%ED rating)
	Standard output during acceleration/deceleration	7.5	11	15	18.5
	Actual acceleration/ deceleration output (Note 3)	9.0	13.2	18	22.2
Base rotation speed [r/min]		1000	1000	900	1000
Maximum rotation speed [r/min]		8000	8000	8000	8000
Frame No.		B112	B160	C160	D160
Continuous rated current [A]		30	51	62	68
Continuous rated torque [N•m]		52.5	85.9	117	143
GD^2 [$kg•m^2$]		0.122	0.41	0.55	0.65
Inertia [$kg•m^2$]		0.031	0.10	0.14	0.16
Tolerable radial load [N]		1960	3430	3920	3920
Cooling fan	Input voltage	3-phase 200V			
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -20°C to 65°C (with no freezing)			
	Ambient humidity	Operation: 90%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)			
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust			
	Altitude	Operation: 1000 meters or less above sea level, Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level			
Degree of protection		IP54 (The shaft-through portion is excluded.)			
Flange size [mm]		204 SQ.	250 SQ.	250 SQ.	250 SQ.
Total length (excluding shaft) [mm]		599	578.5	648.5	693.5
Flange fitting diameter [mm]		Φ180	Φ230	Φ230	Φ230
Shaft diameter [mm]		Φ48	Φ48	Φ55	Φ55
Mass [kg]		86	103	131	147
Heat-resistant class		155 (F)			

(Note 1) The tolerable radial load is the value calculated at the center of output shaft.

(Note 2) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 3) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

(Note 4) IP code classifies the degree of protection of the motor body. It does not apply to the other electronic parts such as the cooling fan and the encoder.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< SJ-V Series (Normal) >

Spindle motor type		SJ-V2.2-01T	SJ-V3.7-02ZT	SJ-V15-09ZT
Compatible spindle drive unit type	MDS-E-SP-	40	80	200
	MDS-E-SP2-	40	80 16080 (M)	-
Output capacity [kW]	Continuous rated output	1.5	2.2	11
	Short time rated output	2.2 (15-minute rating)	3.7 (15-minute rating)	15 (30-minute rating)
	Standard output during acceleration/deceleration	2.2	3.7	15
	Actual acceleration/ deceleration output (Note 3)	2.6	4.4	18
Base rotation speed [r/min]		1500	3000	1500
Maximum rotation speed [r/min]		10000	15000	8000
Frame No.		A90	A90	A160
Continuous rated current [A]		11.5	15	69
Continuous rated torque [N•m]		9.5	7.0	70
GD^2 [kg•m^2]		0.027	0.027	0.23
Inertia [kg•m^2]		0.00675	0.00675	0.0575
Tolerable radial load [N]		980	245	2940
Cooling fan	Input voltage	Single-phase 200V		3-phase 200V
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -20°C to 65°C (with no freezing)		
	Ambient humidity	Operation: 90%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)		
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust		
	Altitude	Operation: 1000 meters or less above sea level, Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level		
Degree of protection		IP44		
Flange size [mm]		174 SQ.	174 SQ.	250 SQ.
Total length (excluding shaft) [mm]		300	300	469.5
Flange fitting diameter [mm]		Φ150	Φ150	Φ230
Shaft diameter [mm]		Φ28	Φ28	Φ48
Mass [kg]		25	25	110
Heat-resistant class		155 (F)		

(Note 1) The tolerable radial load is the value calculated at the center of output shaft.

(Note 2) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 3) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

(Note 4) IP code classifies the degree of protection of the motor body. It does not apply to the other electronic parts such as the cooling fan and the encoder.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< SJ-V Series (Normal) >

Spindle motor type		SJ-V18.5-01ZT	SJ-V18.5-04ZT	SJ-V22-01ZT	SJ-V22-04ZT
Compatible spindle drive unit type	MDS-E-SP-	200	240	240	320
	MDS-E-SP2-	-	-	-	-
Output capacity [kW]	Continuous rated output	15	15	18.5	18.5
	Short time rated output	18.5 (30-minute rating)	18.5 (30-minute rating)	22 (30-minute rating)	22 (30-minute rating)
	Standard output during acceleration/deceleration	18.5	18.5	22	22
	Actual acceleration/ deceleration output (Note 3)	22.2	22.2	26.4	26.4
Base rotation speed [r/min]		1500	1500	1500	1500
Maximum rotation speed [r/min]		8000	8000	8000	8000
Frame No.		A160	A160	B160	B160
Continuous rated current [A]		82	94	101	112
Continuous rated torque [N•m]		95.5	95.5	118	118
GD^2 [kg•m^2]		0.23	0.23	0.319	0.319
Inertia [kg•m^2]		0.0575	0.0575	0.08	0.08
Tolerable radial load [N]		2940	2940	2940	2940
Cooling fan	Input voltage	3-phase 200V			
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -20°C to 65°C (with no freezing)			
	Ambient humidity	Operation: 90%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)			
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust			
	Altitude	Operation: 1000 meters or less above sea level, Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level			
Degree of protection		IP44			
Flange size [mm]		250 SQ.	250 SQ.	250 SQ.	250 SQ.
Total length (excluding shaft) [mm]		469.5	469.5	539.5	539.5
Flange fitting diameter [mm]		Φ230	Φ230	Φ230	Φ230
Shaft diameter [mm]		Φ48	Φ48	Φ55	Φ55
Mass [kg]		110	110	135	135
Heat-resistant class		155 (F)			

(Note 1) The tolerable radial load is the value calculated at the center of output shaft.

(Note 2) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 3) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

(Note 4) IP code classifies the degree of protection of the motor body. It does not apply to the other electronic parts such as the cooling fan and the encoder.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< SJ-V Series (Normal) >

Spindle motor type		SJ-V22-06ZT	SJ-V26-01ZT	SJ-V37-01ZT	SJ-V45-01ZT	SJ-V55-01ZT
Compatible spindle drive unit type	MDS-E-SP-	240	320	400	640	640
	MDS-E-SP2-	-	-	-	-	-
Output capacity [kW]	Continuous rated output	11	22	30	37	45
	Short time rated output	15 (30-minute rating)	26 (30-minute rating)	37 (30-minute rating)	45 (30-minute rating)	55 (30-minute rating)
	Standard output during acceleration/deceleration	15	26	37	45	55
	Actual acceleration/ deceleration output (Note 3)	18	31.2	44.4	54	66
Base rotation speed [r/min]		1500	1500	1150	1500	1150
Maximum rotation speed [r/min]		10000	8000	6000	6000	4500
Frame No.		A160	C160	B180	B180	A225
Continuous rated current [A]		89	140	179	192	219
Continuous rated torque [N•m]		70.0	140	249	236	374
GD^2 [kg•m^2]		0.23	0.37	1.36	1.36	3.39
Inertia [kg•m^2]		0.0575	0.0925	0.34	0.34	0.8475
Tolerable radial load [N]		2450	2940	3920	3920	5880
Cooling fan	Input voltage	3-phase 200V				
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -20°C to 65°C (with no freezing)				
	Ambient humidity	Operation: 90%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)				
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust				
	Altitude	Operation: 1000 meters or less above sea level, Storage: 1000 meters or less above sea level Transportation: 10000 meters or less above sea level				
Degree of protection		IP44				
Flange size [mm]		250 SQ.	250 SQ.	320 SQ.	320 SQ.	480 SQ.
Total length (excluding shaft) [mm]		469.5	585.5	700	700	724
Flange fitting diameter [mm]		Φ230	Φ230	Φ300	Φ300	Φ450
Shaft diameter [mm]		Φ48	Φ55	Φ60	Φ60	Φ75
Mass [kg]		110	155	300	300	450
Heat-resistant class		155 (F)				

(Note 1) The tolerable radial load is the value calculated at the center of output shaft.

(Note 2) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 3) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

(Note 4) IP code classifies the degree of protection of the motor body. It does not apply to the other electronic parts such as the cooling fan and the encoder.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< SJ-V Series (Wide range constant output) >

Spindle motor type		SJ-V11-01T	SJ-V11-09T	SJ-V15-03T	SJ-V18.5-03T
Compatible spindle drive unit type	MDS-E-SP-	160	160	200	240
	MDS-E-SP2-	16080 (L)	16080 (L)	-	-
Output capacity [kW]	Continuous rated output	3.7	5.5	7.5	9
	Short time rated output	5.5 (30-minute rating)	7.5 (30-minute rating)	9 (30-minute rating)	11 (30-minute rating)
	Standard output during acceleration/deceleration	5.5	7.5	9	11
	Actual acceleration/ deceleration output (Note 3)	6.6	9	10.8	13.2
Base rotation speed [r/min]		750	750	750	750
Maximum rotation speed [r/min]		6000	6000	6000	6000
Frame No.		B112	A160	A160	B160
Continuous rated current [A]		46	49	72	84
Continuous rated torque [N•m]		47.1	70.0	95.5	115
GD^2 [kg•m^2]		0.12	0.23	0.23	0.319
Inertia [kg•m^2]		0.03	0.0575	0.0575	0.08
Tolerable radial load [N]		1960	2940	2940	2940
Cooling fan	Input voltage	3-phase 200V			
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -20°C to 65°C (with no freezing)			
	Ambient humidity	Operation: 90%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)			
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust			
	Altitude	Operation: 1000 meters or less above sea level, Storage: 1000 meters or less above sea level Transportation: 10000 meters or less above sea level			
Degree of protection		IP44			
Flange size [mm]		204 SQ.	250 SQ.	250 SQ.	250 SQ.
Total length (excluding shaft) [mm]		490	469.5	469.5	539.5
Flange fitting diameter [mm]		Φ180	Φ230	Φ230	Φ230
Shaft diameter [mm]		Φ48	Φ48	Φ48	Φ55
Mass [kg]		70	110	110	135
Heat-resistant class		155 (F)			

(Note 1) The tolerable radial load is the value calculated at the center of output shaft.

(Note 2) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 3) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

(Note 4) IP code classifies the degree of protection of the motor body. It does not apply to the other electronic parts such as the cooling fan and the encoder.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< SJ-V Series (Wide range constant output) >

Spindle motor type		SJ-V22-05T	SJ-V22-09T	SJ-VK22-19ZT	
Compatible spindle drive unit type	MDS-E-SP-	320	320	320	
	MDS-E-SP2-	-	-	-	
Output capacity [kW]	Continuous rated output	11	15	13	18.5
	Short time rated output	15 (30-minute rating)	18.5 (30-minute rating)	18.5 (10-minute rating)	22 (30-minute rating)
	Standard output during acceleration/deceleration	15	18.5	18.5	22
	Actual acceleration/ deceleration output (Note 3)	18	22.2	22.2	26.4
Base rotation speed [r/min]		750	(Continuous) 600 / (Short time) 500	(Continuous) 400 / (Short time) 330	575
Maximum rotation speed [r/min]		6000	4500	750	6000
Frame No.		B160	A180	B180	
Continuous rated current [A]		107	106	133	
Continuous rated torque [N•m]		140	239	310	307
GD^2 [kg•m^2]		0.319	1.23	1.36	
Inertia [kg•m^2]		0.08	0.308	0.34	
Tolerable radial load [N]		2940	3920	3920	
Cooling fan	Input voltage	3-phase 200V			
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -20°C to 65°C (with no freezing)			
	Ambient humidity	Operation: 90%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)			
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust			
	Altitude	Operation: 1000 meters or less above sea level, Storage: 1000 meters or less above sea level Transportation: 10000 meters or less above sea level			
Degree of protection		IP44			
Flange size [mm]		250 SQ.	320 SQ.	320 SQ.	
Total length (excluding shaft) [mm]		539.5	631	700	
Flange fitting diameter [mm]		Φ230	Φ300	Φ300	
Shaft diameter [mm]		Φ55	Φ60	Φ60	
Mass [kg]		135	280	300	
Heat-resistant class		155 (F)			

(Note 1) The tolerable radial load is the value calculated at the center of output shaft.

(Note 2) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 3) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

(Note 4) IP code classifies the degree of protection of the motor body. It does not apply to the other electronic parts such as the cooling fan and the encoder.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< SJ-VL Series (Low-inertia) >

Spindle motor type		SJ-VL2.2-02ZT	SJ-VL11-02FZT	SJ-VL11-05FZT-S01
Compatible spindle drive unit type	MDS-E-SP-	40	160	160
	MDS-E-SP2-	40	16080 (L)	16080 (L)
Output capacity [kW]	Continuous rated output	1.5	2.2	1.5
	Short time rated output	2.2 (15-minute rating)	3.7 (15-minute rating)	3 (10-minute rating)
	Standard output during acceleration/deceleration	2.2	11	11
	Actual acceleration/ deceleration output (Note 3)	2.6	13.2	13.2
Base rotation speed [r/min]		3000	1500	5000
Maximum rotation speed [r/min]		15000	15000	20000
Frame No.		B71	D90	B71
Continuous rated current [A]		10	35	19
Continuous rated torque [N•m]		4.8	14.0	2.86
GD^2 [kg•m^2]		0.0096	0.012	0.0096
Inertia [kg•m^2]		0.0024	0.003	0.0024
Tolerable radial load [N]		196	245	98
Cooling fan	Input voltage	Single-phase 200V		
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -20°C to 65°C (with no freezing)		
	Ambient humidity	Operation: 90%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)		
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust		
	Altitude	Operation: 1000 meters or less above sea level, Storage: 1000 meters or less above sea level Transportation: 10000 meters or less above sea level		
Degree of protection		IP44		
Flange size [mm]		130 SQ.	174 SQ.	130 SQ.
Total length (excluding shaft) [mm]		325	441	335
Flange fitting diameter [mm]		Φ110	Φ150	Φ110
Shaft diameter [mm]		Φ22	Φ28	Φ22
Mass [kg]		20	42	20
Heat-resistant class		155 (F)		

(Note 1) The tolerable radial load is the value calculated at the center of output shaft.

(Note 2) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 3) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

(Note 4) IP code classifies the degree of protection of the motor body. It does not apply to the other electronic parts such as the cooling fan and the encoder.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

(2) 400V series

< SJ-4-V Series (Normal) >

Spindle motor type		SJ-4-V2.2-03T	SJ-4-V3.7-03T	SJ-4-V5.5-07T	SJ-4-V7.5-12T	SJ-4-V7.5-13ZT
Compatible spindle drive unit type	MDS-EH-SP-	20		40		80
Output capacity [kW]	Continuous rated output	1.5	2.2	3.7	5.5	5.5
	Short time rated output	2.2 (15-minute rating)	3.7 (15-minute rating)	5.5 (30-minute rating)	7.5 (30-minute rating)	7.5 (30-minute rating)
	Standard output during acceleration/deceleration	2.2	3.7	5.5	7.5	7.5
	Actual acceleration/ deceleration output (Note 3)	2.64	4.44	6.6	9	9
Base rotation speed [r/min]		1500		1500		
Maximum rotation speed [r/min]		10000		8000		12000
Frame No.		A90	B90	D90	A112	A112
Continuous rated current [A]		6	8	12	19	24
Continuous rated torque [N•m]		9.5	14.0	23.6	35.0	35.0
GD^2[kg•m^2]		0.027	0.035	0.059	0.098	0.098
Inertia [kg•m^2]		0.00675	0.00875	0.0148	0.0245	0.0245
Tolerable radial load [N]		980		1470	1960	980
Cooling fan	Input voltage	Single-phase 400V			3-phase 400V	
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -20°C to 65°C (with no freezing)				
	Ambient humidity	Operation: 90%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)				
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust				
	Altitude	Operation: 1000 meters or less above sea level, Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level				
Degree of protection		IP44				
Flange size [mm]		174 SQ.	174 SQ.	174 SQ.	204 SQ.	204 SQ.
Total length (excluding shaft) [mm]		300	330	425	440	440
Flange fitting diameter [mm]		Φ150	Φ150	Φ150	Φ180	Φ180
Shaft diameter [mm]		Φ28	Φ28	Φ28	Φ32	Φ32
Mass [kg]		25	30	49	60	60
Heat-resistant class		155 (F)				

(Note 1) The tolerable radial load is the value calculated at the center of output shaft.

(Note 2) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 3) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

(Note 4) The rated output is guaranteed at the rated input voltage (380 to 440VAC 50Hz / 380 to 480VAC 60Hz) to the power supply unit. If the input voltage fluctuates and drops below 380VAC, the rated output may not be attained.

(Note 5) IP code classifies the degree of protection of the motor body. It does not apply to the other electronic parts such as the cooling fan and the encoder.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< SJ-4-V Series (Normal) >

Spindle motor type		SJ-4-V11-18T	SJ-4-V18.5-14T	SJ-4-V22-18ZT	SJ-4-V22-15T
Compatible spindle drive unit type	MDS-EH-SP-	80	100	160	160
Output capacity [kW]	Continuous rated output	7.5	15	11	18.5
	Short time rated output	11 (30-minute rating)	18.5 (30-minute rating)	15 (30-minute rating)	22 (30-minute rating)
	Standard output during acceleration/deceleration	11	18.5	15	22
	Actual acceleration/ deceleration output (Note 3)	13.2	22.2	18	26.4
Base rotation speed [r/min]		1500			
Maximum rotation speed [r/min]		6000	6000	8000	6000
Frame No.		B112	A160	A160	B160
Continuous rated current [A]		23	41	44	46
Continuous rated torque [N•m]		47.7	95.5	70.0	118
GD^2[kg•m^2]		0.12	0.23	0.23	0.32
Inertia [kg•m^2]		0.03	0.0575	0.0575	0.08
Tolerable radial load [N]		1960	2940	2940	2940
Cooling fan	Input voltage	3-phase 400V			
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -20°C to 65°C (with no freezing)			
	Ambient humidity	Operation: 90%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)			
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust			
	Altitude	Operation: 1000 meters or less above sea level, Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level			
Degree of protection		IP44			
Flange size [mm]		204 SQ.	250 SQ.	250 SQ.	250 SQ.
Total length (excluding shaft) [mm]		490	469.5	469.5	539.5
Flange fitting diameter [mm]		Φ180	Φ230	Φ230	Φ230
Shaft diameter [mm]		Φ48	Φ48	Φ48	Φ55
Mass [kg]		70	110	110	135
Heat-resistant class		155 (F)			

(Note 1) The tolerable radial load is the value calculated at the center of output shaft.

(Note 2) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 3) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

(Note 4) The rated output is guaranteed at the rated input voltage (380 to 440VAC 50Hz / 380 to 480VAC 60Hz) to the power supply unit. If the input voltage fluctuates and drops below 380VAC, the rated output may not be attained.

(Note 5) IP code classifies the degree of protection of the motor body. It does not apply to the other electronic parts such as the cooling fan and the encoder.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< SJ-4-V Series (Normal) >

Spindle motor type		SJ-4-V26-08ZT	SJ-4-V37-04ZT	SJ-4-V45-02T	SJ-4-V55-03T
Compatible spindle drive unit type	MDS-EH-SP-	160	200	320	
Output capacity [kW]	Continuous rated output	22	30	37	45
	Short time rated output	26 (30-minute rating)	37 (30-minute rating)	45 (30-minute rating)	55 (30-minute rating)
	Standard output during acceleration/deceleration	26	37	45	55
	Actual acceleration/ deceleration output (Note 3)	31.2	44.4	54	66
Base rotation speed [r/min]		1500	1150	1500	1150
Maximum rotation speed [r/min]		10000	6000	4500	3450
Frame No.		C160	B180	B180	A225
Continuous rated current [A]		70	79	96	110
Continuous rated torque [N•m]		140	249	236	374
GD^2[kg•m^2]		0.37	1.36	1.36	3.39
Inertia [kg•m^2]		0.0925	0.34	0.34	0.85
Tolerable radial load [N]		2450	3920		5880
Cooling fan	Input voltage	3-phase 400V			
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -20°C to 65°C (with no freezing)			
	Ambient humidity	Operation: 90%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)			
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust			
	Altitude	Operation: 1000 meters or less above sea level, Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level			
Degree of protection		IP44			
Flange size [mm]		250 SQ.	320 SQ.	320 SQ.	480 SQ.
Total length (excluding shaft) [mm]		585.5	700	700	724
Flange fitting diameter [mm]		Φ230	Φ300	Φ300	Φ450
Shaft diameter [mm]		Φ48	Φ60	Φ60	Φ75
Mass [kg]		155	300	300	450
Heat-resistant class		155 (F)			

(Note 1) The tolerable radial load is the value calculated at the center of output shaft.

(Note 2) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 3) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

(Note 4) The rated output is guaranteed at the rated input voltage (380 to 440VAC 50Hz / 380 to 480VAC 60Hz) to the power supply unit. If the input voltage fluctuates and drops below 380VAC, the rated output may not be attained.

(Note 5) IP code classifies the degree of protection of the motor body. It does not apply to the other electronic parts such as the cooling fan and the encoder.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< SJ-4-V Series (Wide range constant output) >

Spindle motor type		SJ-4-V15-20T	SJ-4-V22-16T
Compatible spindle drive unit type	MDS-EH-SP-	100	160
Output capacity [kW]	Continuous rated output	7.5	11
	Short time rated output	9 (30-minute rating)	15 (30-minute rating)
	Standard output during acceleration/deceleration	9	15
	Actual acceleration/ deceleration output (Note 3)	10.8	18
Base rotation speed [r/min]		750	
Maximum rotation speed [r/min]		6000	
Frame No.		A160	B160
Continuous rated current [A]		36	53
Continuous rated torque [N•m]		95.5	140
GD^2[kg•m^2]		0.23	0.32
Inertia [kg•m^2]		0.06	0.08
Tolerable radial load [N]		2940	
Cooling fan	Input voltage	3-phase 400V	
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -20°C to 65°C (with no freezing)	
	Ambient humidity	Operation: 90%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)	
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust	
	Altitude	Operation: 1000 meters or less above sea level, Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level	
Degree of protection		IP44	
Flange size [mm]		250 SQ.	250 SQ.
Total length (excluding shaft) [mm]		469.5	539.5
Flange fitting diameter [mm]		Φ230	Φ230
Shaft diameter [mm]		Φ48	Φ55
Mass [kg]		110	135
Heat-resistant class		155 (F)	

(Note 1) The tolerable radial load is the value calculated at the center of output shaft.

(Note 2) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 3) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

(Note 4) The rated output is guaranteed at the rated input voltage (380 to 440VAC 50Hz / 380 to 480VAC 60Hz) to the power supply unit. If the input voltage fluctuates and drops below 380VAC, the rated output may not be attained.

(Note 5) IP code classifies the degree of protection of the motor body. It does not apply to the other electronic parts such as the cooling fan and the encoder.

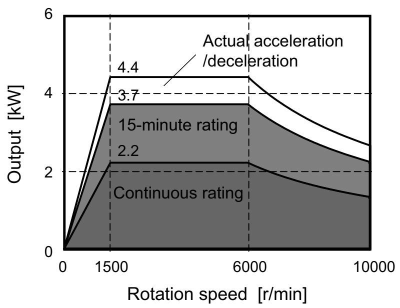
For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

2.2.2 Output Characteristics

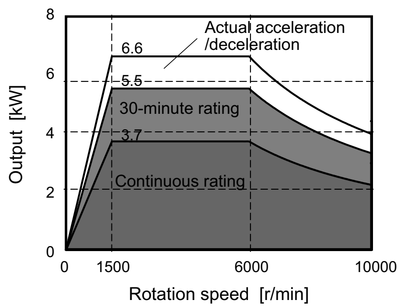
(1) 200V series

< SJ-D Series (Normal) >

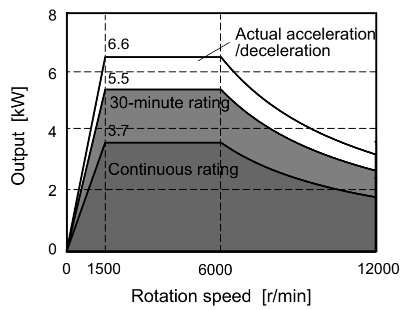
[SJ-D3.7/100-01]



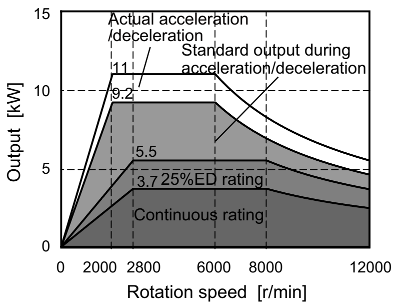
[SJ-D5.5/100-01]



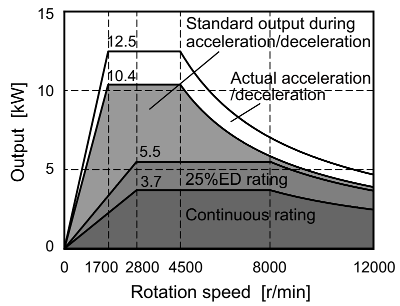
[SJ-D5.5/120-01]



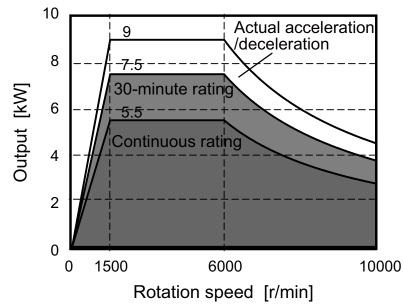
[SJ-D5.5/120-02]
(E-SP-160,E-SP2-16080(L))



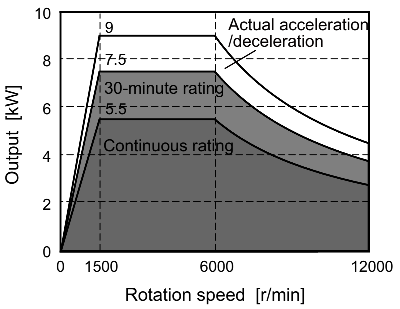
[SJ-D5.5/120-02]
(E-SP-200)



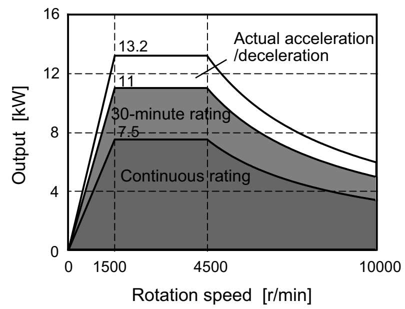
[SJ-D7.5/100-01]



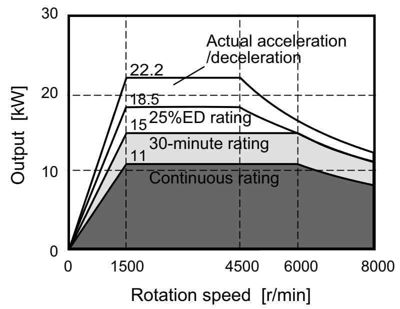
[SJ-D7.5/120-01]



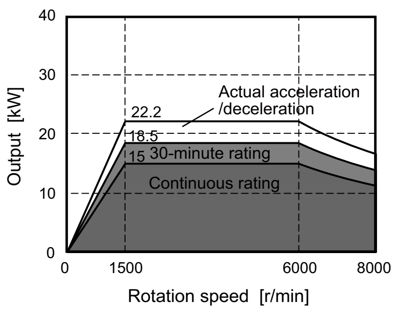
[SJ-D11/100-01]



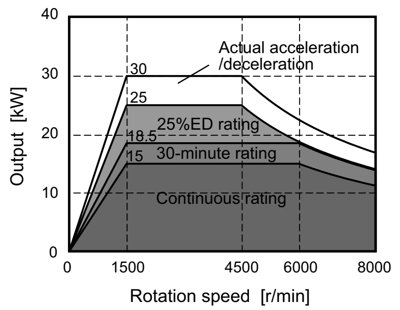
[SJ-D15/80-01]



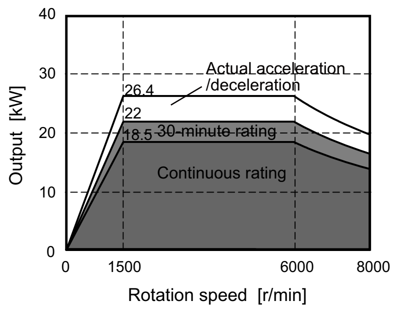
[SJ-D18.5/80-01]
(E-SP-240)



[SJ-D18.5/80-01]
(E-SP-320)



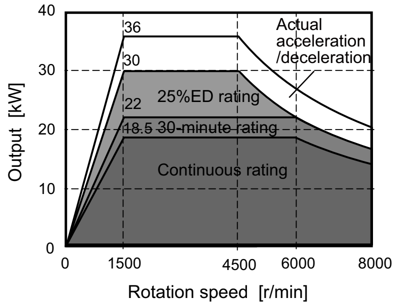
[SJ-D22/80-01]
(E-SP-240)



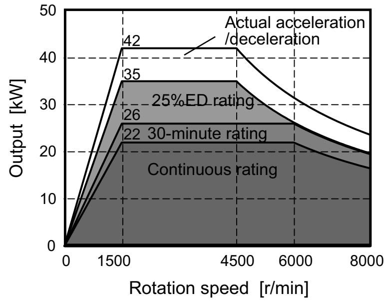
(Note) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

< SJ-D Series (Normal) >

[SJ-D22/80-01]
(E-SP-320)

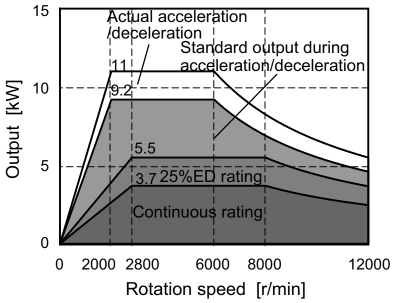


[SJ-D26/80-01]

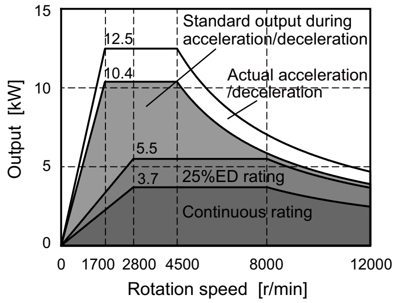


< SJ-D Series (Hollow shaft) >

[SJ-D5.5/120-02T-S]
(E-SP-160, E-SP2-16080(L))

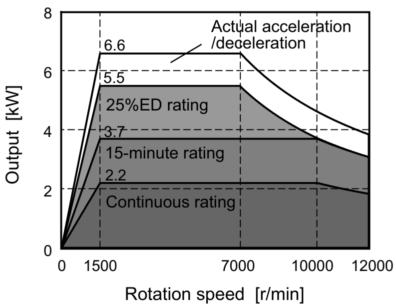


[SJ-D5.5/120-02T-S]
(E-SP-200)

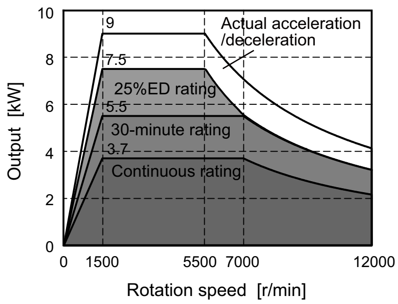


< SJ-DG Series (High-output) (Hollow shaft) >

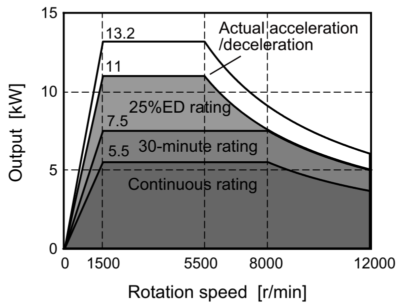
[SJ-DG3.7/120-03T]



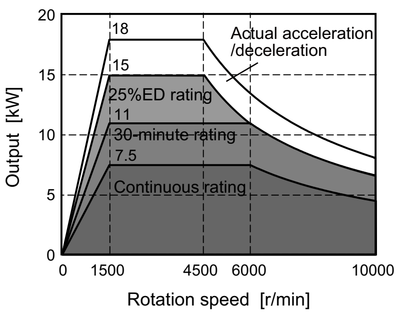
[SJ-DG5.5/120-04T]



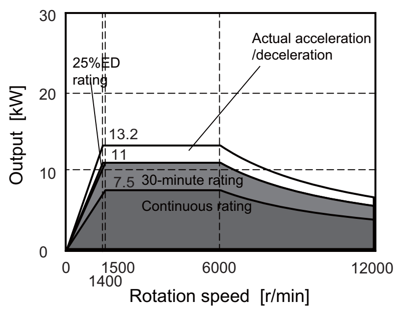
[SJ-DG7.5/120-05T]



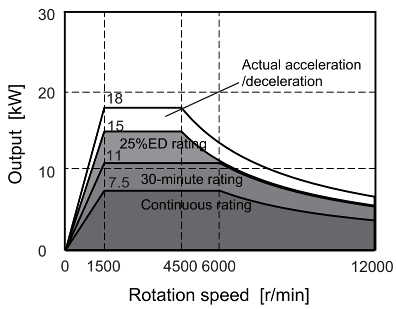
[SJ-DG11/100-03T]



[SJ-DG11/120-03T(-S)]
(E-SP-160, E-SP2-16080(L))



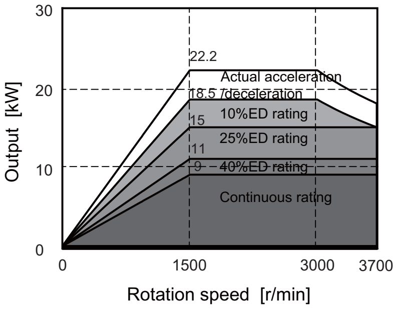
[SJ-DG11/120-03T(-S)]
(E-SP-200)



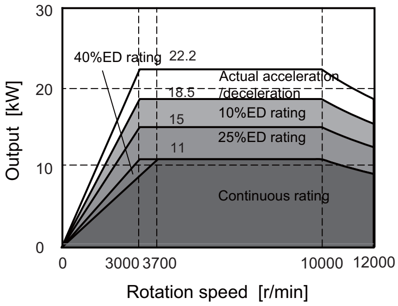
(Note) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

< SJ-DG Series (High-output) (Hollow shaft) >

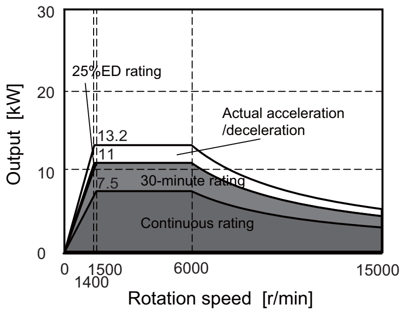
[SJ-DG11/120-12T-K(S)]
Low-speed coil



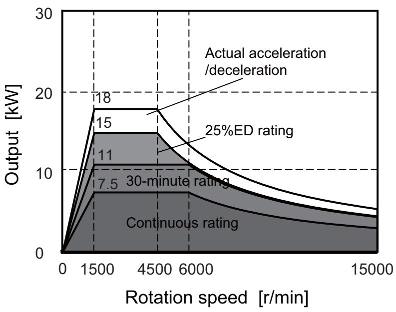
[SJ-DG11/120-12T-K(S)]
High-speed coil



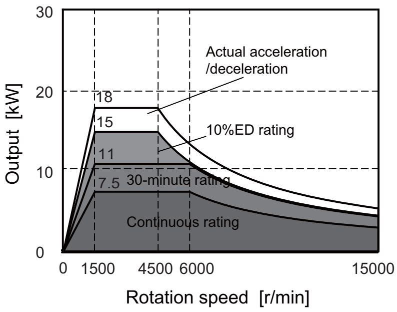
[SJ-DG11/150-06T(-S)]
(MDS-E-SP-160, E-SP2-16080(L))



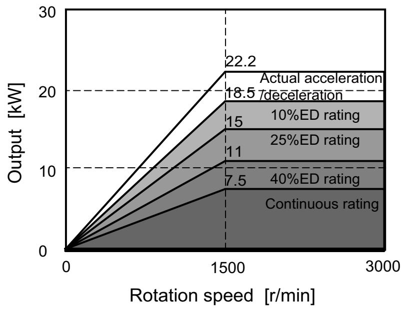
[SJ-DG11/150-06T(-S)]
(MDS-E-SP-200)



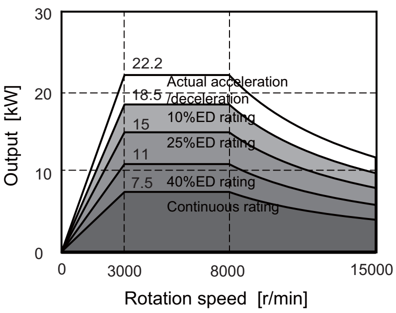
[SJ-DG11/150-06T(-S)]
(MDS-E-SP-200)



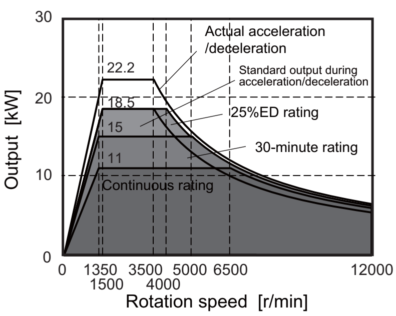
[SJ-DG11/150-15T-K(S)]
Low-speed coil



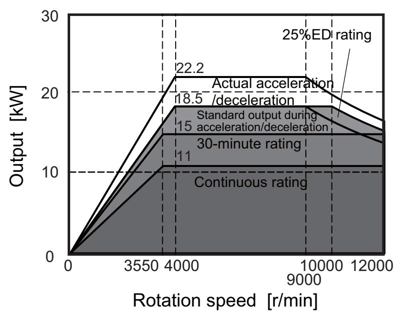
[SJ-DG11/150-15T-K(S)]
High-speed coil



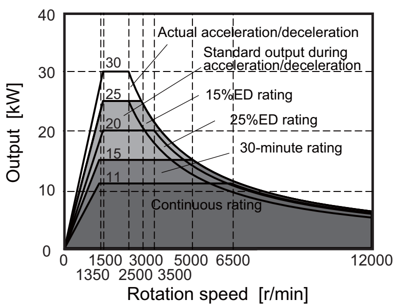
[SJ-DG15/120-02T-K(S)]
(MDS-E-SP-200)
Low-speed coil



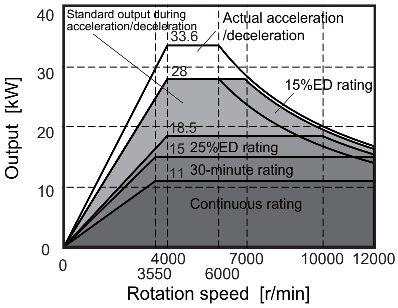
[SJ-DG15/120-02T-K(S)]
(MDS-E-SP-200)
High-speed coil



[SJ-DG15/120-02T-K(S)]
(MDS-E-SP-240)
Low-speed coil



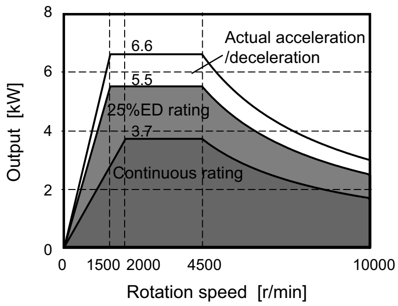
[SJ-DG15/120-02T-K(S)]
(MDS-E-SP-240)
High-speed coil



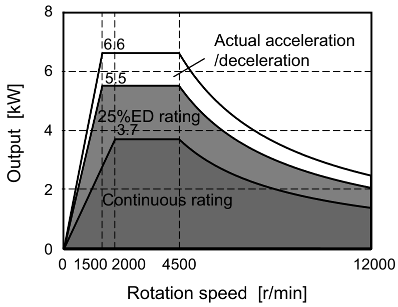
(Note) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

< SJ-DJ Series (Compact & lightweight) >

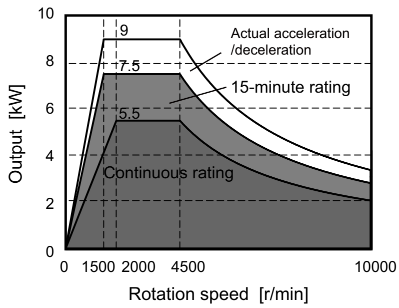
[SJ-DJ5.5/100-01]



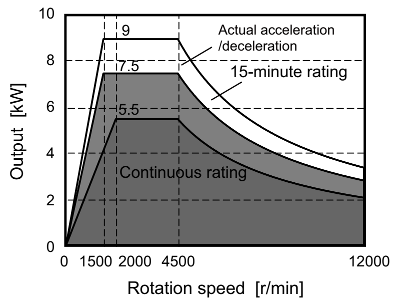
[SJ-DJ5.5/120-01]



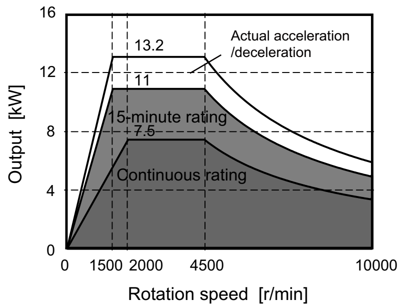
[SJ-DJ7.5/100-01]



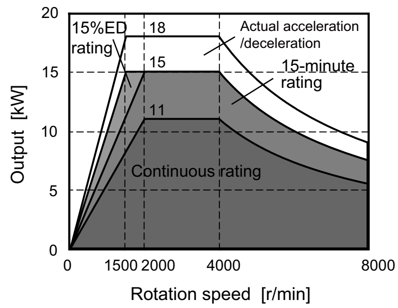
[SJ-DJ7.5/120-01]



[SJ-DJ11/100-01]



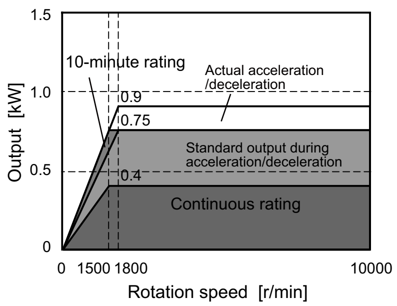
[SJ-DJ15/80-01]



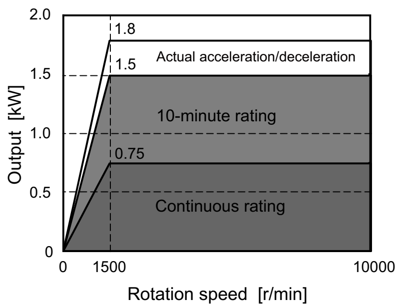
(Note) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

< SJ-DL Series (Low-inertia) >

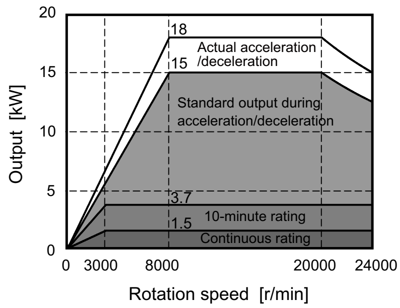
[SJ-DL0.75/100-01]



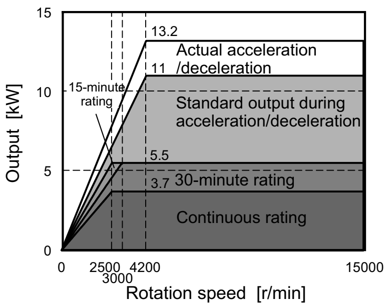
[SJ-DL1.5/100-01]



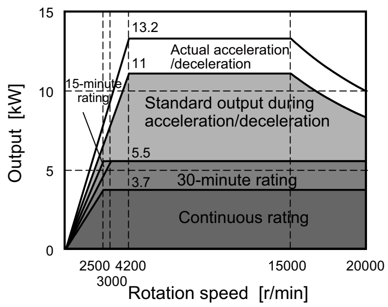
[SJ-DL3.7/240-01T]



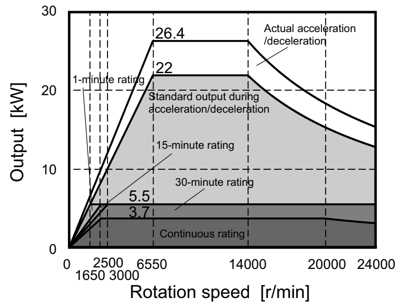
[SJ-DL5.5/150-01T]



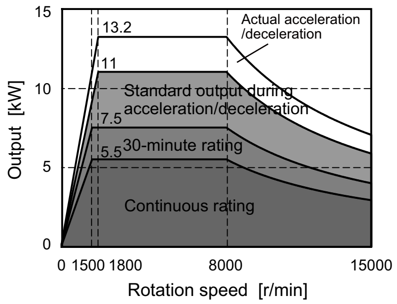
[SJ-DL5.5/200-01T]



[SJ-DL5.5/240-05T]

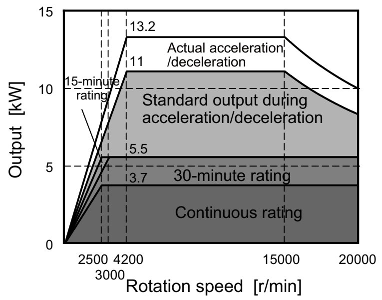


[SJ-DL7.5/150-01T]



< SJ-DL Series (Hollow shaft) >

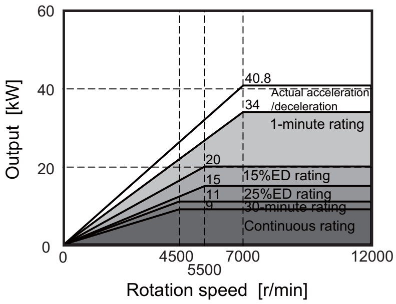
[SJ-DL5.5/200-01T-S]



(Note) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

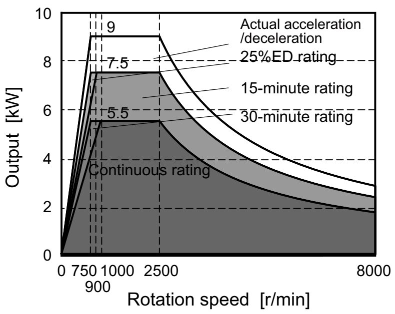
< SJ-DM Series (Magnet) >

[SJ-DM11/120-01T]

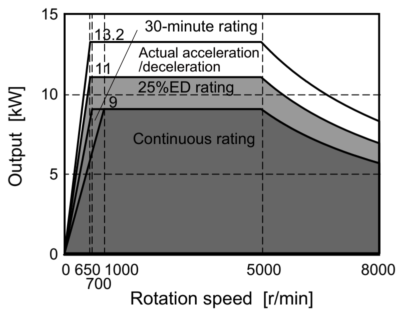


< SJ-DN Series (High-torque) >

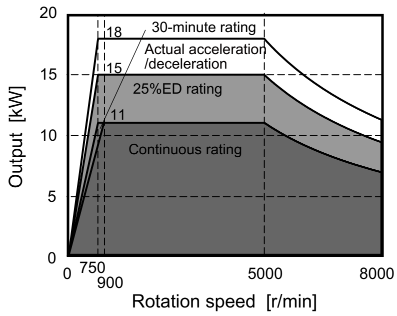
[SJ-DN7.5/80-01]



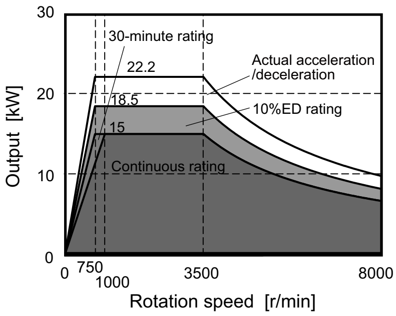
[SJ-DN11/80-01]



[SJ-DN15/80-01]



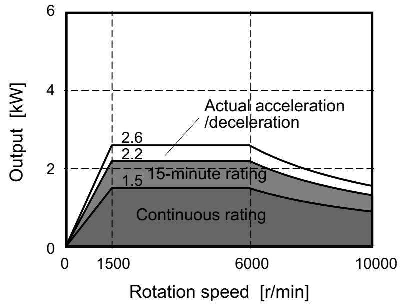
[SJ-DN18.5/80-01]



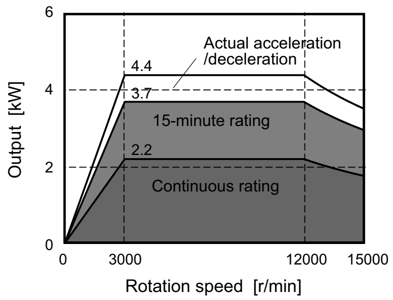
(Note) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

< SJ-V Series (Normal) >

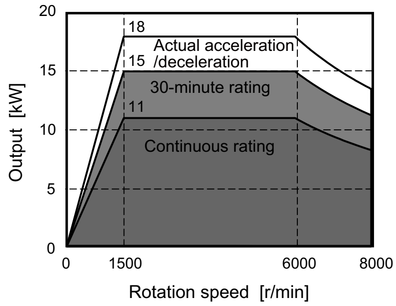
[SJ-V2.2-01T]



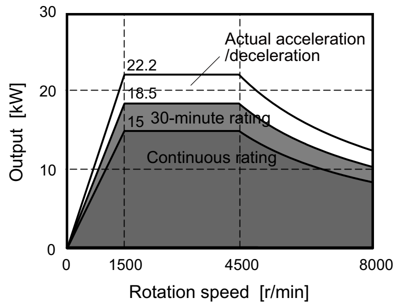
[SJ-V3.7-02ZT]



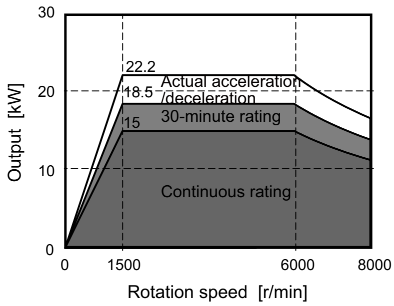
[SJ-V15-09ZT]



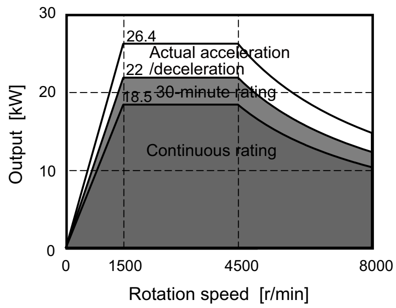
[SJ-V18.5-01ZT]



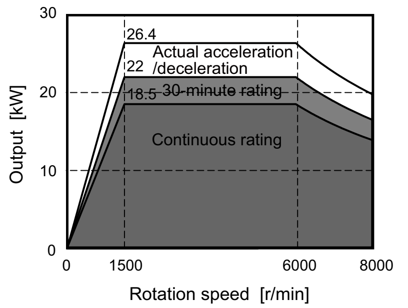
[SJ-V18.5-04ZT]



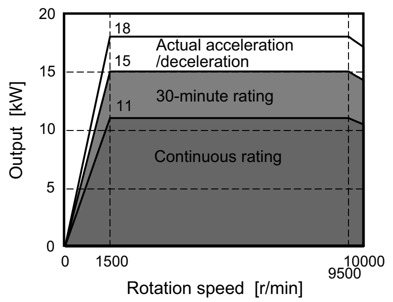
[SJ-V22-01ZT]



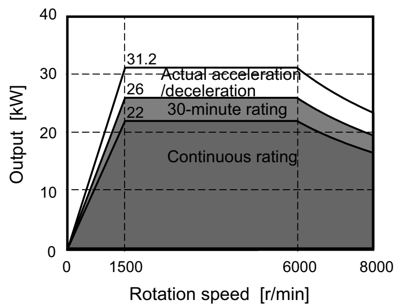
[SJ-V22-04ZT]



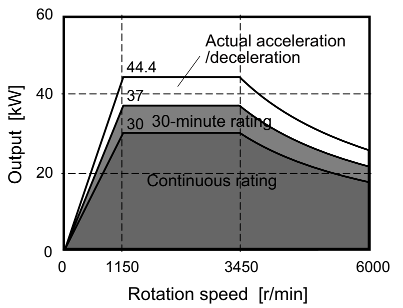
[SJ-V22-06ZT]



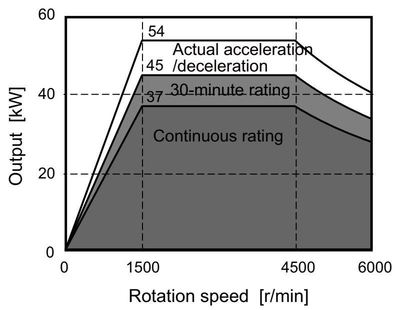
[SJ-V26-01ZT]



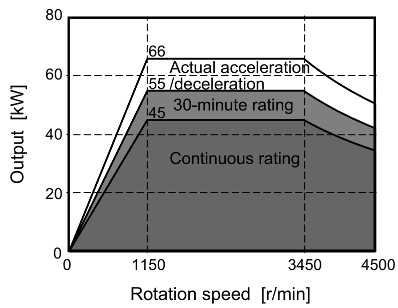
[SJ-V37-01ZT]



[SJ-V45-01ZT]



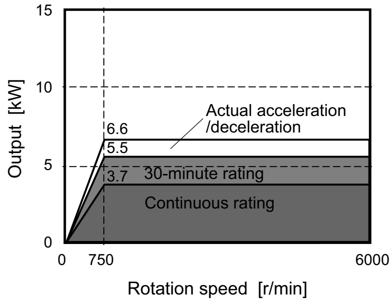
[SJ-V55-01ZT]



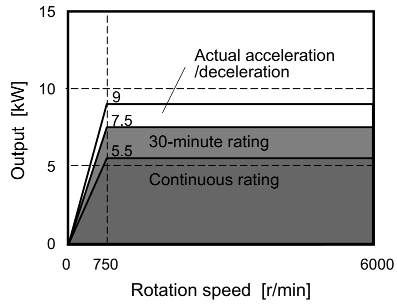
(Note) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

< SJ-V Series (Wide range constant output) >

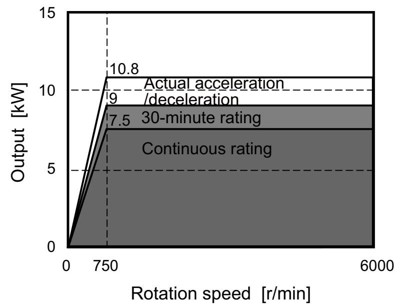
[SJ-V11-01T]



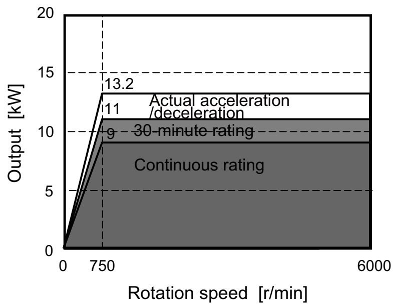
[SJ-V11-09T]



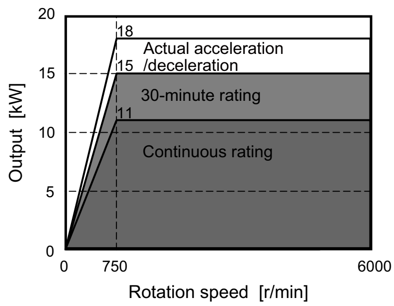
[SJ-V15-03T]



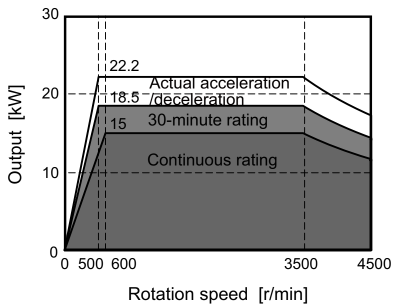
[SJ-V18.5-03T]



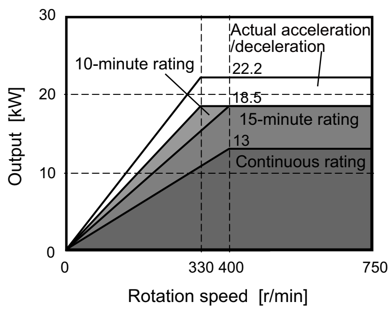
[SJ-V22-05T]



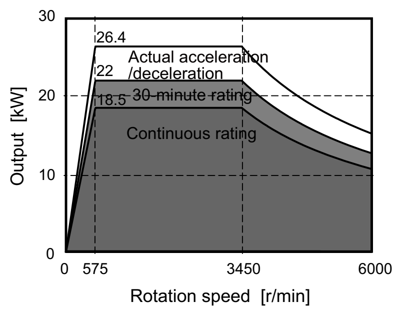
[SJ-V22-09T]



[SJ-VK22-19ZT (in low-speed coil)]

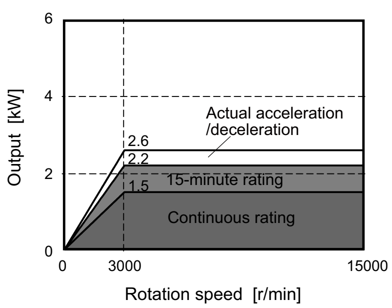


[SJ-VK22-19ZT (in high-speed coil)]

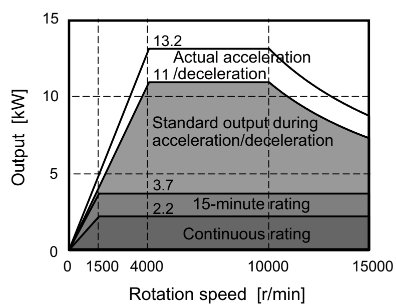


< SJ-VL Series (Low-inertia) >

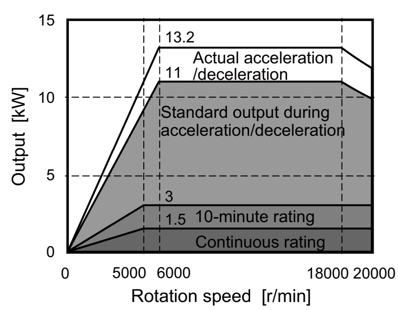
[SJ-VL2.2-02ZT]



[SJ-VL11-02FZT]



[SJ-VL11-05FZT-S01]

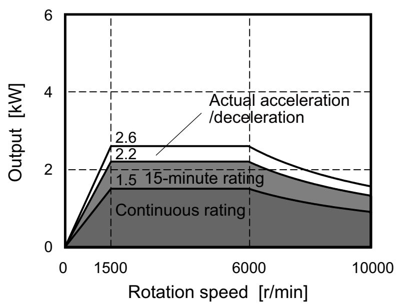


(Note) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

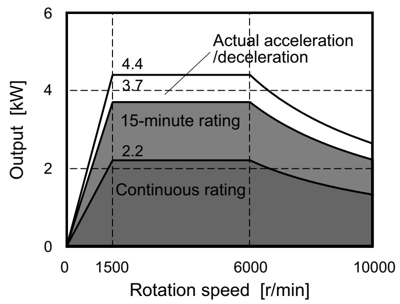
(2) 400V series

< SJ-4-V Series (Normal) >

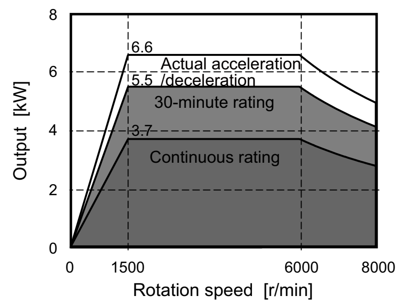
[SJ-4-V2.2-03T]



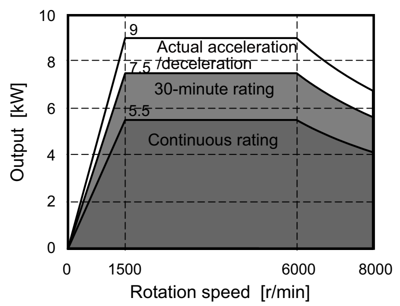
[SJ-4-V3.7-03T]



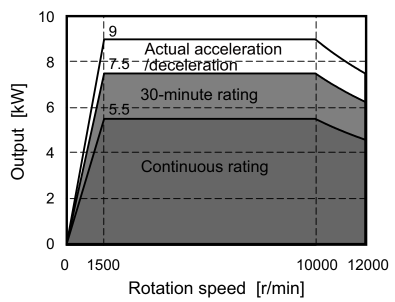
[SJ-4-V5.5-07T]



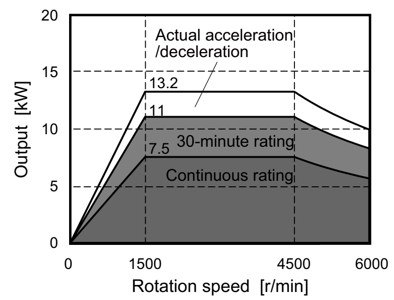
[SJ-4-V7.5-12T]



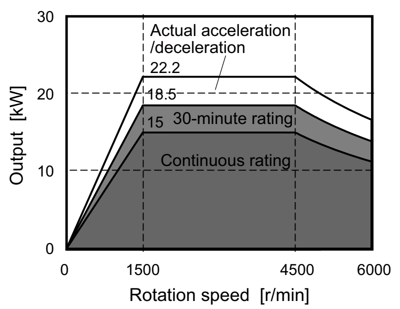
[SJ-4-V7.5-13ZT]



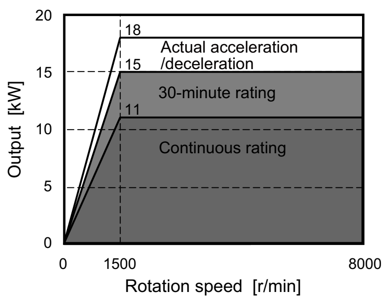
[SJ-4-V11-18T]



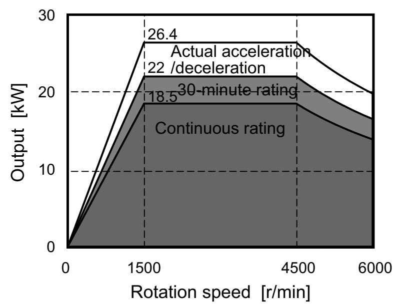
[SJ-4-V18.5-14T]



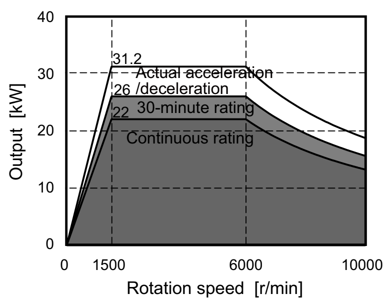
[SJ-4-V22-18ZT]



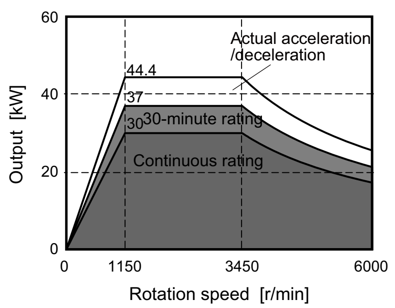
[SJ-4-V22-15T]



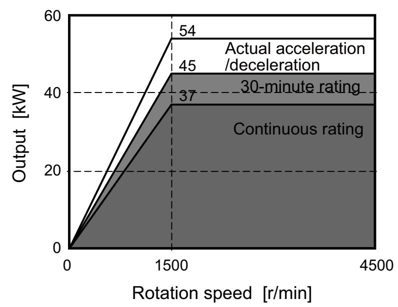
[SJ-4-V26-08ZT]



[SJ-4-V37-04ZT]



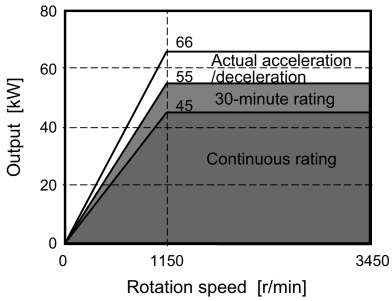
[SJ-4-V45-02T]



(Note) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

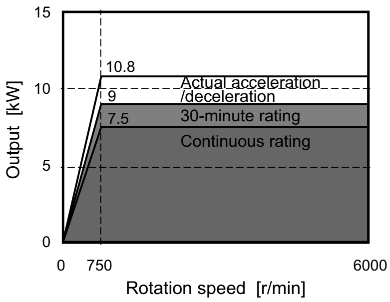
< SJ-4-V Series (Normal) >

[SJ-4-V55-03T]

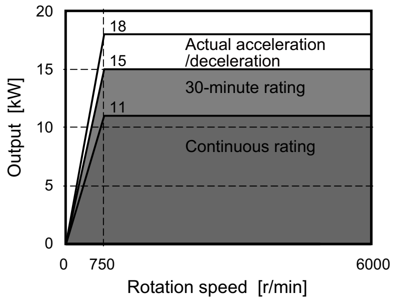


< SJ-4-V Series (Wide range constant output) >

[SJ-4-V15-20T]



[SJ-4-V22-16T]



(Note) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

2.3 Tool Spindle Motor

2.3.1 Specifications

(1) 200V series

< HG Series >

Tool spindle motor type		HG Series		
		HG □ -D47		
		HG46	HG56	HG96
Compatible spindle drive unit type	MDS-E-SP-	20	20	20
	MDS-E-SP2-	20	20	20 40
Continuous characteristics	Rated output [kW]	0.4	0.5	0.9
	Rated current [A]	1.4	1.8	3.3
	Rated torque [N•m]	0.64	0.80	1.43
Rated rotation speed [r/min]		6000		
Maximum rotation speed [r/min]		6000		
Maximum current [A]		5.3	11.2	15.0
Maximum torque [N•m]		2.5	5.0	7.2
Motor inertia [$\times10^{-4}$kg•m^2]		0.234	0.379	1.27
Motor side encoder		Resolution per motor revolution D47:1,048,576 pulse/rev		
Degree of protection		IP67 (The shaft-through portion is excluded.)		
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -15°C to 70°C (with no freezing)		
	Ambient humidity	Operation: 80%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)		
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust		
	Altitude	Operation: 1000 meters or less above sea level, Storage: 10000 meters or less above sea level		
	Vibration	X,Y: 49m/s^2 (5G)		
Flange size [mm]		60 SQ.	60 SQ.	80 SQ.
Total length (excluding shaft) [mm]		117.2	138.9	147.8
Flange fitting diameter [mm]		Φ50	Φ50	Φ70
Shaft diameter [mm]		Φ14	Φ14	Φ19
Mass [kg]		1.2	1.6	2.9
Heat-resistant class		130(B)		

(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) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< HG Series >

Tool spindle motor type		HG Series							
		HG □ -D48							
		HG75	HG105	HG54	HG104	HG154	HG224	HG204	HG354
Compatible spindle drive unit type	MDS-E-SP-	20	20	40	40	80	80	80	160
	MDS-E-SP2-	20 40	20 40	40 80	40 80	80 16080(M)	80 16080(M)	80 16080(M)	16080(L)
Continuous characteristics	Rated output [kW]	0.75	1.0	0.5	1.0	1.5	2.2	2.0	3.5
	Rated current [A]	3.1	3.7	2.0	3.9	5.6	8.6	6.8	12
	Rated torque [N•m]	1.8	2.4	1.6	3.2	4.8	7.0	6.4	11.1
Rated rotation speed [r/min]		4000		3000					
Maximum rotation speed [r/min]		4000		3000					
Maximum current [A]		14.0	15.5	17.0	29.0	52.0	57.0	57.0	116.0
Maximum torque [N•m]		8.0	11.0	13.0	23.3	42.0	46.5	47.0	90.0
Motor inertia [$\times10^{-4}$kg•m^2]		2.62	5.12	6.13	11.9	17.8	23.7	38.3	75.0
Motor side encoder		Resolution per motor revolution D48:1,048,576 pulse/rev							
Degree of protection		IP67 (The shaft-through portion is excluded.)							
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -15°C to 70°C (with no freezing)							
	Ambient humidity	Operation: 80%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)							
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust							
	Altitude	Operation: 1000 meters or less above sea level, Storage: 10000 meters or less above sea level							
	Vibration	X,Y:24.5m/s^2 (2.5G)						X:24.5m/s^2 (2.5G) Y:29.4m/s^2 (3.0G)	
Flange size [mm]		90 SQ.	90 SQ.	130 SQ.	130 SQ.	130 SQ.	130 SQ.	176 SQ.	176 SQ.
Total length (excluding shaft) [mm]		127.5	163.5	118.5	140.5	162.5	184.5	143.5	183.5
Flange fitting diameter [mm]		Φ80	Φ80	Φ110	Φ110	Φ110	Φ110	Φ114.3	Φ114.3
Shaft diameter [mm]		Φ14	Φ14	Φ24	Φ24	Φ24	Φ24	Φ35	Φ35
Mass [kg]		2.6	4.4	4.8	6.5	8.3	10.0	12.0	19.0
Heat-resistant class		155(F)							

(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) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< HG Series >

Tool spindle motor type		HG Series		
		HG □ -D48		
		HG453	HG703	HG903
Compatible spindle drive unit type	MDS-E-SP-	160	160	320
	MDS-E-SP2-	16080(L)	16080(L)	-
Continuous characteristics	Rated output [kW]	4.5	7.0	9.0
	Rated current [A]	19	34	30
	Rated torque [N•m]	14.3	22.3	28.7
Rated rotation speed [r/min]		3000		
Maximum rotation speed [r/min]		3000		
Maximum current [A]		105.0	109.0	204.0
Maximum torque [N•m]		122.0	152.0	208.0
Motor inertia [$\times 10^{-4}$kg•m^2]		112.0	154.0	196.0
Motor side encoder		Resolution per motor revolution D48:1,048,576 pulse/rev		
Degree of protection		IP67 (The shaft-through portion is excluded.)		
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -15°C to 70°C (with no freezing)		
	Ambient humidity	Operation: 80%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)		
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust		
	Altitude	Operation: 1000 meters or less above sea level, Storage: 10000 meters or less above sea level		
	Vibration	X,Y:24.5m/s^2 (2.5G)		X,Y: 9.8m/s^2 (1G)
Flange size [mm]		176 SQ.	176 SQ.	204 SQ.
Total length (excluding shaft) [mm]		223.5	263.5	330
Flange fitting diameter [mm]		Φ114.3	Φ114.3	Φ180
Shaft diameter [mm]		Φ35	Φ35	Φ42
Mass [kg]		25	32.0	43
Heat-resistant class		155 (F)		

(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) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

< HG-JR Series >

Tool spindle motor type		HG-JR Series	
		HG-JR □ E1 □ W9C- □	
		HG-JR73	HG-JR153
Compatible spindle drive unit type	MDS-E-SP-	40	80
	MDS-E-SP2-	40	80 16080(M)
Continuous characteristics	Rated output [kW]	0.75	1.5
	Rated current [A]	5.6	11
	Rated torque [N•m]	2.4	4.8
Rated rotation speed [r/min]		3000	3000
Maximum rotation speed [r/min]		8000	8000
Maximum current [A]		17	32
Maximum torque [N•m]		7.2	14.3
Motor inertia [$\times 10^{-4}$kg•m^2]		2.09	3.79
Motor side encoder		Resolution per motor revolution D48:1,048,576 pulse/rev	
Degree of protection		IP67 (The shaft-through portion is excluded.)	
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -15°C to 70°C (with no freezing)	
	Ambient humidity	Operation: 80%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)	
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust	
	Altitude	Operation: 1000 meters or less above sea level, Storage: 10000 meters or less above sea level	
	Vibration	X,Y:24.5m/s^2 (2.5G)	
Flange size [mm]		90 SQ.	90 SQ.
Total length (excluding shaft) [mm]		145.5	199.5
Flange fitting diameter [mm]		Φ80	Φ80
Shaft diameter [mm]		Φ16	Φ16
Mass [kg]		3.7	5.9
Heat-resistant class		155 (F)	

(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) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

(2) 400V series

< HG-JR Series >

Tool spindle motor type		HG-JR Series HG-JR □ E1 □ W9C- □ HG-JR734	HG-JR1534
Compatible spindle drive unit type	MDS-EH-SP-	20	40
Continuous characteristics	Rated output [kW]	0.75	1.5
	Rated current [A]	2.8	11
	Rated torque [N•m]	2.4	4.8
Rated rotation speed [r/min]		3000	3000
Maximum rotation speed [r/min]		8000	8000
Maximum current [A]		8.4	17
Maximum torque [N•m]		7.2	14.3
Motor inertia [$\times 10^{-4}$kg•m^2]		2.09	3.79
Motor side encoder		Resolution per motor revolution D48:1,048,576 pulse/rev	
Degree of protection		IP67 (The shaft-through portion, power connector portion and brake connector portion are excluded.)	
Environment	Ambient temperature	Operation: 0 to 40°C (with no freezing), Storage: -15°C to 70°C (with no freezing)	
	Ambient humidity	Operation: 80%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)	
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust	
	Altitude	Operation: 1000 meters or less above sea level, Storage: 10000 meters or less above sea level	
	Vibration	X,Y: 24.5m/s^2 (2.5G)	
Flange size [mm]		90 SQ.	90 SQ.
Total length (excluding shaft) [mm]		145.5	199.5
Flange fitting diameter [mm]		Φ80	Φ80
Shaft diameter [mm]		Φ16	Φ16
Mass [kg]		3.7	5.9
Heat-resistant class		155 (F)	

(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) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

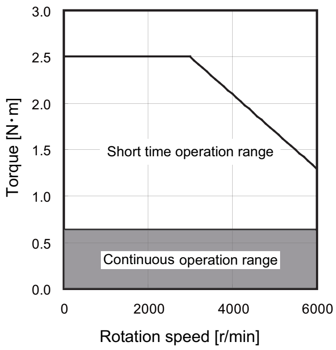
For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

2.3.2 Output Characteristics

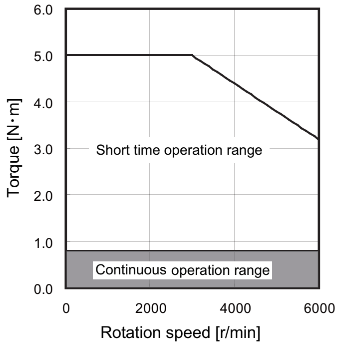
(1) 200V series

< HG Series >

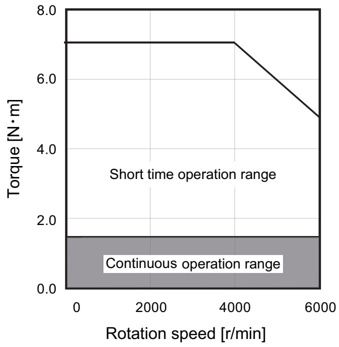
[HG46]



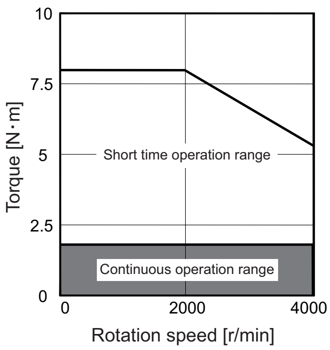
[HG56]



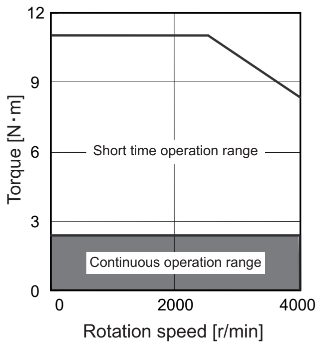
[HG96]



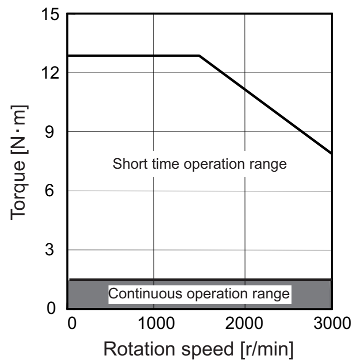
[HG75]



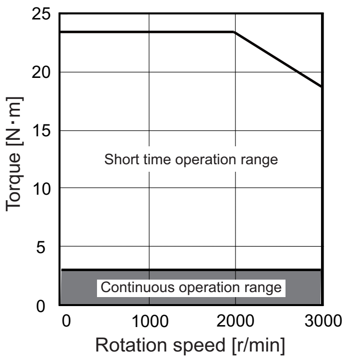
[HG105]



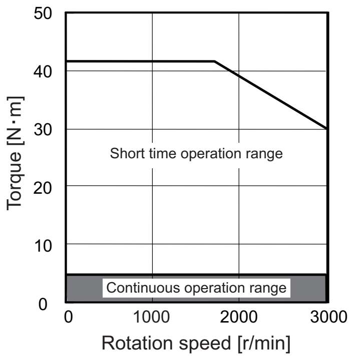
[HG54]



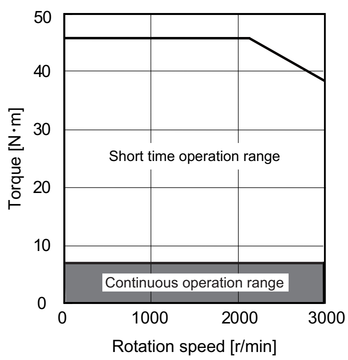
[HG104]



[HG154]



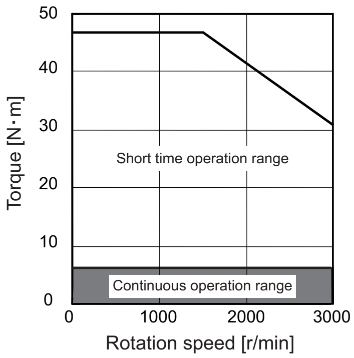
[HG224]



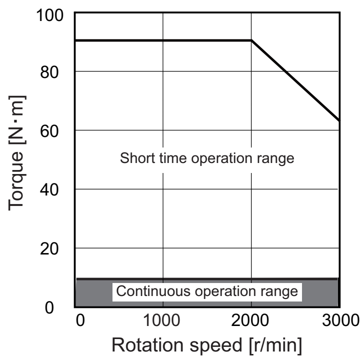
(Note) The above graphs show the data when applied the input voltage of 200VAC. When the input voltage is 200VAC or less, the short time operation range is limited.

< HG Series >

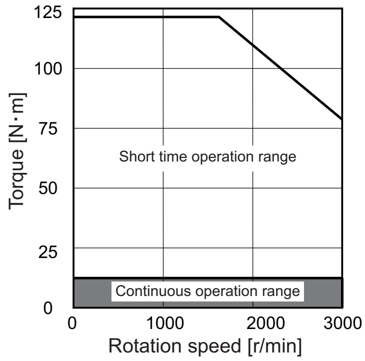
[HG204]



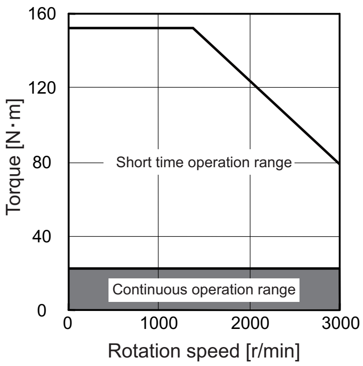
[HG354]



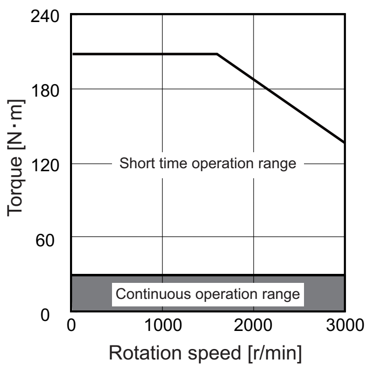
[HG453]



[HG703]

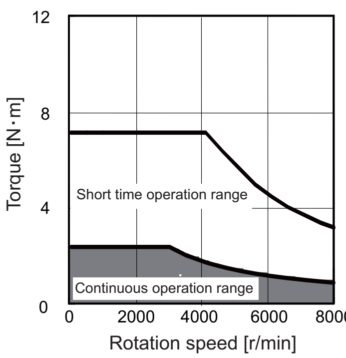


[HG903]

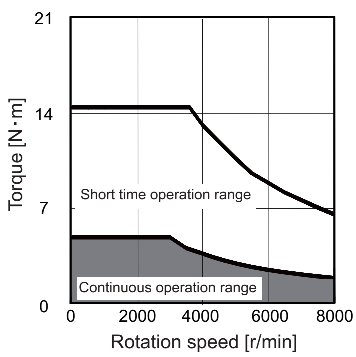


< HG-JR Series >

[HG-JR73]



[HG-JR153]

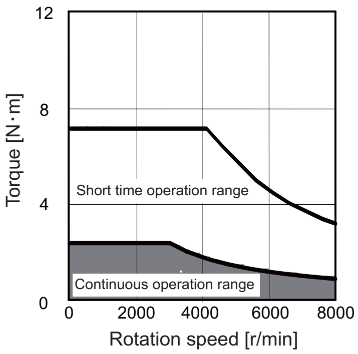


(Note) The above graphs show the data when applied the input voltage of 200VAC. When the input voltage is 200VAC or less, the short time operation range is limited.

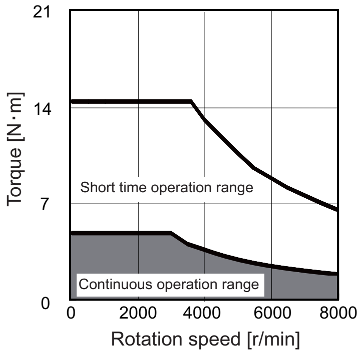
(2) 400V series

< HG-JR Series >

[HG-JR734]



[HG-JR1534]



(Note) The above graphs show the data when applied the input voltage of 380VAC. When the input voltage is 380VAC or less, the short time operation range is limited.

2.4 Drive Unit

2.4.1 Installation Environment Conditions

Common installation environment conditions for servo, spindle and power supply unit are shown below.

Environment	Ambient temperature	Operation: 0 to 55°C (with no freezing), Storage / Transportation: -15°C to 70°C (with no freezing)
	Ambient humidity	Operation: 90%RH or less (with no dew condensation) Storage / Transportation: 90%RH or less (with no dew condensation)
	Atmosphere	Indoors (no direct sunlight) With no corrosive gas, inflammable gas, oil mist, dust or conductive fine particles
	Altitude	Operation/Storage: 1000 meters or less above sea level, Transportation: 13000 meters or less above sea level
	Vibration/impact	4.9m/s^2 (0.5G) / 49m/s^2 (5G)

2.4.2 Servo Drive Unit

(1) 200V series

< MDS-E Series >

		1-axis servo drive unit MDS-E-V1 Series						
Servo drive unit type MDS-E-V1-		20	40	80	160	160W	320	320W
Nominal maximum current (peak) [A]		20	40	80	160	160	320	320
Output	Rated voltage [V]	170AC						
	Rated current [A]	6.4	10.9	16	33	42	65.8	97
Input	Rated voltage [V]	270 to 324DC						
	Rated current [A]	7.0	7.0	14	30	35	45	55
Control power	Voltage [V]	200 to 240AC Tolerable fluctuation : between +10% and -15%						
	Frequency [Hz]	50/60 Tolerable fluctuation : between +5% and -5%						
	Maximum current [A]	0.6						
	Maximum rush current [A]	30						
	Maximum rush conductivity time [ms]	6						
Maximum earth leakage current [mA]		2						
Control method		Sine wave PWM control method						
Braking		Regenerative braking and dynamic brakes						
	Dynamic brakes	Built-in						External (MDS-D-DBU)
External analog output		0 to +5V, 2ch (data for various adjustments)						
Degree of protection		IP20 (excluding terminal block)						
Cooling method		Forced air cooling						
Mass [kg]		3.8				4.5	5.8	7.5
Heat radiated at rated output [W]		40	58	96	184	245	366	471
Unit outline dimension drawing		A1	A1	A1	A1	B1	C1	D1

		2-axis servo drive unit MDS-E-V2 Series				
Servo drive unit type MDS-E-V2-		20	40	80	160	160W
Nominal maximum current (peak) [A]		20/20	40/40	80/80	160/160	160/160
Output	Rated voltage [V]	170AC				
	Rated current [A]	6.4 / 6.4	10.9 / 10.9	16 / 16	33 / 33	42 / 42
Input	Rated voltage [V]	270 to 324DC				
	Rated current [A]	14	14	28	60	70
Control power	Voltage [V]	200 to 240AC Tolerable fluctuation : between +10% and -15%				
	Frequency [Hz]	50/60 Tolerable fluctuation : between +5% and -5%				
	Maximum current [A]	0.6				
	Maximum rush current [A]	30				
	Maximum rush conductivity time [ms]	6				
Maximum earth leakage current [mA]		4				
Control method		Sine wave PWM control method				
Braking		Regenerative braking and dynamic brakes				
	Dynamic brakes	Built-in				
External analog output		0 to +5V, 2ch (data for various adjustments)				
Degree of protection		IP20 (excluding terminal block)				
Cooling method		Forced air cooling				
Mass [kg]		4.5		4.6	5.2	6.3
Heat radiated at rated output [W]		70	106	182	358	480
Unit outline dimension drawing		A1	A1	A1	B1	C1

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

		3-axis servo drive unit MDS-E-V3 Series		
Servo drive unit type MDS-E-V3-		**20**	**40**	**80**
Nominal maximum current (peak) [A]		20/20/20	40/40/40	80/80/80
Output	**Rated voltage [V]**	170AC		
	Rated current [A]	6.4/6.4/6.4	10.9/10.9/10.9	16/16/16
Input	**Rated voltage [V]**	270 to 324DC		
	Rated current [A]	21	21	42
Control power	**Voltage [V]**	200 to 240AC Tolerable fluctuation : between +10% and -15%		
	Frequency [Hz]	50/60 Tolerable fluctuation : between +5% and -5%		
	Maximum current [A]	0.6		
	Maximum rush current [A]	30		
	Maximum rush conductivity time [ms]	6		
Maximum earth leakage current [mA]		6		
Control method		Sine wave PWM control method		
Braking		Regenerative braking and dynamic brakes		
	Dynamic brakes	Built-in		
External analog output		0 to +5V, 2ch (data for various adjustments)		
Degree of protection		IP20 (excluding terminal block)		
Cooling method		Forced air cooling		Natural-cooling
Mass [kg]		4.3		6.2
Heat radiated at rated output [W]		131	225	250
Unit outline dimension drawing		A1		B2

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

(2) 400V series
< MDS-EH Series >

		1-axis servo drive unit MDS-EH-V1 Series							
Servo drive unit type MDS-EH-V1-		10	20	40	80	80W	160	160W	200
Nominal maximum current (peak) [A]		10	20	40	80	80	160	160	200
Output	Rated voltage [V]	323AC							
	Rated current [A]	2.3	4.9	7.7	17	21	32	46	76.8
Input	Rated voltage [V]	513 to 648DC							
	Rated current [A]	0.9	1.6	2.9	6.0	8.0	11.9	16.7	39
Control power	Voltage [V]	380 to 480AC Tolerable fluctuation : between +10% and -15%							
	Frequency [Hz]	50/60 Tolerable fluctuation : between +5% and -5%							
	Maximum current [A]	0.3							
	Maximum rush current [A]	18							
	Maximum rush conductivity time [ms]	12							18
Maximum earth leakage current [mA]		2							
Control method		Sine wave PWM control method							
Braking		Regenerative braking and dynamic brakes							
	Dynamic brakes	Built-in						External (MDS-D-DBU)	
External analog output		0 to +5V, 2ch (data for various adjustments)							
Degree of protection		IP20 (excluding terminal block)							
Cooling method		Natural-cooling	Forced air cooling						
Mass [kg]		3.8				4.5	5.8	7.5	15.4
Heat radiated at rated output [W]		46	68	114	215	269	390	542	735
Unit outline dimension drawing		A1	A1	A1	A1	B1	C1	D1	E1

		2-axis servo drive unit MDS-EH-V2 Series					
Servo drive unit type MDS-EH-V2-		10	20	40	80	80W	160
Nominal maximum current (peak) [A]		10/10	20/20	40/40	80/80	80/80	160/160
Output	Rated voltage [V]	323AC					
	Rated current [A]	2.3 / 2.3	4.9 / 4.9	7.7 / 7.7	17 / 17	21 / 21	32 / 32
Input	Rated voltage [V]	513 to 648DC					
	Rated current [A]	1.8	3.2	5.8	12	16	23.8
Control power	Voltage [V]	380 to 480AC Tolerable fluctuation : between +10% and -15%					
	Frequency [Hz]	50/60 Tolerable fluctuation : between +5% and -5%					
	Maximum current [A]	0.3					
	Maximum rush current [A]	18					
	Maximum rush conductivity time [ms]	12					
Maximum earth leakage current [mA]		4					
Control method		Sine wave PWM control method Current control method					
Braking		Regenerative braking and dynamic brakes					
	Dynamic brakes	Built-in					
External analog output		0 to +5V, 2ch (data for various adjustments)					
Degree of protection		IP20 (excluding terminal block)					
Cooling method		Natural-cooling	Forced air cooling				
Mass [kg]		4.6			5.2	6.3	7.2
Heat radiated at rated output [W]		82	126	218	420	528	767
Unit outline dimension drawing		A1	A1	A1	B1	C1	C1

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

		3-axis servo drive unit MDS-EH-V3 Series
Servo drive unit type MDS-EH-V3-		**40**
Nominal maximum current (peak) [A]		40/40/40
Output	Rated voltage [V]	323AC
	Rated current [A]	7.7 / 7.7 / 7.7
Input	Rated voltage [V]	513 to 648DC
	Rated current [A]	8.7
Control power	Voltage [V]	380 to 480AC Tolerable fluctuation : between +10% and -15%
	Frequency [Hz]	50/60 Tolerable fluctuation : between +5% and -5%
	Maximum current [A]	0.3
	Maximum rush current [A]	18
	Maximum rush conductivity time [ms]	12
Maximum earth leakage current [mA]		6
Control method		Sine wave PWM control method
Braking		Regenerative braking and dynamic brakes
	Dynamic brakes	Built-in
External analog output		0 to +5V, 2ch (data for various adjustments)
Degree of protection		IP20 (excluding terminal block)
Cooling method		Natural-cooling
Mass [kg]		6.2
Heat radiated at rated output [W]		208
Unit outline dimension drawing		B2

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

2.4.3 Spindle Drive Unit

(1) 200V series

< MDS-E Series >

		1-axis spindle drive unit MDS-E-SP Series								
Spindle drive unit type MDS-E-SP-		20	40	80	160	200	240	320	400	640
Nominal maximum current (peak) [A]		20	40	80	160	200	240	320	400	640
Output	Rated voltage [V]	170AC								
	Rated current [A]	9.0	15	27	54	85	94	150	180	225
Input	Rated voltage [V]	270 to 324DC								
	Rated current [A]	7.0	13	20	41	76	95	140	150	210
Control power	Voltage [V]	200 to 240AC Tolerable fluctuation : between +10% and -15%								
	Frequency [Hz]	50/60 Tolerable fluctuation : between +5% and -5%								
	Maximum current [A]	0.6								
	Maximum rush current [A]	30								
	Maximum rush conductivity time [ms]	6							9	
Maximum earth leakage current [mA]		15								
Control method		Sine wave PWM control method								
Braking		Regenerative braking								
External analog output		0 to +5V, 2ch (data for various adjustments)								
Degree of protection		IP20 (excluding terminal block)								
Cooling method		Forced air cooling								
Mass [kg]		3.8			4.5	5.8	7.5	8.5	15.6	18.3
Heat radiated at continuous rated output [W]		55	94	158	290	481	620	806	1045	1427
Unit outline dimension drawing		A1	A1	A1	B1	C1	D1	D2	E1	F1

		2-axis spindle drive unit MDS-E-SP2 Series			
Spindle drive unit type MDS-E-SP2-		20	40	80	16080
Nominal maximum current (peak) [A]		20/20	40/40	80/80	160/80
Output	Rated voltage [V]	170AC			
	Rated current [A]	9.0 / 9.0	15 / 15	27 / 27	54 / 27
Input	Rated voltage [V]	270 to 324DC			
	Rated current [A]	14	26	40	61
Control power	Voltage [V]	200 to 240AC Tolerable fluctuation : between +10% and -15%			
	Frequency [Hz]	50/60 Tolerable fluctuation : between +5% and -5%			
	Maximum current [A]	0.6			
	Maximum rush current [A]	30			
	Maximum rush conductivity time [ms]	6			
Maximum earth leakage current [mA]		30			
Control method		Sine wave PWM control method			
Braking		Regenerative braking			
External analog output		0 to +5V, 2ch (data for various adjustments)			
Degree of protection		IP20 (excluding terminal block)			
Cooling method		Forced air cooling			
Mass [kg]		4.5	4.5	5.2	5.2
Heat radiated at continuous rated output [W]		90	168	298	428
Unit outline dimension drawing		A1	A1	B1	B1

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

(2) 400V series

< MDS-EH Series >

		1-axis spindle drive unit MDS-EH-SP Series								
Spindle drive unit type MDS-EH-SP-		**20**	**40**	**80**	**100**	**160**	**200**	**320**	**480**	**600**
Nominal maximum current (peak) [A]		20	40	80	100	160	200	320	480	600
Output	**Rated voltage [V]**	323AC								
	Rated current [A]	11	18	27	43	75	90	125	180	200
Input	**Rated voltage [V]**	513 to 648DC								513 to 700DC
	Rated current [A]	10	15	21	38	72	82	119	150	200
Control power	**Voltage [V]**	380 to 480AC Tolerable fluctuation : between +10% and -15%								
	Frequency [Hz]	50/60 Tolerable fluctuation : between +5% and -5%								
	Maximum current [A]	0.3								
	Maximum rush current [A]	18								
	Maximum rush conductivity time [ms]	12					18			
Maximum earth leakage current [mA]		15								
Control method		Sine wave PWM control method								
Braking		Regenerative braking								
External analog output		0 to +5V, 2ch (data for various adjustments)								
Degree of protection		IP20 (excluding terminal block)								
Cooling method		Forced air cooling								
Mass [kg]		3.8		4.5	5.8	7.5	15.4		18.3	20.1
Heat radiated at continuous rated output [W]		120	200	291	442	749	872	1202	1720	2349
Unit outline dimension drawing		A1	A1	B1	C1	D1	E1	E1	F1	F1

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

2.4.4 Power Supply Unit

(1) 200V series

< MDS-E Series >

		Power supply unit MDS-E-CV Series							
Power supply unit type MDS-E-CV-		37	75	110	185	300	370	450	550
30-minute rated output [kW]		3.7	7.5	11.0	18.5	30.0	37.0	45.0	55.0
Continuous rated output [kW]		2.2	5.5	7.5	15.0	26.0	30.0	37.0	45.0
Power facility capacity [kVA]		5.3	11	16.0	27.0	43.0	53.0	64.0	78.0
Input	Rated voltage [V]	200 to 240AC Tolerable fluctuation : between +10% and -15%							
	Frequency [Hz]	50/60 Tolerable fluctuation : between +5% and -5%							
	Rated current [A]	15	26	35	65	107	121	148	200
Output	Rated voltage [V]	270 to 324DC							
	Rated current [A]	17	30	41	76	144	164	198	238
Control power	Voltage [V]	200 to 240AC Tolerable fluctuation : between +10% and -15%							
	Frequency [Hz]	50/60 Tolerable fluctuation : between +5% and -5%							
	Maximum current [A]	0.2							
	Maximum rush current [A]	38							
	Maximum rush conductivity time [ms]	3							
Main circuit method		Converter with power regeneration circuit							
Degree of protection		IP20 (excluding terminal block)							
Cooling method		Natural-cooling		Forced air cooling					
Mass [kg]		3.5		5.6	5.7	10.6	11.2	11.7	25.5
Heat radiated at rated output [W]		54	79	124	193	317	396	496	595
Unit outline dimension drawing		A2	A2	B1	B1	D1	D1	D2	F1

(2) 400V series

< MDS-EH Series >

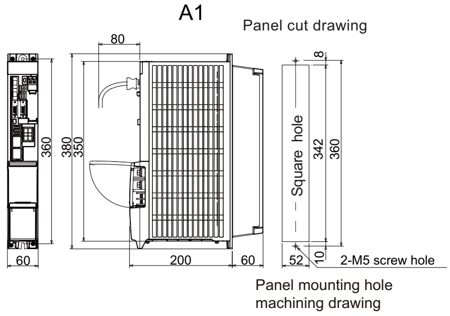
		Power supply unit MDS-EH-CV Series								
Power supply unit type MDS-EH-CV-		37	75	110	185	300	370	450	550	750
30-minute rated output [kW]		3.7	7.5	11.0	18.5	30.0	37.0	45.0	55.0	75.0
Continuous rated output [kW]		2.2	5.5	7.5	15.0	26.0	30.0	37.0	45.0	55.0
Power facility capacity [kVA]		5.3	11.0	16.0	27.0	43.0	53.0	64.0	78.0	107.0
Input	Rated voltage [V]	380 to 480AC Tolerable fluctuation : between +10% and -15%								
	Frequency [Hz]	50/60 Tolerable fluctuation : between +5% and -5%								
	Rated current [A]	5.2	13	18	35	61	70	85	106	130
Output	Rated voltage [V]	513 to 648DC								
	Rated current [A]	7.1	15	21	38	72	82	99	119	150
Control power	Voltage [V]	380 to 480AC Tolerable fluctuation : between +10% and -15%								
	Frequency [Hz]	50/60 Tolerable fluctuation : between +5% and -5%								
	Maximum current [A]	0.1								
	Maximum rush current [A]	18								
	Maximum rush conductivity time [ms]	12								
Main circuit method		Converter with power regeneration circuit								
Degree of protection		IP20 (excluding terminal block)								
Cooling method		Forced air cooling								
Mass [kg]		5.7		6.0		10.0			25.5	
Heat radiated at rated output [W]		54	79	124	193	317	402	496	595	842
Unit outline dimension drawing		B1	B1	B1	B1	D1	D1	D1	F1	F1

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1501252(ENG)).

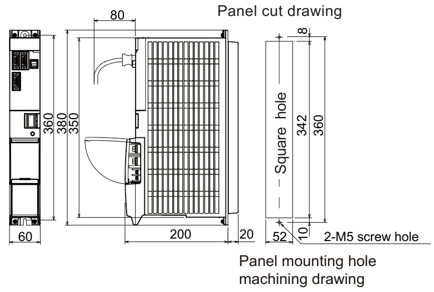
2.4.5 Unit Outline Dimension Drawing

[Unit:mm]

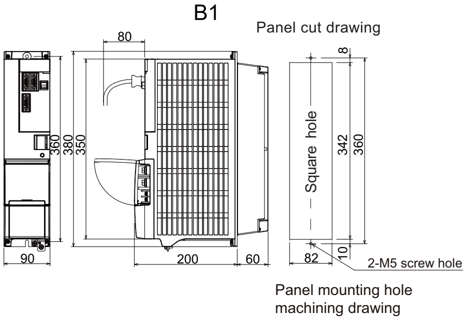
A1



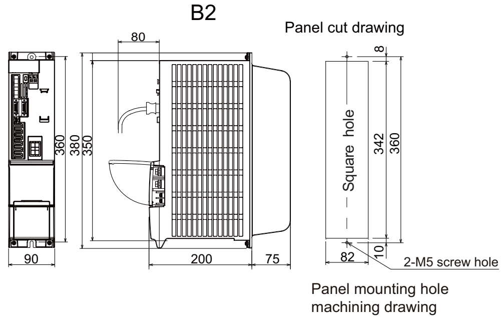
A2



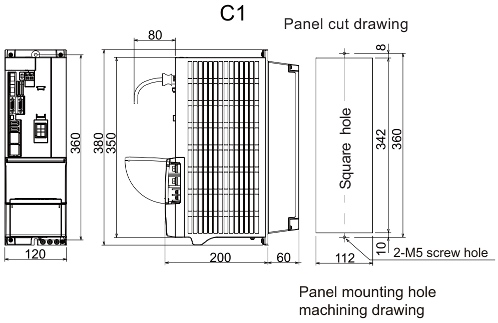
B1



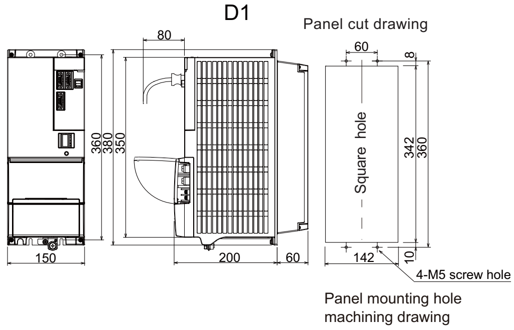
B2



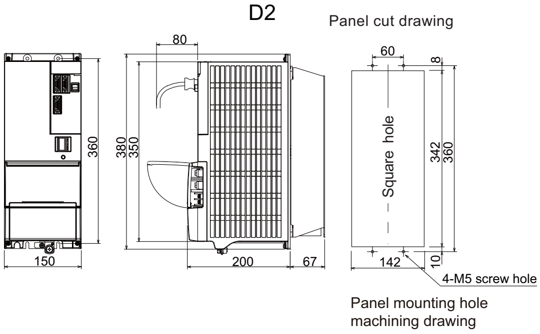
C1



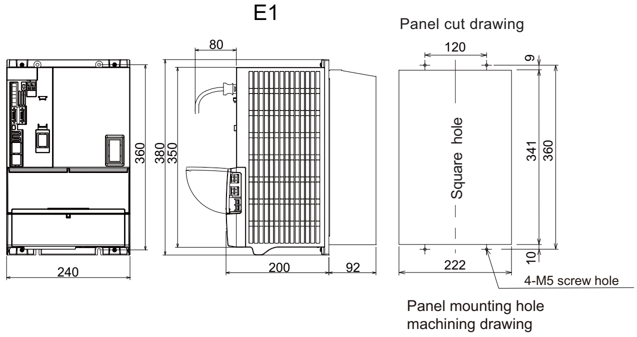
D1



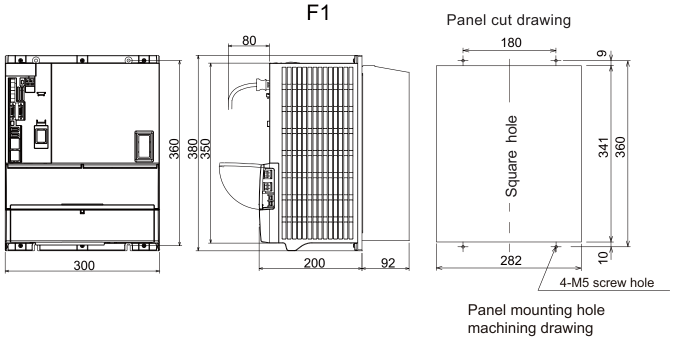
D2



E1



F1



2.4.6 AC Reactor

An AC reactor must be installed for each power supply unit.

(1) 200V series

< MDS-E Series >

		AC reactor						
AC reactor model D-AL-		7.5K	11K	18.5K	30K	37K	45K	55K
Compatible power supply unit type MDS-E-CV-		37,75	110	185	300	370	450	550
Rated capacity [kW]		7.5	11	18.5	30	37	45	55
Rated voltage [V]		200 to 240AC Tolerable fluctuation : between +10% and -15%						
Rated current [A]		27	40	66	110	133	162	198
Frequency [Hz]		50/60 Tolerable fluctuation : between +5% and -5%						
Environment	Ambient temperature	Operation: -10°C to 60°C (with no freezing), Storage/Transportation: -10°C to 60°C (with no freezing)						
	Ambient humidity	Operation: 80%RH or less (with no dew condensation), Storage/Transportation: 80%RH or less (with no dew condensation)						
	Atmosphere	Indoors (no direct sunlight) With no corrosive gas, inflammable gas, oil mist or dust						
	Altitude	Operation/Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level						
	Vibration / impact	$9.8m/s^2$ (1G) / $98m/s^2$ (10G)						
Mass [kg]		4.2	3.7	5.3	6.1	8.6	9.7	11.5

(2) 400V series

< MDS-EH Series >

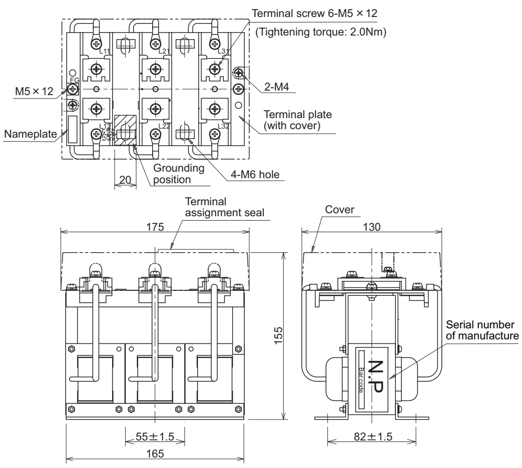
		AC reactor							
AC reactor model DH-AL-		7.5K	11K	18.5K	30K	37K	45K	55K	75K
Compatible power supply unit type MDS-EH-CV-		37, 75	110	185	300	370	450	550	750
Rated capacity [kW]		7.5	11	18.5	30	37	45	55	75
Rated voltage [V]		380 to 480AC Tolerable fluctuation : between +10% and -15%							
Rated current [A]		14	21	37	65	75	85	105	142
Frequency [Hz]		50/60 Tolerable fluctuation : between +5% and -5%							
Environment	Ambient temperature	Operation: -10°C to 60°C (with no freezing), Storage/Transportation: -10°C to 60°C (with no freezing)							
	Ambient humidity	Operation: 80%RH or less (with no dew condensation), Storage/Transportation: 80%RH or less (with no dew condensation)							
	Atmosphere	Indoors (no direct sunlight) With no corrosive gas, inflammable gas, oil mist or dust							
	Altitude	Operation/Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level							
	Vibration / impact	$9.8m/s^2$ (1G) / $98m/s^2$ (10G)							
Mass [kg]		4.0	3.7	5.3	6.0	8.5	9.8	10.5	13.0

⚠ CAUTION

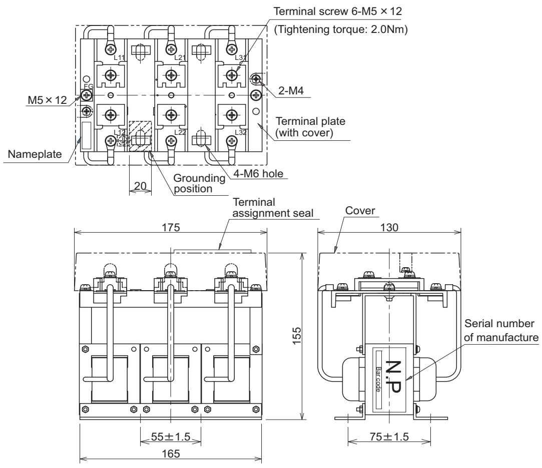
D-AL/DH-AL is used for MDS-E/EH-CV.

Outline dimension drawing

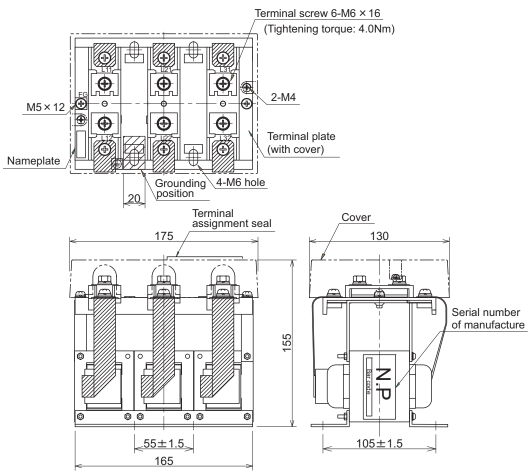
[Unit:mm]



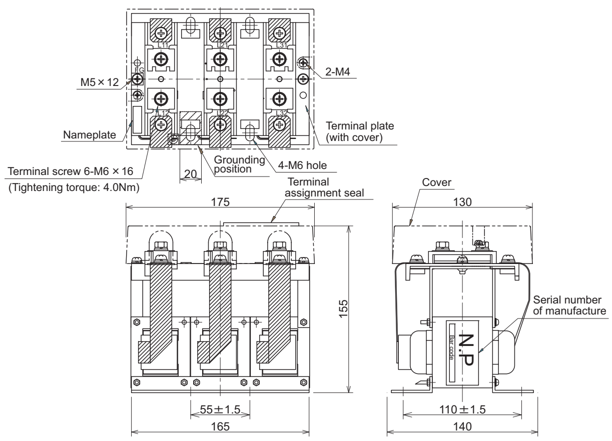
D/DH-AL-7.5K



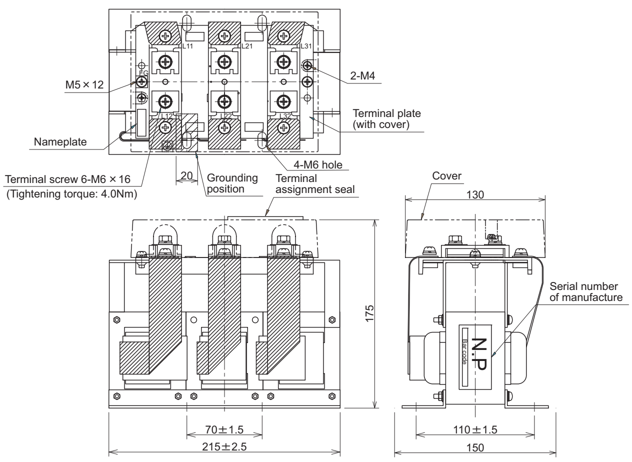
D/DH-AL-11K



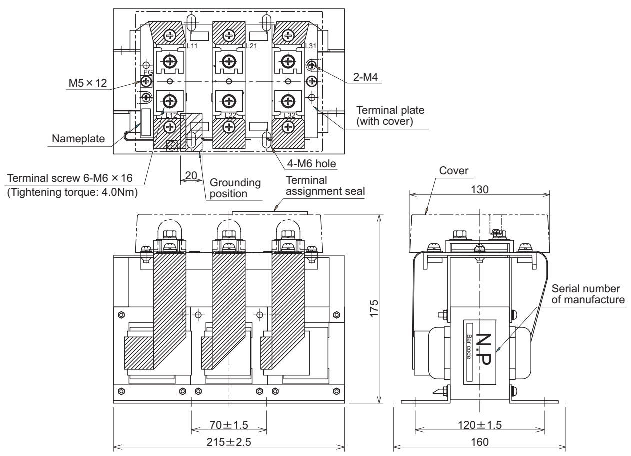
D/DH-AL-18.5K



D/DH-AL-30K

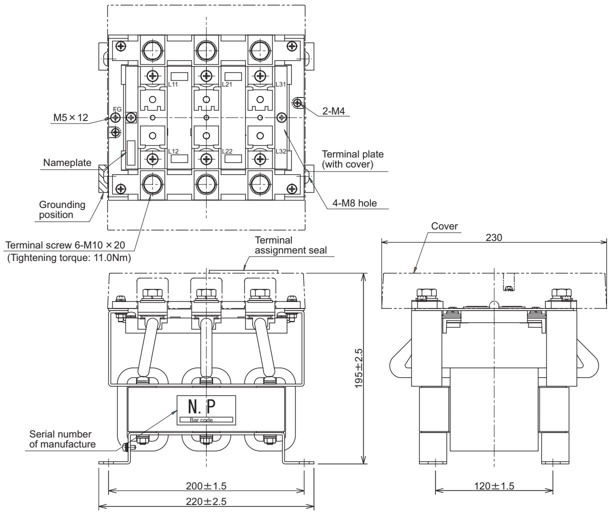


D/DH-AL-37K

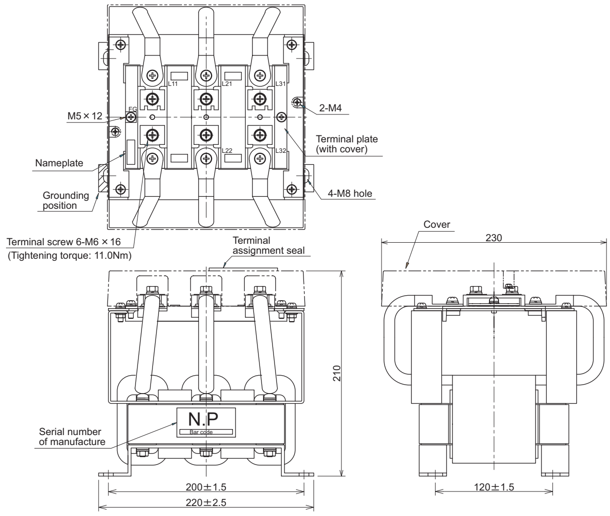


D/DH-AL-45K

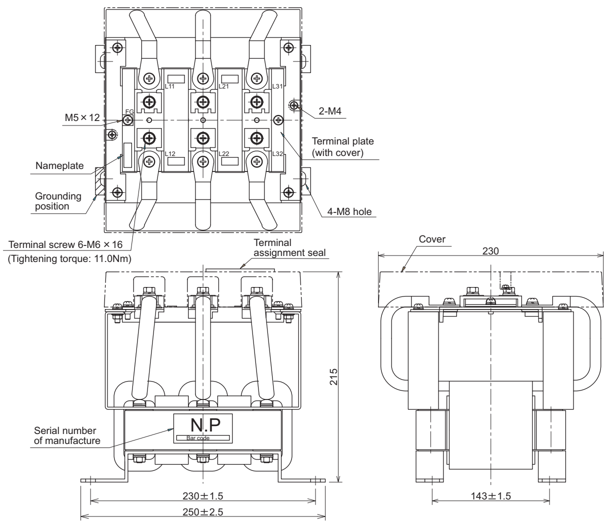
[Unit:mm]



D-AL-55K



DH-AL-55K



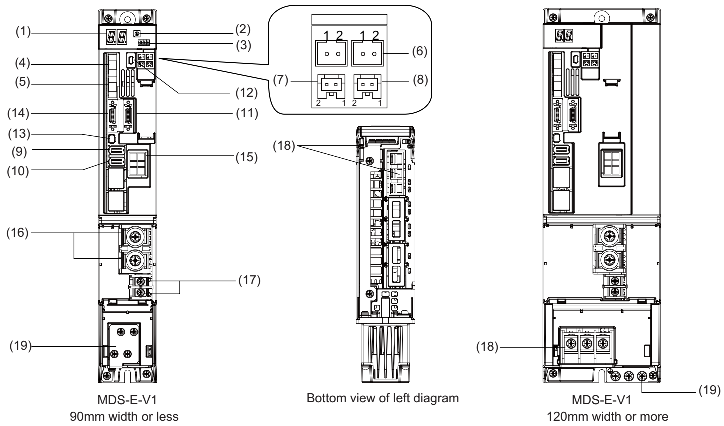
DH-AL-75K

2.4.7 Explanation of Each Part

(1) 200V series

< MDS-E Series >

(a) Explanation of each 1-axis servo drive unit part



The connector and terminal block layout may differ according to the unit being used. Refer to each unit outline drawing for details.

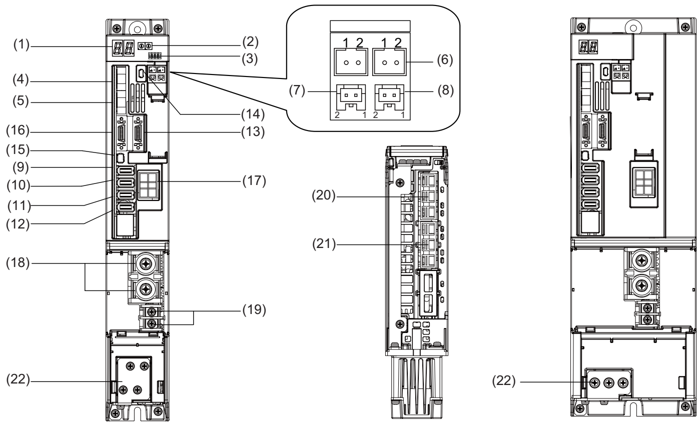
< Each part name >

		Name		Description
(1)	Control circuit	LED	---	Unit status indication LED
(2)		SWL	---	Axis No. setting switch
(3)		SW1	---	Unused axis setting switch
(4)		CN1A	---	NC or master axis optical communication connector
(5)		CN1B	---	Slave axis optical communication connector
(6)		BTA,BTB	---	(Unused)
(7)		BTI	---	Battery input side
(8)		BTO	---	Battery output side
(9)		CN2L	---	Motor side encoder connection connector 5V power supply capacity:0.35A
(10)		CN3L	---	Machine side encoder connection connector 5V power supply capacity:0.35A
(11)		CN4	---	Power supply communication connector
(12)		CN5	---	USB maintenance connector (usually not used)
(13)		CN8	---	External STO input connector (Insert the provided STO short-circuit connector when not using external STO input.)
(14)		CN9	---	DIO/analog output connector
(15)		CN20	---	Motor brake/dynamic brake unit control connector (Key way: X type)
(16)	Main circuit	TE2	L+ L-	Converter voltage input terminal (DC input)
(17)		TE3	L11 L21	Control power input terminal (single-phase AC input)
(18)		TE1	LU, LV, LW	Motor power supply output connector (3-phase AC output) (for 90mm width or less) Motor power supply output terminal (3-phase AC output) (for 120mm width or more)
(19)		PE	⏚	Grounding terminal, Motor grounding terminal

< Screw size >

	1-axis servo drive unit MDS-E-V1-			
Type	**20 to 160**	**160W**	**320**	**320W**
Unit width (mm)	60	90	120	150
(16) TE2	M6 × 18			
(17) TE3	M4 × 10			
(18) TE1	-	-	M5 × 12	M8 × 16
(19) ⏚	M4 × 12	M5 × 12		M8 × 16

(b) Explanation of each 2-axis servo drive unit part



MDS-E-V2
90mm width or less

Bottom view of left diagram

MDS-E-V2
120mm width

The connector and terminal block layout may differ according to the unit being used. Refer to each unit outline drawing for details.

< Each part name >

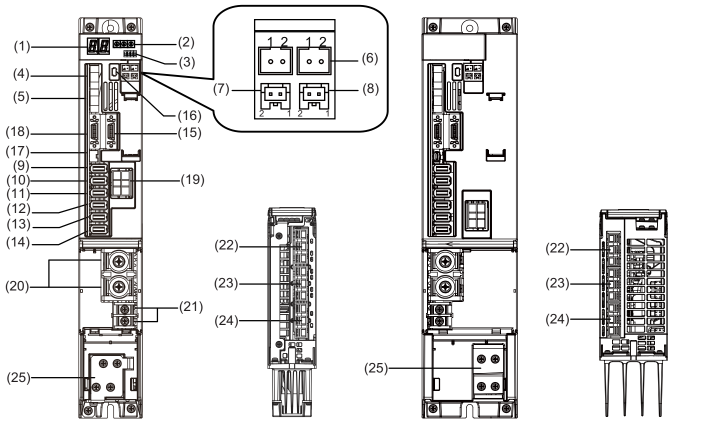
		Name		Description
(1)	Control circuit	LED	---	Unit status indication LED
(2)		SWL,SWM	---	Axis No. setting switch (L, M-axis)
(3)		SW1	---	Unused axis setting switch (L, M-axis)
(4)		CN1A	---	NC or master axis optical communication connector
(5)		CN1B	---	Slave axis optical communication connector
(6)		BTA,BTB	---	(Unused)
(7)		BTI	---	Battery input side
(8)		BTO	---	Battery output side
(9)		CN2L	---	Motor side encoder connection connector (L-axis) 5V power supply capacity:0.35A (Note)
(10)		CN3L	---	Machine side encoder connection connector (L-axis) 5V power supply capacity:0.35A (Note)
(11)		CN2M	---	Motor side encoder connection connector (M-axis) 5V power supply capacity:0.35A (Note)
(12)		CN3M	---	Machine side encoder connection connector (M-axis) 5V power supply capacity:0.35A (Note)
(13)		CN4	---	Power supply communication connector
(14)		CN5	---	USB maintenance connector (usually not used)
(15)		CN8	---	External STO input connector (Insert the provided STO short-circuit connector when not using external STO input.)
(16)		CN9	---	DIO/analog output connector
(17)		CN20	---	Motor brake control connector (Key way: X type)
(18)	Main circuit	TE2	L+ L-	Converter voltage input terminal (DC input)
(19)		TE3	L11 L21	Control power input terminal (single-phase AC input)
(20)		TE1	LU, LV, LW	Motor power supply output connector (3-phase AC output)
(21)			MU, MV, MW	
(22)		PE	⏚	Grounding terminal, Motor grounding terminal

(Note) Select a machine side encoder so that the consumption current of the entire unit is 1.0A or less with a motor side encoder set to 0.25A.

< Screw size >

	2-axis servo drive unit MDS-E-V2-		
Type	**20 to 80**	**160**	**160W**
Unit width (mm)	60	90	120
(18) TE2	M6×18		
(19) TE3	M4×10		
(22) ⏚	M4×12	M5×12	

(c) Explanation of each 3-axis servo drive unit part



MDS-E-V3 Bottom view of left diagram MDS-E-V3 90mm width Bottom view of left diagram

The connector and terminal block layout may differ according to the unit being used. Refer to each unit outline drawing for details.

< Each part name >

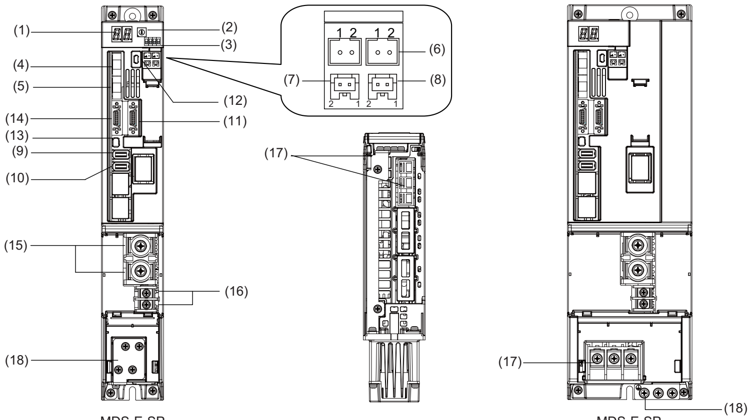
		Name		Description
(1)	Control circuit	LED	---	Unit status indication LED
(2)		SWL,SWM,SWS	---	Axis No. setting switch (L,M,S-axis)
(3)		SW1	---	Unused axis setting switch (L,M,S-axis)
(4)		CN1A	---	NC or master axis optical communication connector
(5)		CN1B	---	Slave axis optical communication connector
(6)		BTA,BTB	---	(Unused)
(7)		BTI	---	Battery input side
(8)		BTO	---	Battery output side
(9)		CN2L	---	Motor side encoder connection connector (L-axis) 5V power supply capacity:0.35A (Note)
(10)		CN3L		Machine side encoder connection connector (L-axis) 5V power supply capacity:0.35A (Note)
(11)		CN2M	---	Motor side encoder connection connector (M-axis) 5V power supply capacity:0.35A (Note)
(12)		CN3M		Machine side encoder connection connector (M-axis) 5V power supply capacity:0.35A (Note)
(13)		CN2S	---	Motor side encoder connection connector (S-axis) 5V power supply capacity:0.35A (Note)
(14)		CN3S		Machine side encoder connection connector (S-axis) 5V power supply capacity:0.35A (Note)
(15)		CN4	---	Power supply communication connector
(16)		CN5	---	USB maintenance connector (usually not used)
(17)		CN8	---	External STO input connector (Insert the provided STO short-circuit connector when not using external STO input.)
(18)		CN9	---	DIO/analog output connector
(19)		CN20	---	Motor brake control connector (Key way: X type)
(20)	Main circuit	TE2	L+ L-	Converter voltage input terminal (DC input)
(21)		TE3	L11 L21	Control power input terminal (single-phase AC input)
(22)		TE1	LU, LV, LW	Motor power supply output connector (3-phase AC output)
(23)			MU, MV, MW	
(24)			SU, SV, SW	
(25)		PE	⏚	Grounding terminal, Motor grounding terminal

(Note) Select a machine side encoder so that the consumption current of the entire unit is 1.5A or less with a motor side encoder set to 0.25A.

< Screw size >

	3-axis servo drive unit MDS-E-V3-		
Type	20	40	80
Unit width (mm)	60		90
(20) TE2	M6x 18		
(21) TE3	M4x 10		
(25) ⏚	M4x 12		

(d) Explanation of each 1-axis spindle drive unit part



MDS-E-SP 60mm width
Bottom view of left diagram
MDS-E-SP 90mm width or more

The connector and terminal block layout may differ according to the unit being used. Refer to each unit outline drawing for details.

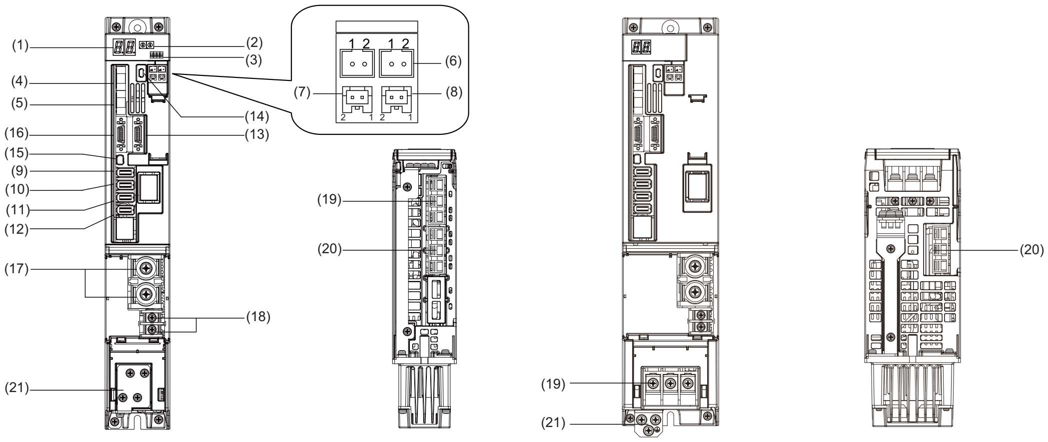
< Each part name >

		Name		Description
(1)	Control circuit	LED	---	Unit status indication LED
(2)		SWL	---	Axis No. setting switch
(3)		SW1	---	Unused axis setting switch
(4)		CN1A	---	NC or master axis optical communication connector
(5)		CN1B	---	Slave axis optical communication connector
(6)		BTA,BTB	---	(Unused)
(7)		BTI	---	(Unused)
(8)		BTO	---	(Unused)
(9)		CN2L	---	Motor side encoder connection connector 5V power supply capacity:0.35A
(10)		CN3L	---	Spindle side encoder connection connector 5V power supply capacity:0.35A
(11)		CN4	---	Power supply communication connector
(12)		CN5	---	USB maintenance connector (usually not used)
(13)		CN8	---	External STO input connector (Insert the provided STO short-circuit connector when not using external STO input.)
(14)		CN9	---	DIO/analog output connector
(15)	Main circuit	TE2	L+ L-	Converter voltage input terminal (DC input)
(16)		TE3	L11 L21	Control power input terminal (single-phase AC input)
(17)		TE1	LU, LV, LW	Motor power supply output connector (3-phase AC output) (for 60mm width) Motor power supply output terminal (3-phase AC output) (for 90mm width or more)
(18)		PE	⏚	Grounding terminal, Motor grounding terminal

< Screw size >

	Spindle drive unit MDS-E-SP-					
Type	**20,40,80**	**160**	**200**	**240,320**	**400**	**640**
Unit width (mm)	60	90	120	150	240	300
(15) TE2	M6 x 18				M6 x 16	
(16) TE3	M4 x 10				M4 x 10	
(17) TE1	-	M5 x 12		M8 x 16	M10 x 20	
(18) ⏚	M4 x 12	M5 x 12		M8 x 16	M10 x 20	

(e) Explanation of each 2-axis spindle drive unit part



MDS-E-SP2-20/40/80　Bottom view of left diagram　MDS-E-SP2-16080　Bottom view of left diagram

The connector and terminal block layout may differ according to the unit being used. Refer to each unit outline drawing for details.

< Each part name >

		Name		Description
(1)	**Control circuit**	LED	---	Unit status indication LED
(2)		SWL,SWM	---	Axis No. setting switch (L, M-axis)
(3)		SW1	---	Unused axis setting switch (L, M-axis)
(4)		CN1A	---	NC or master axis optical communication connector
(5)		CN1B	---	Slave axis optical communication connector
(6)		BTA,BTB	---	(Unused)
(7)		BTI	---	(Unused)
(8)		BTO	---	(Unused)
(9)		CN2L	---	Motor side encoder connection connector (L-axis) 5V power supply capacity:0.35A (Note)
(10)		CN3L	---	Spindle side encoder connection connector (L-axis) 5V power supply capacity:0.35A (Note)
(11)		CN2M	---	Motor side encoder connection connector (M-axis) 5V power supply capacity:0.35A (Note)
(12)		CN3M	---	Spindle side encoder connection connector (M-axis) 5V power supply capacity:0.35A (Note)
(13)		CN4	---	Power supply communication connector
(14)		CN5	---	USB maintenance connector (usually not used)
(15)		CN8	---	External STO input connector (Insert the provided STO short-circuit connector when not using external STO input.)
(16)		CN9	---	DIO/analog output connector
(17)	**Main circuit**	TE2	L+ L-	Converter voltage input terminal (DC input)
(18)		TE3	L11 L21	Control power input terminal (single-phase AC input)
(19)		TE1	LU, LV, LW	Motor power supply output connector (3-phase AC output) Motor power supply output terminal (3-phase AC output) (For MDS-E-SP2-16080)
(20)			MU, MV, MW	Motor power supply output connector (3-phase AC output)
(21)		PE	⏚	Grounding terminal, Motor grounding terminal

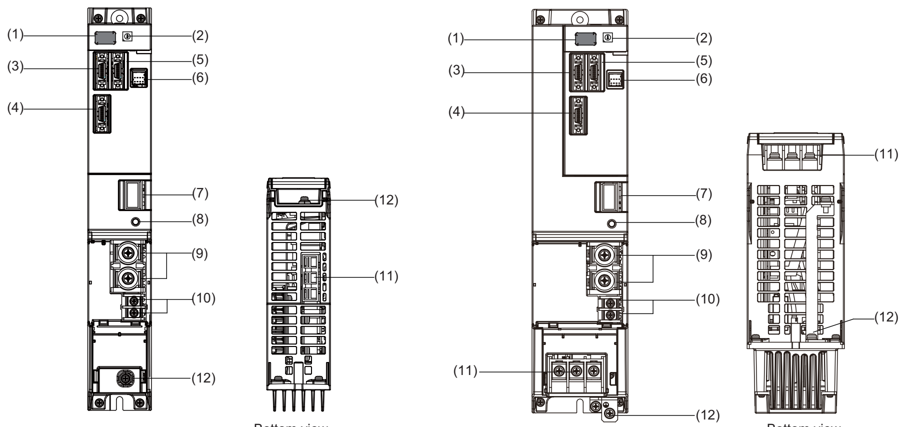
(Note) Select a machine side encoder so that the consumption current of the entire unit is 1.0A or less with a motor side encoder set to 0.25A.

< Screw size >

	2-axis servo drive unit MDS-E-SP2-		
Type	**20, 40**	**80**	**16080**
Unit width (mm)	60	90	
(17) TE2	M6×18		
(18) TE3	M4×10		
(20) TE1	-		M5×12
(21) ⏚	M4×12	M5×12	

(f) Explanation of each power supply unit part

< MDS-E-CV-37 to 450 >



MDS-E-CV Bottom view 60mm width MDS-E-CV Bottom view 90mm width or more

The connector and terminal block layout may differ according to the unit being used. Refer to each unit outline drawing for details.

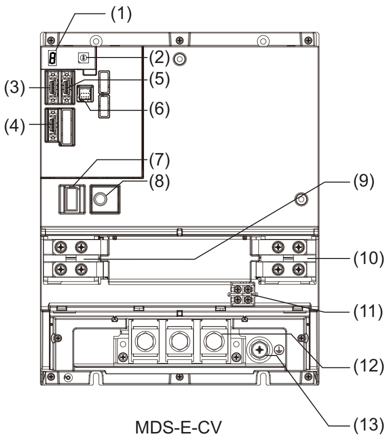
< Each part name >

		Name		Description
(1)	Control circuit	LED	---	Power supply status indication LED
(2)		SW1	---	Power supply setting switch
(3)		CN4	---	Servo/spindle communication connector (primary)
(4)		CN9	---	Servo/spindle communication connector (secondary)
(5)		CN41	---	Power backup unit communication connector
(6)		CN24	---	External emergency stop input connector
(7)	Main circuit	CN23	---	External contactor control connector
(8)		---	CHARGE	TE2 output charging/discharging circuit indication LED
(9)		TE2	L+ L-	Converter voltage output terminal (DC output)
(10)		TE3	L11 L21	Control power input terminal (single-phase AC input)
(11)		TE1	L1,L2,L3	Power input terminal (3-phase AC input)
(12)		PE	⏚	Grounding terminal

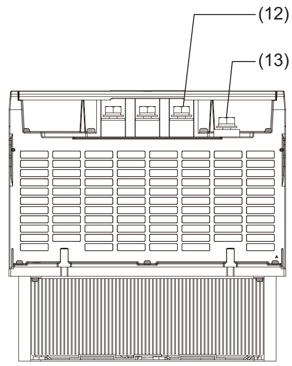
< Screw size >

	Power supply unit MDS-E-CV-		
Type	**37, 75**	**110,185**	**300 to 450**
Unit width (mm)	60	90	150
(9) TE2	M6 x 18		
(10) TE3	M4 x 10		
(11) TE1	-	M5 x 12	M8 x 16
(12) ⏚	M4 x 12	M5 x 12	M8 x 16

< MDS-E-CV-550 >



MDS-E-CV



Bottom view

The connector and terminal block layout may differ according to the unit being used. Refer to each unit outline drawing for details.

< Each part name >

		Name		Description
(1)	Control circuit	LED	---	Power supply status indication LED
(2)		SW1	---	Power supply setting switch
(3)		CN4	---	Servo/spindle communication connector (primary)
(4)		CN9	---	Servo/spindle communication connector (secondary)
(5)		CN41	---	Power backup unit communication connector
(6)		CN24	---	External emergency stop input connector
(7)	Main circuit	CN23	---	External contactor control connector
(8)		---	CHARGE	TE2 output charging/discharging circuit indication LED
(9) (10)		TE2	L+ L-	Converter voltage output terminal (DC output)
(11)		TE3	L11 L21	Control power input terminal (single-phase AC input)
(12)		TE1	L1,L2,L3	Power input terminal (3-phase AC input)
(13)		PE	⏚	Grounding terminal

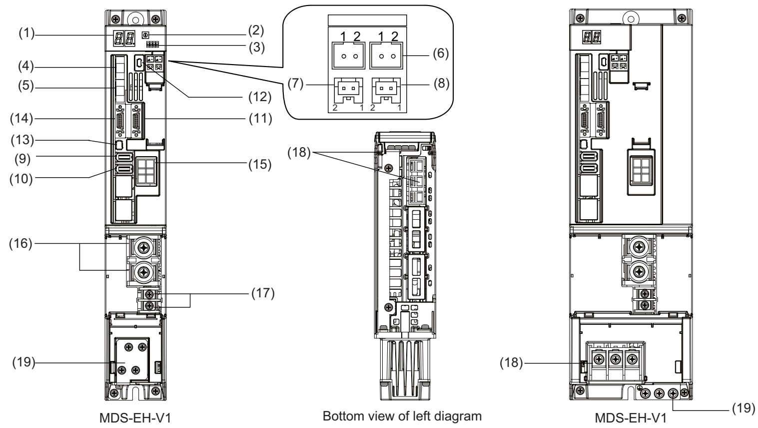
< Screw size >

	Power supply unit MDS-E-CV-
Type	**550**
Unit width (mm)	300
(9) (10) TE2	M6 x 16
(11) TE3	M4 x 10
(12) TE1	M10 x 20
(13) ⏚	M10 x 20

(2) 400V series

< MDS-EH Series >

(a) Explanation of each 1-axis servo drive unit part



MDS-EH-V1
90mm width or less

Bottom view of left diagram

MDS-EH-V1
120mm width or more

The connector and terminal block layout may differ according to the unit being used. Refer to each unit outline drawing for details.

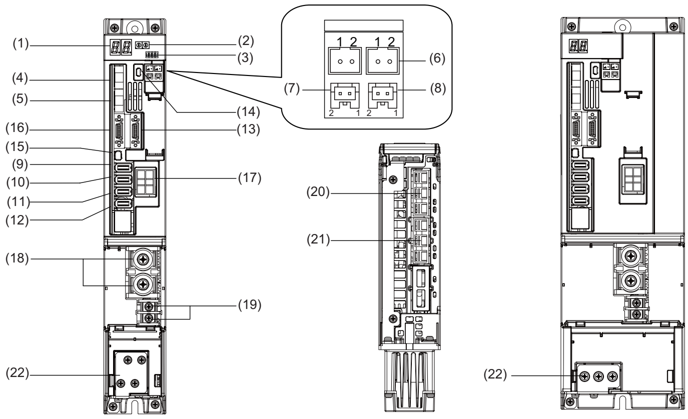
< Each part name >

		Name		Description
(1)	Control circuit	LED	---	Unit status indication LED
(2)		SWL	---	Axis No. setting switch
(3)		SW1	---	Unused axis setting switch
(4)		CN1A	---	NC or master axis optical communication connector
(5)		CN1B	---	Slave axis optical communication connector
(6)		BTA,BTB	---	(Unused)
(7)		BTI	---	Battery input side
(8)		BTO		Battery output side
(9)		CN2L	---	Motor side encoder connection connector 5V power supply capacity:0.35A
(10)		CN3L	---	Machine side encoder connection connector 5V power supply capacity:0.35A
(11)		CN4	---	Power supply communication connector
(12)		CN5	---	USB maintenance connector (usually not used)
(13)		CN8	---	External STO input connector (Insert the provided STO short-circuit connector when not using external STO input.)
(14)		CN9	---	DIO/analog output connector
(15)		CN20	---	Motor brake/dynamic brake unit control connector (Key way: X type)
(16)	Main circuit	TE2	L+ L-	Converter voltage input terminal (DC input)
(17)		TE3	L11 L21	Control power input terminal (single-phase AC input)
(18)		TE1	LU, LV, LW	Motor power supply output connector (3-phase AC output) (for 90mm width or less) Motor power supply output terminal (3-phase AC output) (for 120mm width or more)
(19)		PE	⏚	Grounding terminal, Motor grounding terminal

< Screw size >

	1-axis servo drive unit MDS-EH-V1-				
Type	10 to 80	80W	160	160W	200
Unit width (mm)	60	90	120	150	240
(16) TE2	M6×18				M6×16
(17) TE3	M4×10				M4×10
(18) TE1	-		M5×12		M8×15
(19) ⏚	M4×12	M5×12			M8×16

(b) Explanation of each 2-axis servo drive unit part



MDS-EH-V2
90mm width or less

Bottom view of left diagram

MDS-EH-V2
120mm width

The connector and terminal block layout may differ according to the unit being used. Refer to each unit outline drawing for details.

< Each part name >

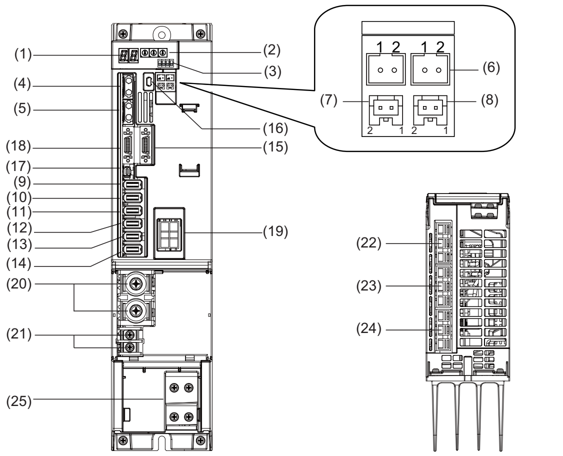
		Name		Description
(1)	Control circuit	LED	---	Unit status indication LED
(2)		SWL,SWM	---	Axis No. setting switch (L, M-axis)
(3)		SW1	---	Unused axis setting switch (L, M-axis)
(4)		CN1A	---	NC or master axis optical communication connector
(5)		CN1B	---	Slave axis optical communication connector
(6)		BTA,BTB	---	(Unused)
(7)		BTI	---	Battery input side
(8)		BTO	---	Battery output side
(9)		CN2L	---	Motor side encoder connection connector (L-axis) 5V power supply capacity:0.35A (Note)
(10)		CN3L	---	Machine side encoder connection connector (L-axis) 5V power supply capacity:0.35A (Note)
(11)		CN2M	---	Motor side encoder connection connector (M-axis) 5V power supply capacity:0.35A (Note)
(12)		CN3M	---	Machine side encoder connection connector (M-axis) 5V power supply capacity:0.35A (Note)
(13)		CN4	---	Power supply communication connector
(14)		CN5	---	USB maintenance connector (usually not used)
(15)		CN8	---	External STO input connector (Insert the provided STO short-circuit connector when not using external STO input.)
(16)		CN9	---	DIO/analog output connector
(17)		CN20	---	Motor brake control connector (Key way: X type)
(18)	Main circuit	TE2	L+ L-	Converter voltage input terminal (DC input)
(19)		TE3	L11 L21	Control power input terminal (single-phase AC input)
(20)		TE1	LU, LV, LW	Motor power supply output connector (3-phase AC output)
(21)			MU, MV, MW	
(22)		PE	⏚	Grounding terminal, Motor grounding terminal

(Note) Select a machine side encoder so that the consumption current of the entire unit is 1.0A or less with a motor side encoder set to 0.25A.

< Screw size >

	2-axis servo drive unit MDS-EH-V2-		
Type	**10 to 40**	**80**	**80W, 160**
Unit width (mm)	60	90	120
(18) TE2	M6×18		
(19) TE3	M4×10		
(22) ⏚	M4×12	M5×12	

(c) Explanation of each 3-axis servo drive unit part



MDS-EH-V3　　Bottom view of left diagram

The connector and terminal block layout may differ according to the unit being used. Refer to each unit outline drawing for details.

< Each part name >

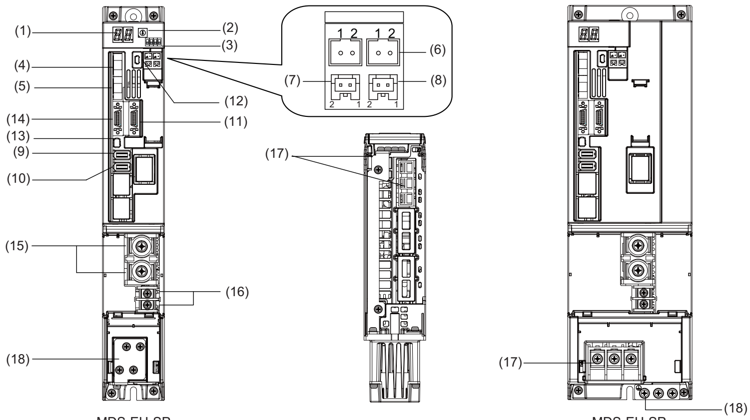
		Name		Description
(1)	Control circuit	LED	---	Unit status indication LED
(2)		SWL,SWM,SWS	---	Axis No. setting switch (L,M,S-axis)
(3)		SW1	---	Unused axis setting switch (L,M,S-axis)
(4)		CN1A	---	NC or master axis optical communication connector
(5)		CN1B	---	Slave axis optical communication connector
(6)		BTA,BTB	---	(Unused)
(7)		BTI	---	Battery input side
(8)		BTO	---	Battery output side
(9)		CN2L	---	Motor side encoder connection connector (L-axis) 5V power supply capacity:0.35A (Note)
(10)		CN3L		Machine side encoder connection connector (L-axis) 5V power supply capacity:0.35A (Note)
(11)		CN2M	---	Motor side encoder connection connector (M-axis) 5V power supply capacity:0.35A (Note)
(12)		CN3M		Machine side encoder connection connector (M-axis) 5V power supply capacity:0.35A (Note)
(13)		CN2S	---	Motor side encoder connection connector (S-axis) 5V power supply capacity:0.35A (Note)
(14)		CN3S		Machine side encoder connection connector (S-axis) 5V power supply capacity:0.35A (Note)
(15)		CN4	---	Power supply communication connector
(16)		CN5	---	USB maintenance connector (usually not used)
(17)		CN8	---	External STO input connector (Insert the provided STO short-circuit connector when not using external STO input.)
(18)		CN9	---	DIO/analog output connector
(19)		CN20	---	Motor brake control connector (Key way: X type)
(20)	Main circuit	TE2	L+ L-	Converter voltage input terminal (DC input)
(21)		TE3	L11 L21	Control power input terminal (single-phase AC input)
(22)		TE1	LU, LV, LW	Motor power supply output connector (3-phase AC output)
(23)			MU, MV, MW	
(24)			SU, SV, SW	
(25)		PE	⏚	Grounding terminal, Motor grounding terminal

(Note) Select a machine side encoder so that the consumption current of the entire unit is 1.5A or less with a motor side encoder set to 0.25A.

< Screw size >

	3-axis servo drive unit MDS-EH-V3-
Type	**40**
Unit width (mm)	90
(20) TE2	M6x 18
(21) TE3	M4x 10
(25) ⏚	M4x 12

(d) Explanation of each 1-axis spindle drive unit part



MDS-EH-SP 90mm width or less
Bottom view of left diagram
MDS-EH-SP 120mm width or more

The connector and terminal block layout may differ according to the unit being used. Refer to each unit outline drawing for details.

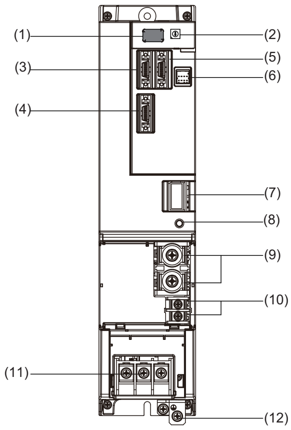
< Each part name >

		Name		Description
(1)	Control circuit	LED	---	Unit status indication LED
(2)		SWL	---	Axis No. setting switch
(3)		SW1	---	Unused axis setting switch
(4)		CN1A	---	NC or master axis optical communication connector
(5)		CN1B	---	Slave axis optical communication connector
(6)		BTA,BTB	---	(Unused)
(7)		BTI	---	(Unused)
(8)		BTO	---	(Unused)
(9)		CN2L	---	Motor side encoder connection connector 5V power supply capacity:0.35A
(10)		CN3L	---	Spindle side encoder connection connector 5V power supply capacity:0.35A
(11)		CN4	---	Power supply communication connector
(12)		CN5	---	USB maintenance connector (usually not used)
(13)		CN8	---	External STO input connector (Insert the provided STO short-circuit connector when not using external STO input.)
(14)		CN9	---	DIO/analog output connector
(15)	Main circuit	TE2	L+ L-	Converter voltage input terminal (DC input)
(16)		TE3	L11 L21	Control power input terminal (single-phase AC input)
(17)		TE1	LU, LV, LW	Motor power supply output connector (3-phase AC output) (for 90mm width or less) Motor power supply output terminal (3-phase AC output) (for 120mm width or more)
(18)		PE	⏚	Grounding terminal, Motor grounding terminal

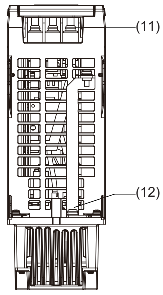
< Screw size >

	Spindle drive unit MDS-EH-SP-						
Type	20, 40	80	100	160	200, 320	480	600
Unit width (mm)	60	90	120	150	240	300	
(15) TE2	M6×18				M6×16		
(16) TE3	M4×10						
(17) TE1	-		M5×12		M8×15		M10×20
(18) ⏚	M4×12	M5×12			M8×16		M10×20

(e) Explanation of each power supply unit part
< MDS-EH-CV-37 to 450 >



MDS-EH-CV



Bottom view
90mm width or more

The connector and terminal block layout may differ according to the unit being used. Refer to each unit outline drawing for details.

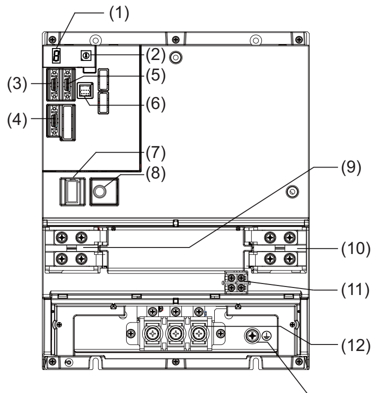
< Each part name >

		Name		Description
(1)	**Control circuit**	LED	---	Power supply status indication LED
(2)		SW1	---	Power supply setting switch
(3)		CN4	---	Servo/spindle communication connector (primary)
(4)		CN9	---	Servo/spindle communication connector (secondary)
(5)		CN41	---	Power backup unit communication connector
(6)		CN24	---	External emergency stop input connector
(7)	**Main circuit**	CN23	---	External contactor control connector
(8)		---	CHARGE	TE2 output charging/discharging circuit indication LED
(9)		TE2	L+ L-	Converter voltage output terminal (DC output)
(10)		TE3	L11 L21	Control power input terminal (single-phase AC input)
(11)		TE1	L1, L2, L3	Power input terminal (3-phase AC input)
(12)		PE	⏚	Grounding terminal

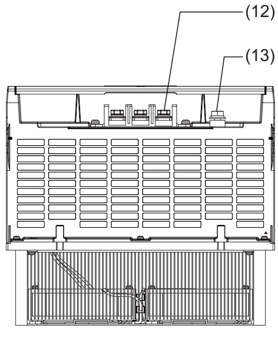
< Screw size >

	Power supply unit MDS-EH-CV-	
Type	**37 to 185**	**300 to 450**
Unit width (mm)	90	150
(9) TE2	M6×18	
(10) TE3	M4×10	
(11) TE1	M5×12	M8×16
(12) ⏚	M5×12	M8×16

< MDS-EH-CV-550 to 750 >



MDS-EH-CV



Bottom view

The connector and terminal block layout may differ according to the unit being used. Refer to each unit outline drawing for details.

< Each part name >

		Name		Description
(1)	Control circuit	LED	---	Power supply status indication LED
(2)		SW1	---	Power supply setting switch
(3)		CN4	---	Servo/spindle communication connector (primary)
(4)		CN9	---	Servo/spindle communication connector (secondary)
(5)		CN41	---	Power backup unit communication connector
(6)		CN24	---	External emergency stop input connector
(7)	Main circuit	CN23	---	External contactor control connector
(8)		---	CHARGE	TE2 output charging/discharging circuit indication LED
(9) (10)		TE2	L+ L-	Converter voltage output terminal (DC output)
(11)		TE3	L11 L21	Control power input terminal (single-phase AC input)
(12)		TE1	L1, L2, L3	Power input terminal (3-phase AC input)
(13)		PE	⏚	Grounding terminal

< Screw size >

	Power supply unit MDS-EH-CV-
Type	**550, 750**
Unit width (mm)	300
(9) (10) TE2	M6×16
(11) TE3	M4×10
(12) TE1	M8×16
(13) ⏚	M8×16

3

Function Specifications

Function Specifications List

< Power supply specification >

Item		MDS-E/EH-CV	MDS-EM/EMH-SPV3 built-in converter	MDS-EJ/EJH-V1/V2/SP/SP2 built-in converter	MDS-EX-CVP Series
1 Base control functions	1.15 Power regeneration control	●	●	-	-
	1.16 Resistor regeneration control	-	-	●	-
	1.17 PWM control (Note 1)	-	-	-	●
4 Protection function	4.5 Fan stop detection	●	●	●	●
	4.6 Open-phase detection	●	●	-	●
	4.7 Contactor weld detection	●	●	●	●
	4.10 Deceleration and stop function at power failure (Note 2)	●	-	-	●
	4.11 Retraction function at power failure (Note 3)	●	-	-	●
5 Sequence function	5.1 Contactor control function	●	●	●	●
	5.3 External emergency stop function	●	●	●	●
	5.5 High-speed READY ON sequence	●	●	-	●
6 Diagnosis function	6.6 Power supply diagnosis display function	●	●	-	●
	6.7 Drive unit diagnosis display function	●	●	●	●

(Note 1) Refer to "MDS-EX-CVP Series Specifications and Instruction Manual"(IB-1501587(ENG)) for details.
(Note 2) The power backup unit and resistor unit option are required.
(Note 3) The power backup unit and capacitor unit option are required.

< Servo specification >

Item		MDS-E-V1/V2/V3	MDS-EH-V1/V2	MDS-EM/EMH-SPV3	MDS-EJ/EJH-V1	MDS-EJ-V2
1 Base control functions	1.1 Full closed loop control	●	●	●	●	●
	1.2 Position command synchronous control	●	●	●	●	●
	1.3 Speed command synchronous control	● (Note 1)	●	-	-	●
	1.4 Common encoder current command synchronous control (Note 5)	●	●	-	-	●
	1.5 Distance-coded reference position control	●	●	●	●	●
2 Servo control function	2.1 Torque limit function (stopper function)	●	●	●	●	●
	2.2 Variable speed loop gain control	●	●	●	●	●
	2.3 Gain changeover for synchronous tapping control	●	●	●	●	●
	2.4 Speed loop PID changeover control	●	●	●	●	●
	2.5 Disturbance torque observer	●	●	●	●	●
	2.6 Smooth High Gain control (SHG control)	●	●	●	●	●
	2.7 High-speed synchronous tapping control (OMR-DD control)	●	●	●	●	●
	2.8 Dual feedback control	●	●	●	●	●
	2.9 HAS control	●	●	●	●	●
	2.10 OMR-FF control	●	●	●	●	●
3 Compensation control function	3.1 Jitter compensation	●	●	●	●	●
	3.2 Notch filter	Variable frequency: 4 Fixed frequency: 1	Variable frequency: 4 Fixed frequency: 1	Variable frequency: 4 Fixed frequency: 1	Variable frequency: 4 Fixed frequency: 1	Variable frequency: 4 Fixed frequency: 1
	3.3 Adaptive tracking-type notch filter	●	●	●	●	●
	3.4 Overshooting compensation	●	●	●	●	●
	3.5 Machine end compensation control	●	●	●	●	●
	3.6 Lost motion compensation type 2	●	●	●	●	●
	3.7 Lost motion compensation type 3	●	●	●	●	●
	3.9 Real-time tuning I	●	●	●	●	●
	3.10 Full-closed torsion compensation function	●	●	●	●	●
4 Protection function	4.1 Deceleration control at emergency stop	●	●	●	●	●
	4.2 Vertical axis drop prevention/pull-up control	●	●	●	●	●
	4.3 Earth fault detection	●	●	●	●	●
	4.4 Collision detection function	●	●	●	●	●
	4.5 Fan stop detection	●	●	●	●	●
	4.8 STO (Safe Torque Off) function	●	●	● (Note 2)	●	●
	4.9 SBC (Safe Brake Control) function	●	●	●	●	●
	4.10 Deceleration and stop function at power failure (Note 3)	●	●	●	-	-
	4.11 Retraction function at power failure (Note 4)	●	●	-	-	-
5 Sequence function	5.2 Motor brake control function	●	●	●	●	●
	5.4 Specified speed output	●	●	●	-	-
	5.5 Quick READY ON sequence	●	●	●	-	-
6 Diagnosis function	6.1 Monitor output function	●	●	●	●	●
	6.2 Machine resonance frequency display function	●	●	●	●	●
	6.3 Machine inertia display function	●	●	●	●	●

(Note 1) Always set L-axis as primary axis and M-axis as secondary axis for the speed command synchronous control using MDS-E-V3. Other settings cause the initial parameter error alarm.
(Note 2) The dedicated wiring STO is not supported by MDS-EM/EMH Series.
(Note 3) The power backup unit and resistor unit option are required.
(Note 4) The power backup unit and capacitor unit option are required.
(Note 5) When using common encoder current command synchronous control with a multi axes integrated type drive unit, only M-axis can be set as the secondary axis.

< Spindle specifications >

Item		MDS-E/EH-SP	MDS-E-SP2	MDS-EM/EMH-SPV3	MDS-EJ-SP	MDS-EJ-SP2
1 Base control functions	1.1 Full closed loop control	●	●	●	●	●
	1.6 Spindle's continuous position loop control	●	●	●	●	●
	1.7 Coil changeover control	●	●	●	-	-
	1.8 Gear changeover control	●	●	●	●	●
	1.9 Orientation control	●	●	●	●	●
	1.10 Indexing control	●	●	●	●	●
	1.11 Synchronous tapping control	●	●	●	●	●
	1.12 Spindle synchronous control	●	●	●	●	●
	1.13 Spindle/C axis control	●	●	●	●	●
	1.14 Proximity switch orientation control	●	● (Note 1)	●	●	● (Note 1)
2 Spindle control functions	2.1 Torque limit function	●	●	●	●	●
	2.2 Variable speed loop gain control	●	●	●	●	●
	2.5 Disturbance torque observer	●	●	●	●	●
	2.6 Smooth High Gain control (SHG control)	●	●	●	●	●
	2.7 High-speed synchronous tapping control (OMR-DD control)	●	●	●	●	●
	2.8 Dual feedback control	●	●	●	●	●
	2.10 OMR-FF control	●	●	●	●	●
	2.11 Control loop gain changeover	●	●	●	●	●
	2.12 Spindle output stabilizing control	●	●	●	●	●
	2.13 High-response spindle acceleration/ deceleration function	●	●	●	●	●
3 Compensation control function	3.1 Jitter compensation	●	●	●	●	●
	3.2 Notch filter	Variable frequency: 4 Fixed frequency: 1	Variable frequency: 4 Fixed frequency: 1	Variable frequency: 4 Fixed frequency: 1	Variable frequency: 4 Fixed frequency: 1	Variable frequency: 4 Fixed frequency: 1
	3.3 Adaptive tracking-type notch filter	●	●	●	●	●
	3.4 Overshooting compensation	●	●	●	●	●
	3.6 Lost motion compensation type 2	●	●	●	●	●
	3.8 Spindle motor temperature compensation function	●	●	●	●	●
	3.9 Real-time tuning I	●	●	●	●	●
4 Protection function	4.1 Deceleration control at emergency stop	●	●	●	●	●
	4.3 Earth fault detection	●	●	●	●	●
	4.5 Fan stop detection	●	●	●	●	●
	4.8 STO (Safe Torque Off) function	●	●	● (Note 2)	●	●
	4.10 Deceleration and stop function at power failure (Note 3)	●	●	●	-	-
	4.11 Retraction function at power failure (Note 4)	●	●	-	-	-
5 Sequence functions	5.4 Specified speed output	●	●	●	-	-
	5.5 Quick READY ON sequence	●	●	●	-	-
6 Diagnosis functions	6.1 Monitor output function	●	●	●	●	●
	6.2 Machine resonance frequency display function	●	●	●	●	●
	6.3 Machine inertia display function	●	●	●	●	●
	6.4 Motor temperature display function	●	●	●	●	●
	6.5 Load monitor output function	●	●	●	●	●

(Note 1) As for 2-axis spindle drive unit, setting is available only for one of the axes.
(Note 2) The dedicated wiring STO is not supported by MDS-EM/EMH Series.
(Note 3) The power backup unit and resistor unit option are required.
(Note 4) The power backup unit and capacitor unit option are required.

3.1 Base Control Functions

3.1.1 Full Closed Loop Control

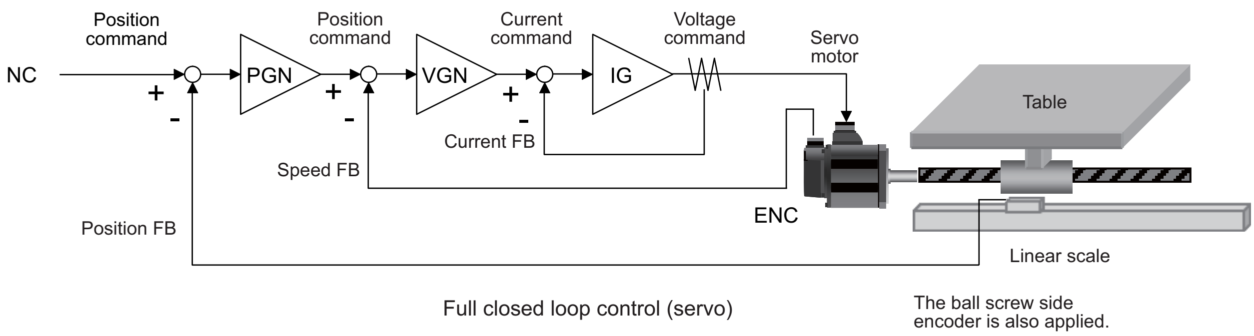
The servo control is all closed loop control using the encoder's feedback. "Full closed loop control" is the system that directly detects the machine position using a linear scale, whereas the general "semi-closed loop" is the one that detects the motor position.

In a machine that drives a table with a ball screw, the following factors exist between the motor and table end:

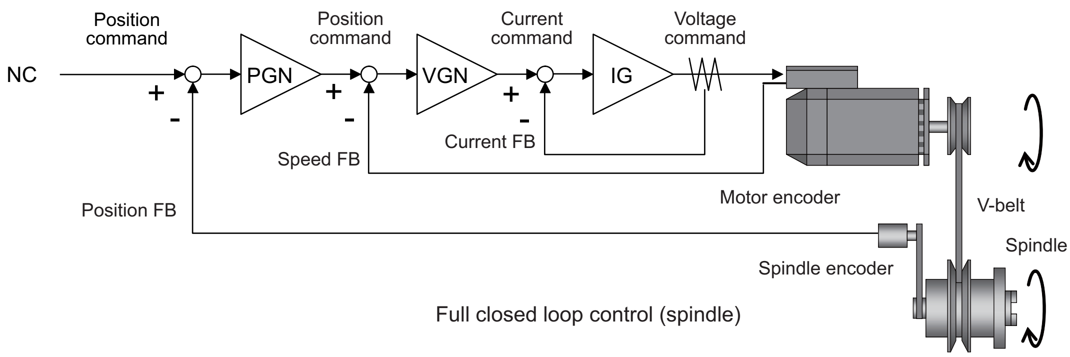
(1) Coupling or ball screw table bracket's backlash

(2) Ball screw pitch error

These can adversely affect the accuracy. If the table position of the machine side is directly detected with a linear scale, high-accuracy position control which is not affected by backlash or pitch error is possible.



Full closed loop control (servo)



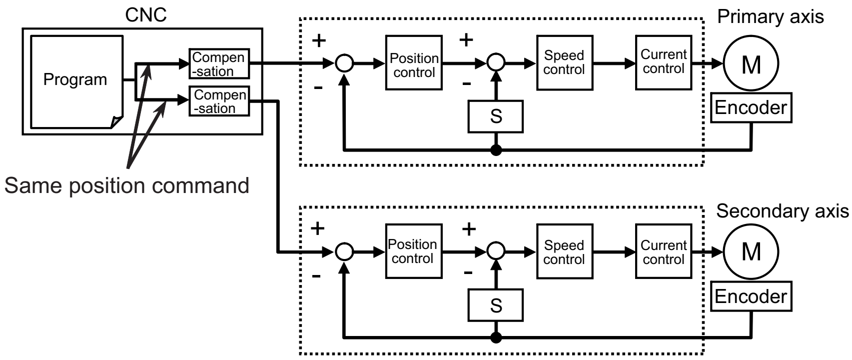
Full closed loop control (spindle)

3.1.2 Position Command Synchronous Control

This is one of the controls which enable two servo motors to drive the same axis. This is also called "Position tandem control".
The same position command is issued to the 2-axis servo control, and the control is carried out according to each axis' position and speed feedbacks.

<Features>

(1) The position commands in which machine's mechanical errors (pitch error, backlash, etc.) have been compensated, can be output to each axis.
(2) Each axis conducts independent position control, therefore the machine posture can be kept constant.
(3) Deviation between the two axes is always monitored, and if excessive, the alarm is detected.



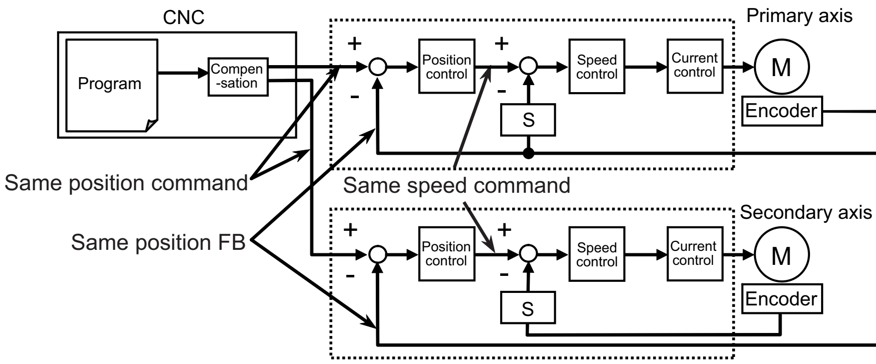
> ⚠ **CAUTION**
>
> When the rigidity between two axes is high, such as when the ball screw interval between the tandem axes is narrow in full closed control, use the speed command synchronous control.

3.1.3 Speed Command Synchronous Control

This is one of the controls which enable two servo motors to drive the same axis. This is also called "Speed tandem control".
The same position command is issued to the 2-axis servo control, and the control is carried out according to each axis' position and speed feedbacks.
This function is usually used when the control is performed with one linear scale during the full closed loop control.

<Features>

(1) When a linear scale is used, two axes can share the position feedback signal from one linear scale.
(2) Feed rates of each axis are controlled with each axis' speed feedback signals, which allows stable control.
(3) Mechanical errors (pitch error, backlash, etc.) are compensated using the common values.



⚠ CAUTION

1. The speed command synchronous control cannot be used for a primary or secondary axis on which load unbalance is generated (Example: an axis carrying an operating axis). Use the position command synchronous control.
2. Disturbance observer cannot be used during the speed command synchronous control.
3. The speed command synchronous control cannot be performed with the distance-coded reference scale.

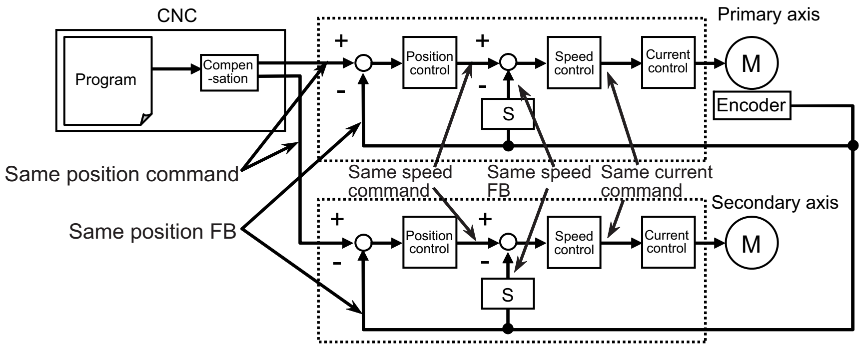
3.1.4 Common Encoder Current Command Synchronous Control

This is a control that enables two servo motors to drive the same axis. This is also called "Common encoder current tandem control".

The same current command is supplied to the servo control of two axes, which are controlled using a common position feedback and speed feedback.

< Advantages >

(1) As the same torque as the the primary axis is always applied on the secondary axis, the torque interference between axes can be controlled.



⚠ CAUTION

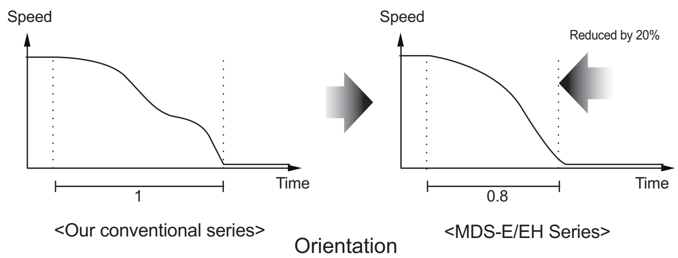
1. Since the position of the secondary axis is not controlled, the stop accuracy of the secondary axis depends on the axis accuracy (machine rigidity).
2. Common encoder current command synchronous control cannot be used for the standard motor series (SV017/bitC-F=0,1,2,3).
3. An NC and drive unit must both be set for common encoder current command synchronous control.
4. When using common encoder current command synchronous control with a single axis type drive unit, use an absolute position system.
5. When using the multi axes integrated type drive unit, only M-axis can be set as the secondary axis.
6. The thermal protection function of drive units cannot be used for a motor on the secondary axis. Protect the motor using another method such as incorporating a thermistor signal in the remote I/O to enable monitoring.

3.1.5 Distance-coded Reference Position Control

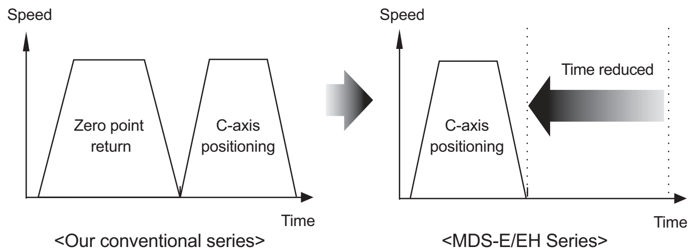
This is the function to establish the reference point from axis movements of the reference points using a scale with distance-coded reference mark.
Since it is not necessary to move the axis to the reference point, the axis movement amount to establish the reference point can be reduced.
No dog is used as the position is calculated using reference marks.
If the distance-coded reference check function is used to verify the motor end encoder data, select a battery option before setting the parameter.

3.1.6 Spindle's Continuous Position Loop Control

Under this control, position loop control is always applied to spindle, including when speed command is issued (in cutting). There is no need for control changeover nor zero point return during orientation and C axis control changeover. Therefore, the operation can be completed in a shorter time than the previous.
In acceleration/deceleration with S command, the acceleration/deceleration and orientation are always controlled with the spindle motor's maximum torque.



Orientation



C-axis changeover

3.1.7 Coil Changeover Control

A signal output from the spindle drive unit controls the changeover of the low-speed and high-speed specification coils in a spindle motor.
The drive unit automatically outputs the coil changeover sequence in accordance with the motor speed.

3.1.8 Gear Changeover Control

This function enables a spindle motor to perform both high-speed light cutting and low-speed heavy cutting by changing the gear ratio between the motor and spindle.
The gear change is carried out while the spindle is not running.

3.1.9 Orientation Control

This control enables a spindle motor to stop at a designated angle when the motor is rotating at a high-speed with a speed command. This control is used for exchanging the tools in machining centers and performing index positioning in lathes, etc.

3.1.10 Indexing Control

This control enables positioning of a spindle motor at an arbitrary angle (in increments of 0.01 degrees) from the orientation stop position. This control is used for positioning in lathes for hole drilling, etc.

3.1.11 Synchronous Tapping Control

Under synchronous tapping control, spindle control is completely synchronized with Z axis servo control, and Z axis is accurately fed by one screw pitch in accordance with one tap revolution. The tap is completely fixed to the spindle head. As a result, feed pitch error is less likely to occur, which allows high-speed, high-accuracy and high-durable tapping.

3.1.12 Spindle Synchronous Control

This control enables two spindles to run at the same speed. A spindle being driven with a speed command is synchronized with another spindle at a constant rate or acceleration/deceleration rate.
This control is applied such as when a workpiece is transferred between two rotating chucks in lathe or a workpiece is held with two chucks.

3.1.13 Spindle/C Axis Control

An axis rotating about Z axis is called C axis, whose rotation direction is normally the same as of spindle. This function enables high-accuracy spindle control including interpolation control, like servo axis, when a high-resolution position encoder is attached to the spindle motor.

3.1.14 Proximity Switch Orientation Control

Orientation control is carried out based on the leading edge position of the proximity switch output signal (ON/OFF) after the spindle is stopped.

3.1.15 Power Regeneration Control

This control enables the regeneration energy generated when the motor decelerates to return to the power supply.
This is an energy saving method because regeneration energy is hardly converted to heat.

3.1.16 Resistor Regeneration Control

This control enables the regeneration energy generated when the motor decelerates to convert to heat with regenerative resistance.
The drive system can be downsized because the regeneration capacity is also small in the motor of relatively small capacity.
Select a suitable regenerative resistance according to the load inertia, motor operation speed, etc.

3.1.17 PWM Control

Refer to "MDS-EX-CVP Series Specifications and Instruction Manual"(IB-1501587(ENG)) for function details.

3.2 Servo/Spindle Control Functions

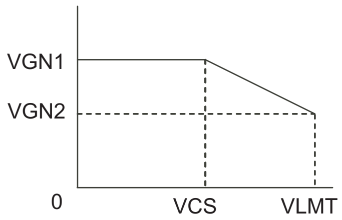
3.2.1 Torque Limit Function

This control suppresses the motor output torque with the parameter values (SV013, SV014).
This function is used for stopper positioning control and stopper reference position establishment, by switching the two setting values.

3.2.2 Variable Speed Loop Gain Control

< Servo >

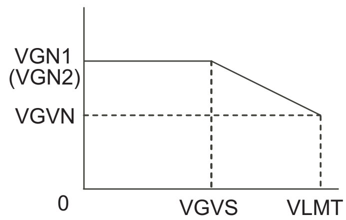
If disturbing noise occurs when the motor is rotating at a high speed, such as during rapid traverse, the high speed loop gain during high-speed rotation can be lowered with this function.

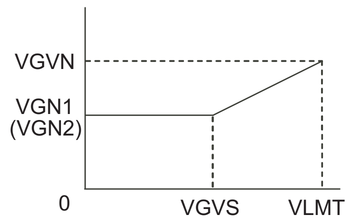


VGN1:SV005
VGN2:SV006
VCS :SV029
VLMT:Motor limitation speed

< Spindle >

For a high-speed spindle of machining center etc., adequate response can be ensured with this function by suppressing noise and vibration at low speeds and increasing the speed loop gain at high-speeds.

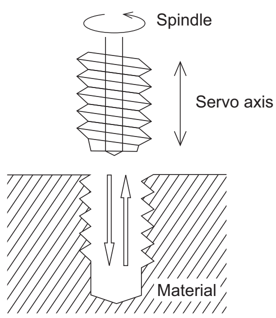




VGN1:SP005
VGN2:SP008
VGVN:SP005×SP073/100
VGVS:SP074
VLMT:Motor limitation speed

3.2.3 Gain Changeover for Synchronous Tapping Control

SV003, SV004 and SV057 are used as the position loop gain for normal control. Under synchronous tapping control, SV049, SV050 and SV058 are used instead to meet the spindle characteristics.



3.2.4 Speed Loop PID Changeover Control

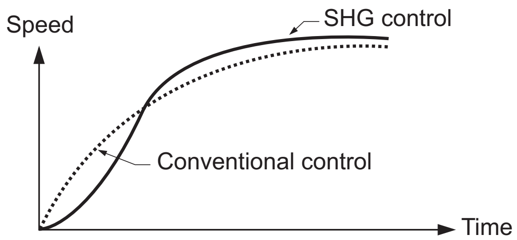
This function is used under full-closed loop control. Normally, machine-end position tracking delays compared with the motor-end position.
Under full-closed position loop control, machine-end position is used for position feedback. Therefore, the motor-end position tends to advance too much, which may cause overshooting of the machine-end position.
This function can suppress the generation of overshoot by adding the D (delay) control to the speed control, which is normally controlled with PI (proportional integral), in order to weaken the PI control after the position droop becomes 0.

3.2.5 Disturbance Torque Observer

The effect caused by disturbance, frictional resistance or torsion vibration during cutting can be reduced by estimating the disturbance torque and compensating it.

3.2.6 Smooth High Gain Control (SHG Control)

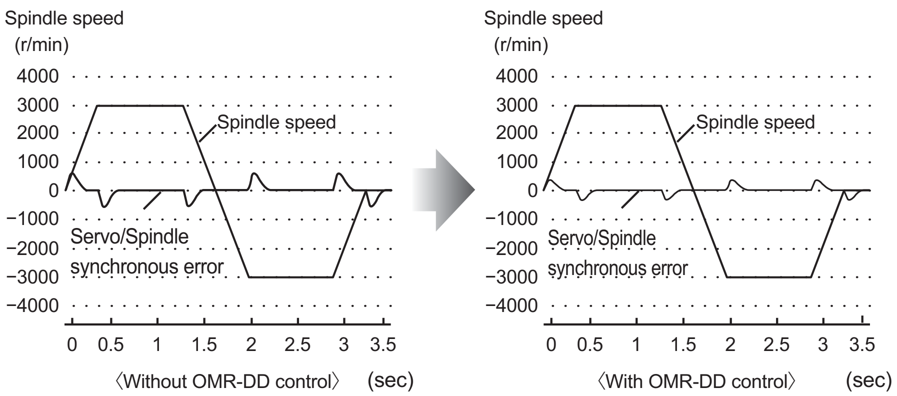
A high-response control and smooth control (reduced impact on machine) were conventionally conflicting elements; however, SHG control enables the two elements to function simultaneously by controlling the motor torque (current FB) with an ideal waveform during acceleration/deceleration.



Position loop step response

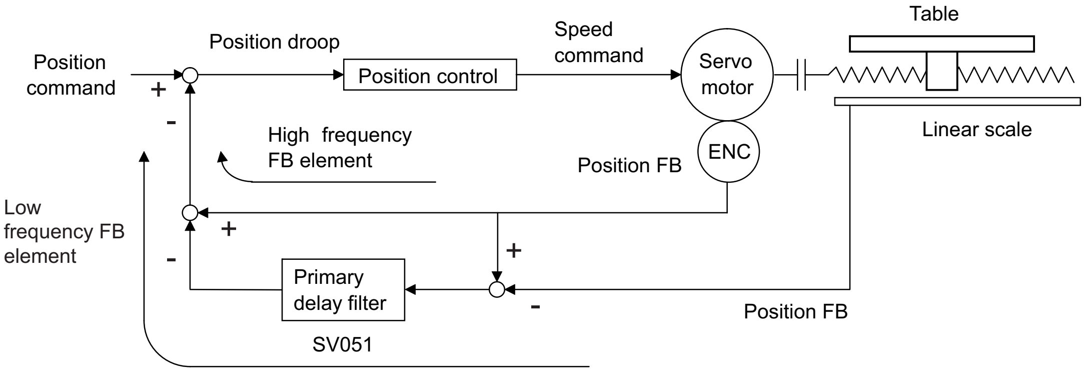
3.2.7 High-speed Synchronous Tapping Control (OMR-DD Control)

Servo drive unit detects the spindle position by high-speed data communication, and compensates the synchronization errors. This control enables more accurate tapping than the previous.



3.2.8 Dual Feedback Control

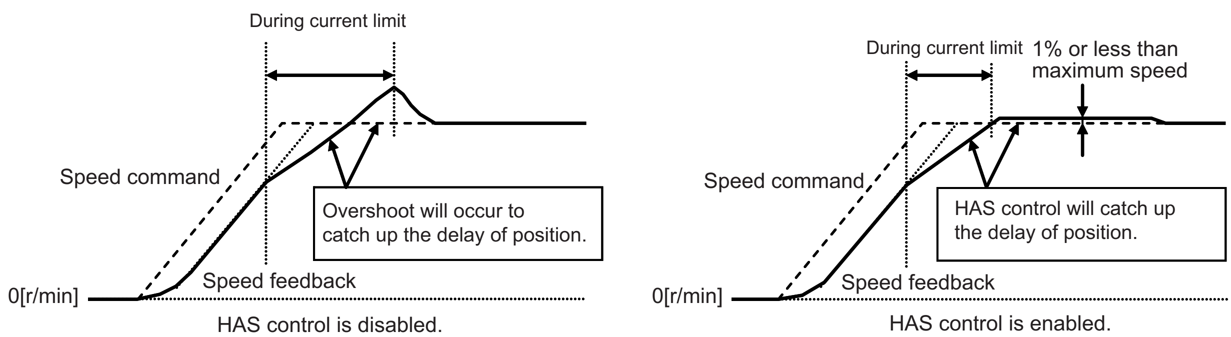
This function is used under full-closed loop control.
When a linear scale is used, the machine-end position, such as a table, is directly detected, which may render the position loop control unstable.
With this control, however, high-frequency components are eliminated from the machine-end feedback signals, which will lead to stable control.



Dual feedback control

3.2.9 HAS Control

If the torque output during acceleration/deceleration is close to the servo motor's maximum torque, the motor cannot accelerate with the commanded time constant when the torque is saturated due to input voltage fluctuation, etc. As a result, speed overshoot occurs when a constant speed command is issued, because the position droop for the delay is canceled.
With HAS control, however, this overshoot is smoothened so that the machine operation can be stable.



3.2.10 OMR-FF Control

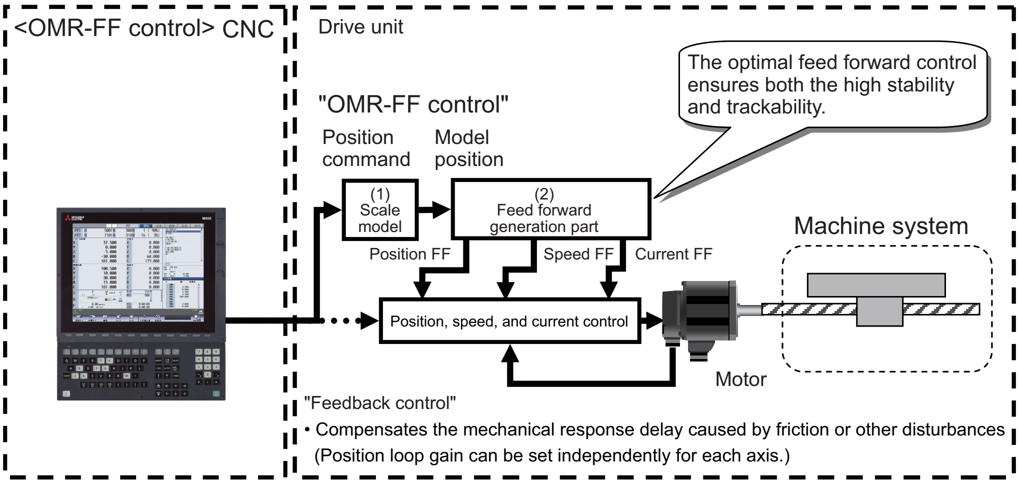
OMR-FF control enables fine control by generating feed forward inside the drive unit and can realize the strict feedback control to the program command than the conventional high-speed accuracy control.
The conventional position control method causes machine vibration when increasing the gain because it ensures both the trackability to the position command and the servo rigidity to the friction or cutting load, etc. by setting the position loop gain (PGN).
OMR-FF function allows the improvement of the command trackability by independently deciding the trackability with the scale model position loop gain (PGM) and the servo rigidity with the position control gain (PGN).

OMR-FF control option for NC side is required when using this function.
It is recommended that this function is used for linear motors, direct-drive motors, or general motors in semi-closed loop control.

< Features >

(1) The command trackability can be decided independently of the position control gain (PGN) with the scale model position loop gain (PGM).

(2) Position loop gain (PGN) can be set for each axis.
-> Delay in the machine's response caused by friction or cutting load, etc. can be compensated with high gain.



3.2.11 Control Loop Gain Changeover

Position loop gain and speed loop gain are switched between non-interpolation mode, which is used during speed command, and interpolation mode, which is used during synchronous tapping and C axis control. By switching these gains, optimum control for each mode can be realized.

3.2.12 Spindle Output Stabilizing Control

Spindle motor's torque characteristic is suppressed due to voltage saturation in the high-speed rotation range, therefore the current control responsiveness significantly degrades, which may cause excessive current.
With this control, however, the current and flux commands are compensated to avoid the voltage saturation so that the current control responsiveness will not degrade.

3.2.13 High-response Spindle Acceleration/Deceleration Function

This function enables reduction of the spindle motor's setting time (from when the command value becomes 0 until when the motor actually stops) without being affected by the position loop gain, when the spindle motor stops under deceleration stop control using the S command.
This function is not active when the spindle is stopped while performing position control, such as orientation control and synchronous tapping control.

3.3 Compensation Control Function

3.3.1 Jitter Compensation

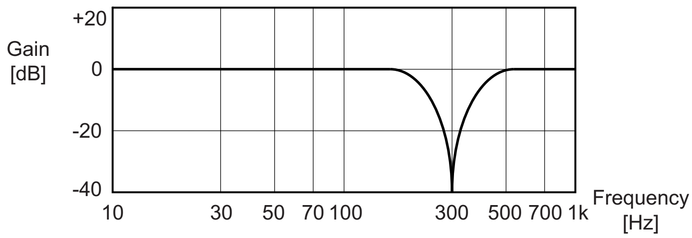
The load inertia becomes much smaller than usual if the motor position enters the machine backlash when the motor is stopped.
Because this means that an extremely large VGN1 is set for the load inertia, vibration may occur.
Jitter compensation can suppress the vibration that occurs at the motor stop by ignoring the backlash amount of speed feedback pulses when the speed feedback polarity changes.

3.3.2 Notch Filter

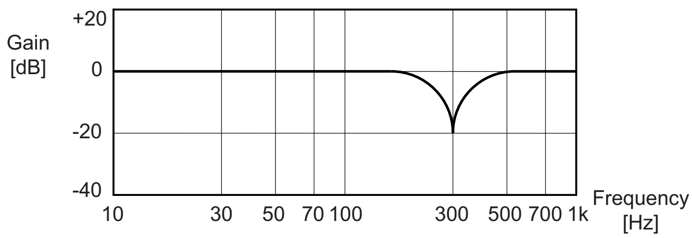
This filter can damp vibrations of servo torque commands at a specified frequency.
Machine vibrations can be suppressed by adjusting the notch filter frequency to the machine's resonance frequency.
Filter depth adjustment is also available that allows stable control even when the filter is set to an extremely low frequency.

<Specifications>

Notch filter	Frequency	Depth compensation
Notch filter 1	0Hz to 5000Hz	Enabled
Notch filter 2	0Hz to 5000Hz	Enabled
Notch filter 3	Fixed at 1125Hz	Disabled
Notch filter 4	0Hz to 5000Hz	Enabled
Notch filter 5	0Hz to 5000Hz	Enabled



Example of filter characteristic set to 300Hz



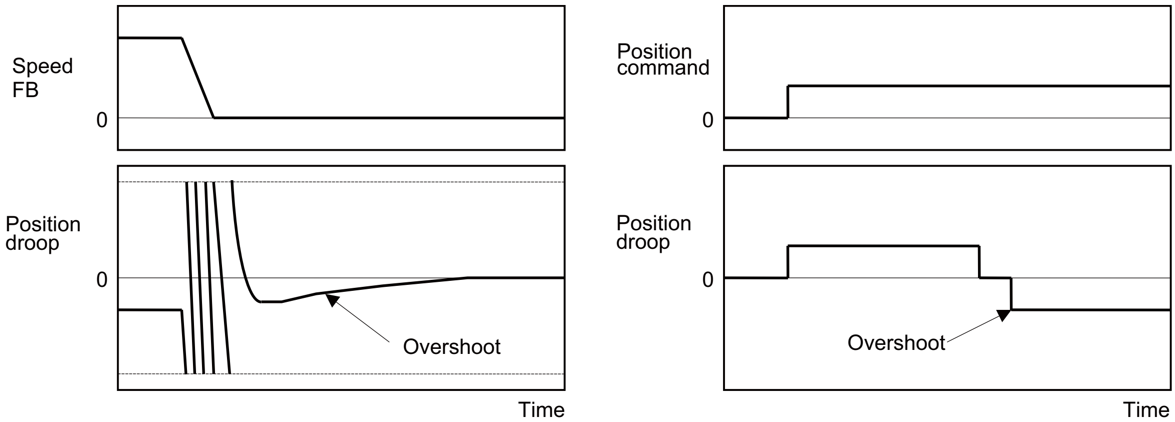
For shallow setting by additionally using the depth compensation at 300Hz

3.3.3 Adaptive Tracking-type Notch Filter

Machine's specific resonance frequency tends to change due to aged deterioration or according to machine's operation conditions. Therefore, the frequency may be deviated from the filter frequency set at the initial adjustment. With adaptive tracking-type notch filter, resonance point fluctuation due to the machine's condition change is estimated using the vibration components of the current commands, and effective notch filter frequency, which has been deviated from the setting value, is automatically corrected to suppress the resonance.

3.3.4 Overshooting Compensation

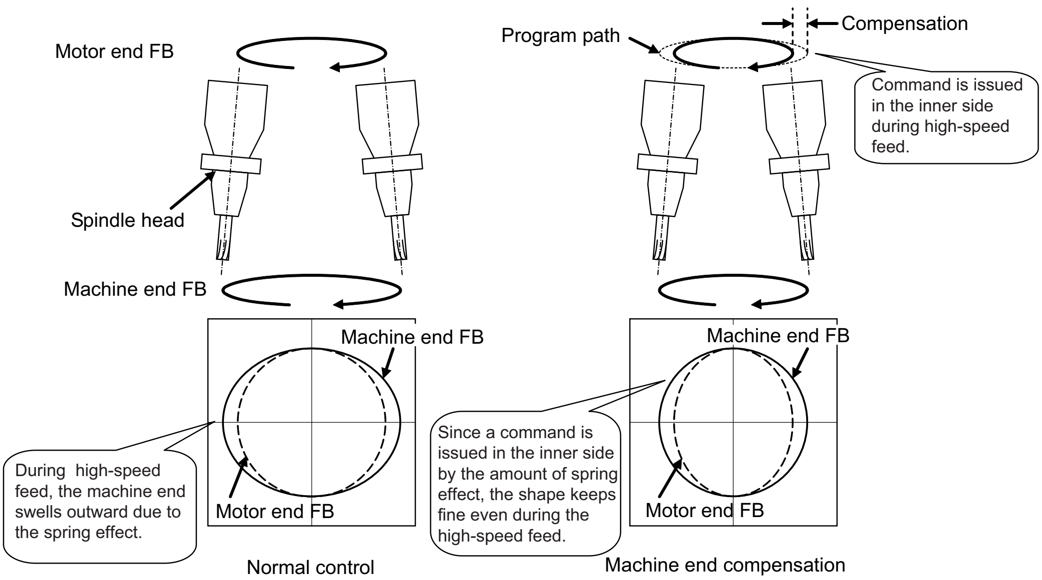
The phenomenon when the machine position goes past or exceeds the command during feed stopping is called overshooting.
In OVS compensation, the overshooting is suppressed by subtracting the torque command set in the parameters when the motor stops.



[1] Overshooting during rapid traverse settling　　[2] Overshooting during pulse feed

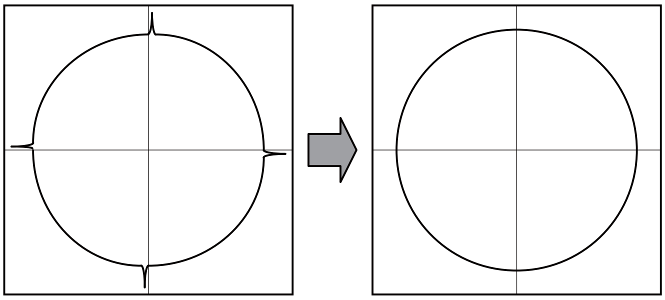
3.3.5 Machine End Compensation Control

The shape of the machine end during high-speed and high-speed acceleration operation is compensated by compensating the spring effect from the machine end to the motor end.
The shape may be fine during low-speed operation. However, at high speeds, the section from the machine end to the outer sides could swell. This function compensates that phenomenon.



3.3.6 Lost Motion Compensation Type 2

A servo motor generates torque against frictional force to drive the machine, and the torque required to overcome the friction during the axial movement is output from the integral (I) control of the speed loop PI control. When the movement direction is changed, the frictional force works in the opposite direction momentarily, however, the machine will stop while the command torque is less than the frictional force as it takes some time to reverse the command torque in I control.
After the momentary stop, the machine accelerates suddenly to catch up with the commanded position. This phenomenon is generally called stick motion, and appears as protrusions (quadrant protrusions) that closely follow quadrant changeover points when errors displayed in a circular path are expanded in the direction of polar coordinates.
The lost motion compensation function compensates for the accuracy degradation caused by the stick motion.



No compensation　　　　With compensation

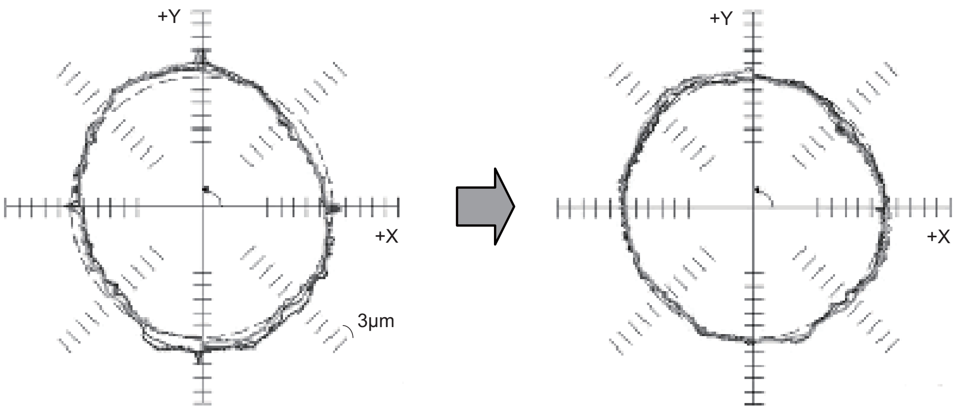
3.3.7 Lost Motion Compensation Type 3

For a machine model where the travel direction is reversed, the compensation in accordance with the changes in the cutting conditions is enabled by also considering the spring component and viscosity component in addition to the friction.
This function can be used to accommodate quadrant projection changes that accompany feed rate and circular radius changes which could not be compensated by Lost motion compensation type 2.

1.Mechanical spring elements can't be ignored.
2.Changes between static and dynamic frictions are wide and steep.

Conventional control can't perform enough compensation.

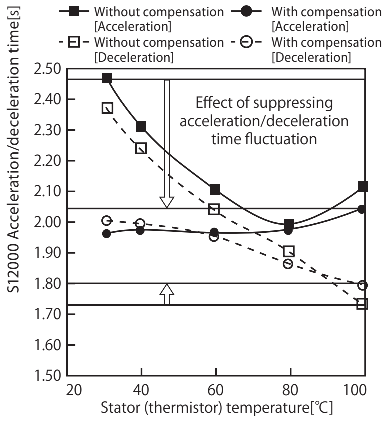
Not only frictions but spring element and viscosity element can be compensated, thus quadrant protrusions are suppressed within a wide band.



Conventional compensation control　　　　Lost motion compensation control type 3

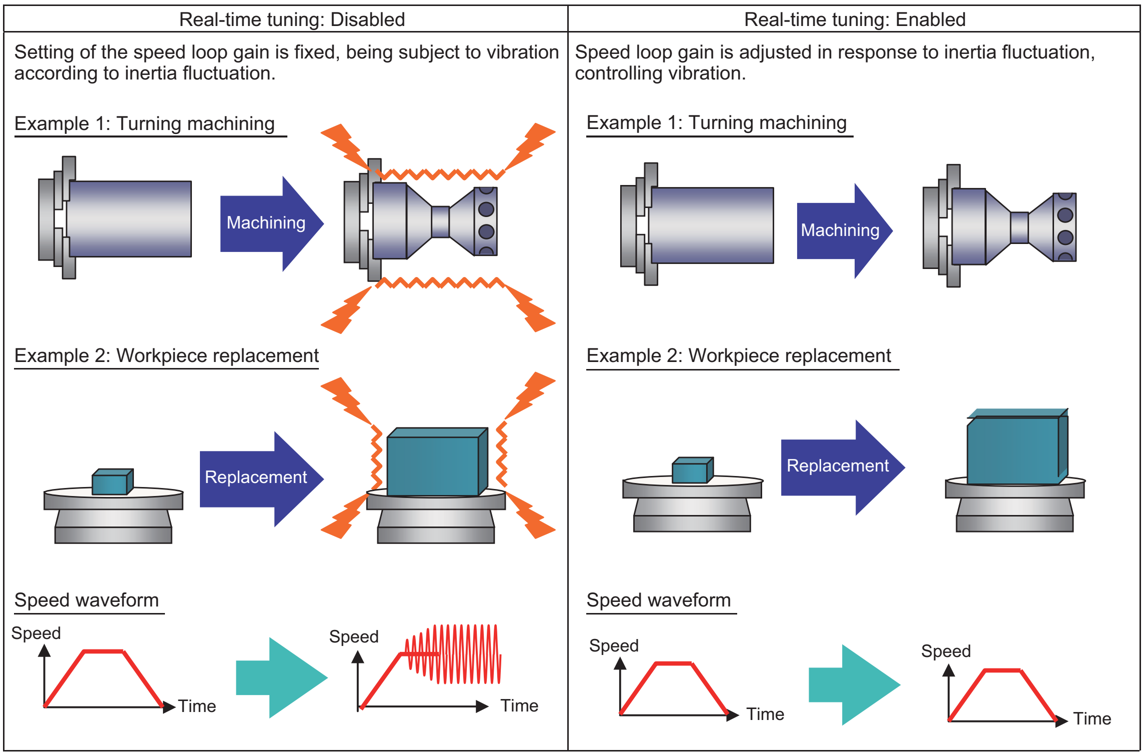
3.3.8 Spindle Motor Temperature Compensation Function

As for the low-temperature state of the IM spindle motor, the output characteristic may deteriorate in comparison with the warm-up state and the acceleration/deceleration time may become long, or the load display during cutting may become high immediately after operation. This function performs the control compensation depending on the motor temperature with the thermistor built into the spindle motor and suppresses the output characteristic deterioration when the temperature is low. Temperature compensation function is not required for IPM spindle motor in principle.



3.3.9 Real-time Tuning I

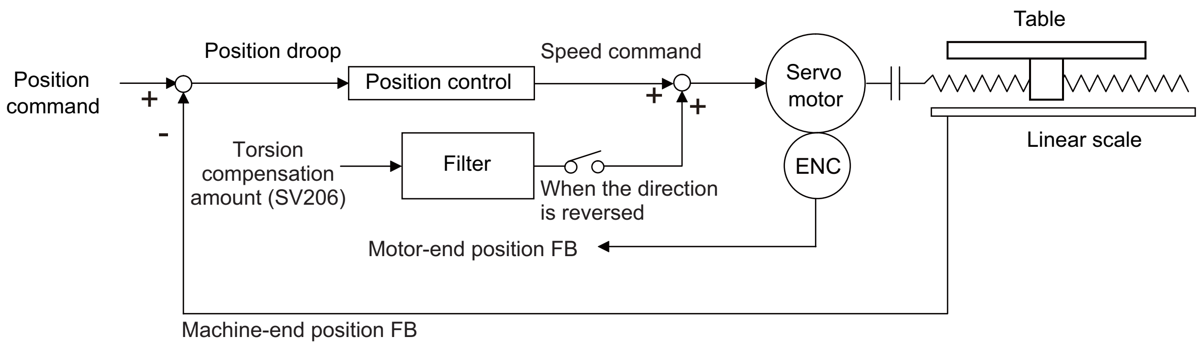
This function estimates the inertia of mechanical system and changes the speed loop gain automatically according to the inertia fluctuation to suppress mechanical vibration. In turning machining or workpiece replacement, this function suppresses mechanical vibration caused by inertia fluctuation.



Outline of real-time tuning

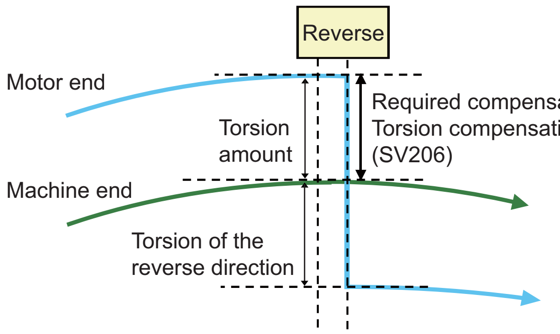
3.3.10 Full-closed Torsion Compensation Function

This function performs compensation by setting the torsion compensation amount based on the distance between the motor-end position and the machine-end position when the direction is reversed. Setting the torsion compensation amount in addition to the conventional lost motion compensation enables to reduce the distance from the machine end and smooth the tracking to the position command. When "SV116/bit1" is set to "1", compensation is performed not only in the reverse direction but also in the forward direction. Compensation in the forward direction performs the starting torque compensation by restoring the torsion compensation amount based on the distance between the motor-end position and the machine-end position when stopped.

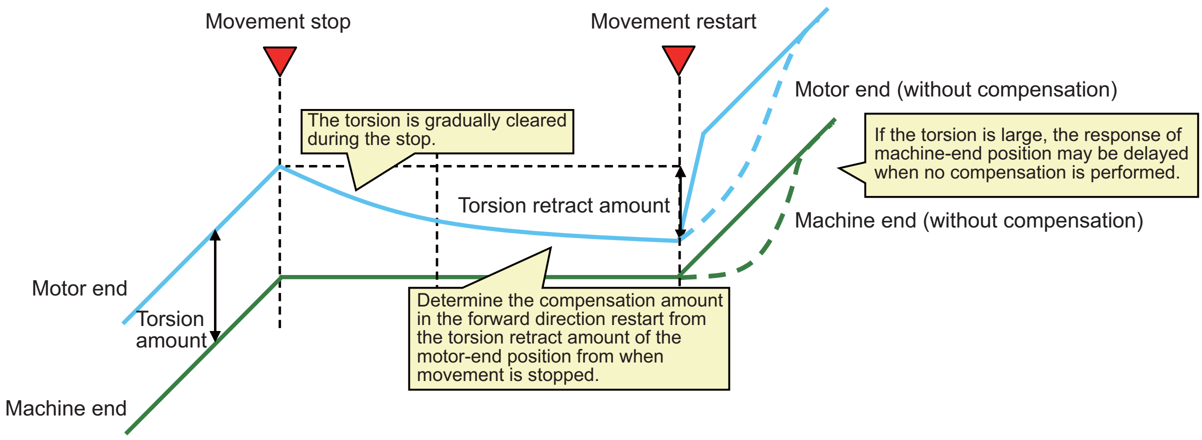


Full-closed torsion compensation

< Movement of machine end/motor end in the reverse direction >



< Movement of machine end/motor end in the forward direction >



⚠ CAUTION

Always readjust the lost motion compensation when setting the torsion compensation amount (SV206).

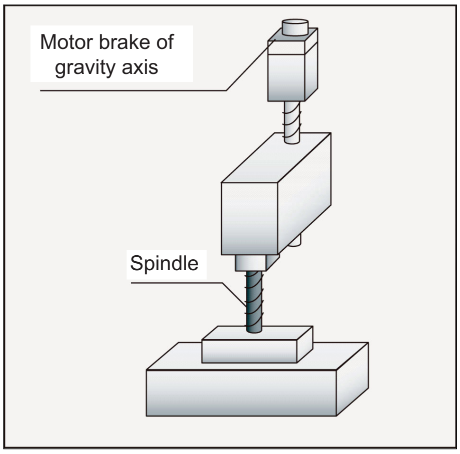
3.4 Protection Function

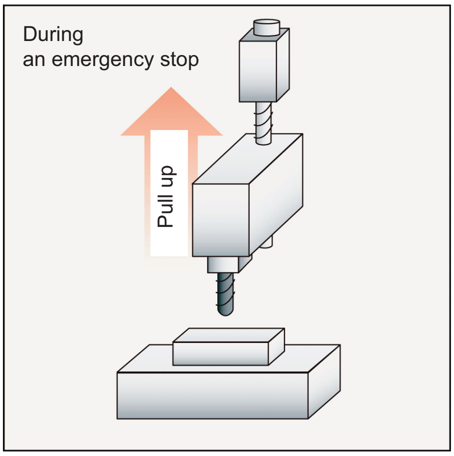
3.4.1 Deceleration Control at Emergency Stop

When an emergency stop (including NC failure, servo alarm) occurs, the motor will decelerate following the set time constant while maintaining the READY ON state.
READY will turn OFF and the dynamic brakes will function after stopping. The deceleration stop can be executed at a shorter distance than the dynamic brakes.

3.4.2 Vertical Axis Drop Prevention/Pull-up Control

If the READY OFF and brake operation are commanded at same time when an emergency stop occurs, the axis drops due to a delay in the brake operation.
The no-control time until the brakes activate can be eliminated by delaying the servo READY OFF sequence by the time set in the parameters.
Always use this function together with deceleration control.
When an emergency stop occurs in a vertical machining center, the Z axis is slightly pulled upwards before braking to compensate the drop of even a few μm caused by the brake backlash.





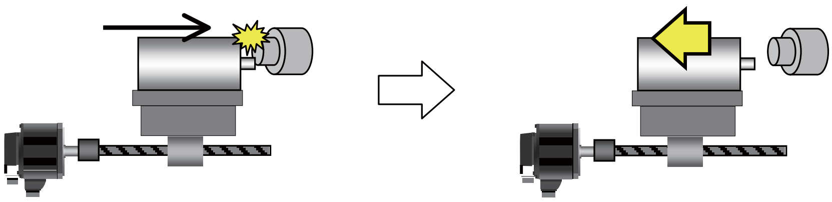
3.4.3 Earth Fault Detection

When an emergency stop is canceled, the earth fault current is measured using the power module's special switching circuit before Servo ready ON.
Specifying the faulty axis is possible in this detection, as the detection is carried out for each axis.

3.4.4 Collision Detection Function

Collision detection function quickly detects a collision of the motor shaft, and decelerates and stops the motor. This suppresses the generation of an excessive torque in the machine tool, and helps to prevent an abnormal state from occurring.Impact at a collision will not be prevented by using this collision detection function, so this function does not necessarily guarantee that the machine tool will not be damaged or that the machine accuracy will be maintained after a collision.
The same caution as during regular operation is required to prevent the machine from colliding.

Collision detection function outline



(a) A collision of machine is detected.

(b) A retracting torque is generated.
The collision of machine is reduced.

3.4.5 Fan Stop Detection

The rotation of the radiation fin cooling fan is observed and when the fan stops rotating for a breakdown of the fan or an external factor, warning is detected.(The system will not be stopped.) Before sudden system down by the power module overheat, inspection and replacement of the fan are prompted.

3.4.6 Open-phase Detection

Disconnection of a phase of the 3-phase input power is detected.
The occurrence of abnormal operation will be avoided by open-phase detection because open-phase does not cause a power failure, however, abnormal operation will occur when the motor load becomes large.

3.4.7 Contactor Weld Detection

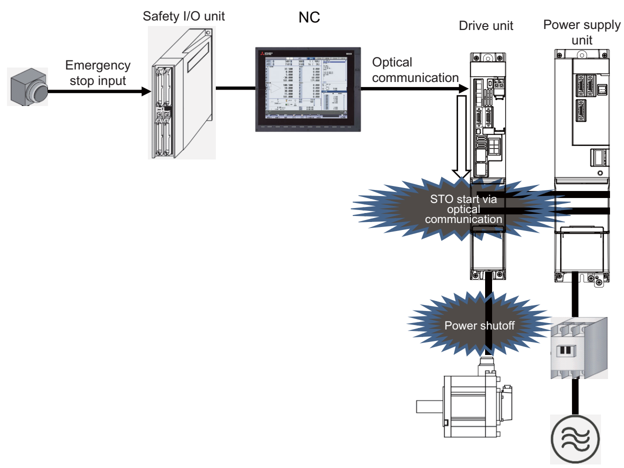
It detects that a contact of the external contactor is welding and cannot be opened.

3.4.8 STO (Safe Torque Off) Function

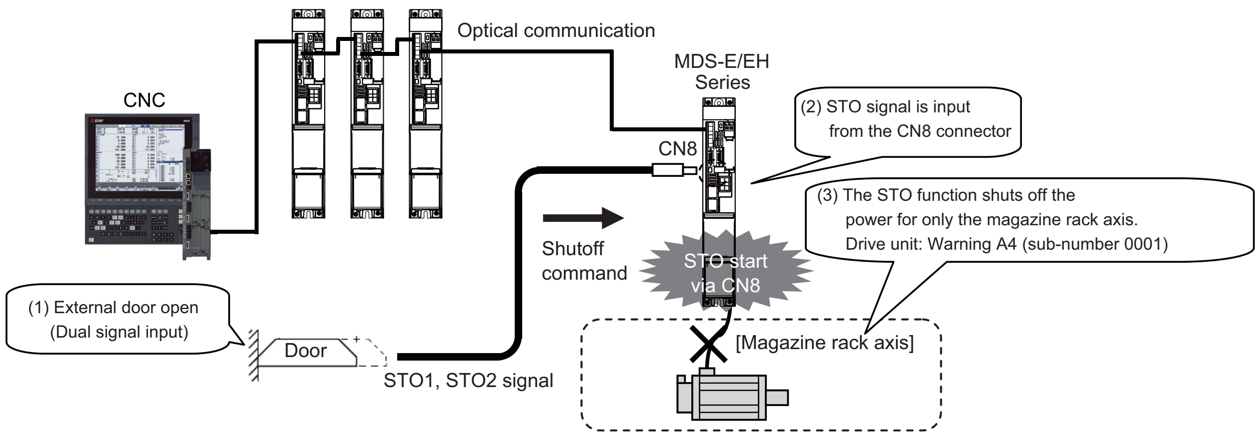
STO (Safe Torque Off) function is a shutoff function which stops the supply of energy to the motor capable of generating torque. It shuts off an energy supply electronically inside the drive unit.
It is an uncontrolled stop function in accordance with "IEC60204-1 Stop Category 0".

STO function can be used in the following two ways ([1] and [2] below), which directly input the STO signal from the external device by using a network cable and CN8 connector.

[1] When using network STO function
STO function shuts off the motor power by inputting the STO signal with a network cable.

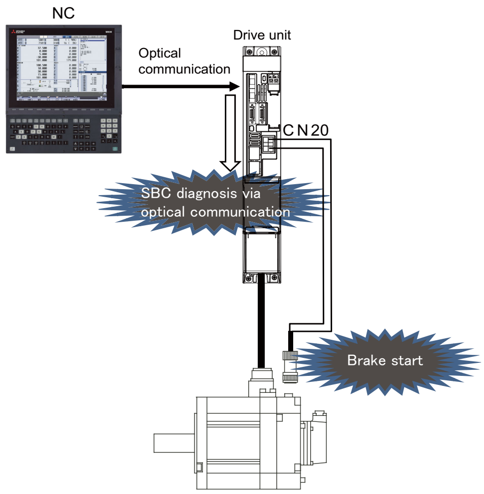


[2] When using dedicated wiring STO function
This method is used to shut off the motor power with STO function only for the specific axis.



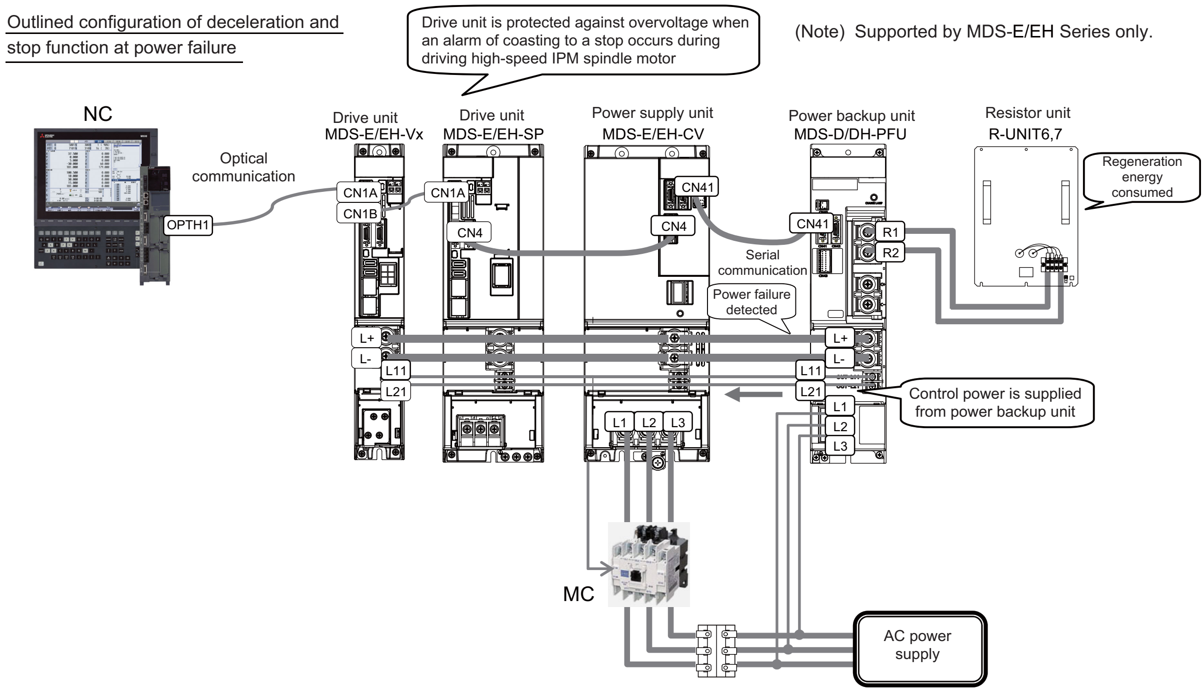
3.4.9 SBC (Safe Brake Control) Function

SBC observes operation of the two motor brake control contacts prepared on the servo drive unit to enhance the reliability of the brake operation.
* SBT (Safe Brake Test) function is also included in this function. Refer to the function specifications of NC.



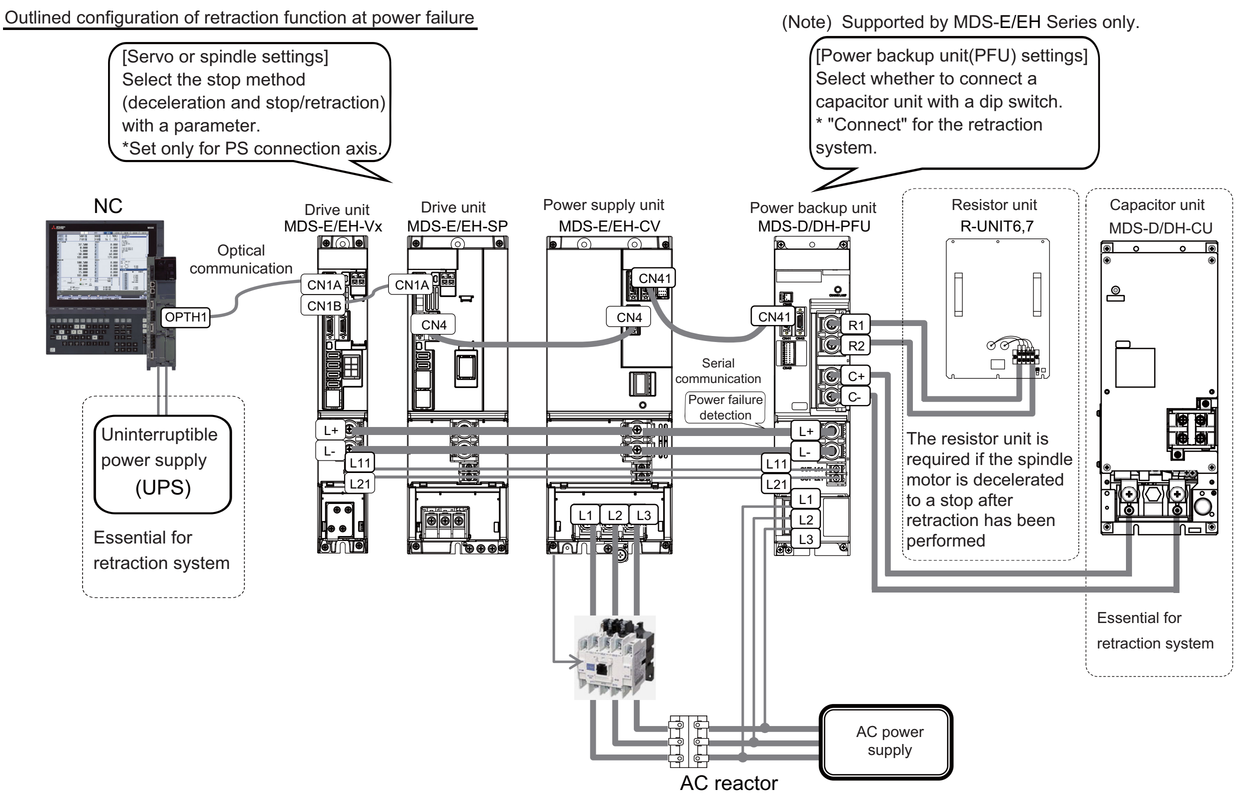
3.4.10 Deceleration and Stop Function at Power Failure

The deceleration and stop function at power failure is a function to safely decelerate the servo axes and the spindle when a power failure occurs. This function prevents a damage on the machine due to an overrun of the servo axes, and at the same time, realizes a protection against overvoltage for high-speed IPM spindle motors and high-speed DDMs.



3.4.11 Retraction Function at Power Failure

The retraction function at power failure is a function to backup the power of the main circuit from the capacitor unit and perform a tool escape by the retraction operation with the NC command when a power failure occurs.



3.5 Sequence Functions

3.5.1 Contactor Control Function

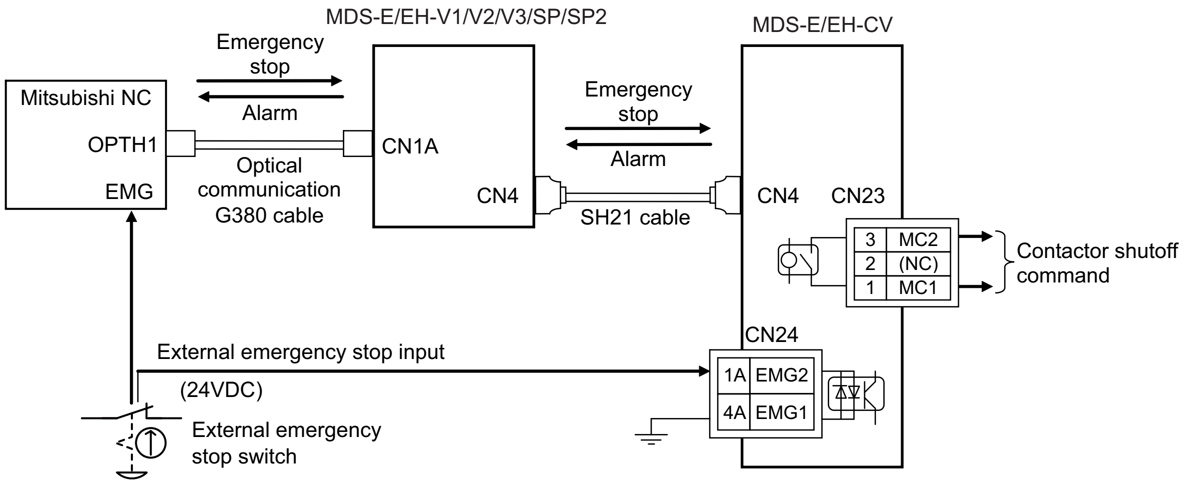
With this function, the contactor ON/OFF command is output from the power supply unit (or servo/spindle drive unit for integrated type) based on the judgement as to whether it is in emergency stop, emergency stop cancel, spindle deceleration and stop or vertical axis drop prevention control, etc.

3.5.2 Motor Brake Control Function

With this function, the brake ON/OFF command is output from the servo drive unit based on the judgement as to whether it is in emergency stop, emergency stop cancel or vertical axis drop prevention/pull-up control, etc.

3.5.3 External Emergency Stop Function

Besides the emergency stop input from the NC, double-protection when an emergency stop occurs can be provided by directly inputting an external emergency stop, which is a second emergency stop input, to the power supply unit (servo/ spindle drive unit for integrated type).
Even if the emergency stop is not input from NC for some reason, the contactors will be activated by the external emergency stop input, and the power can be shut off.



3.5.4 Specified Speed Output

This function is to output a signal that indicates whether the machine-end speed has exceeded the speed specified with the parameter.
With this function, the safety door, etc. can be locked to secure the machine operator when the machine-end speed has exceeded the specified speed. This function can also be used for judging whether the current machine-end speed is higher than the specified speed.

3.5.5 Quick READY ON Sequence

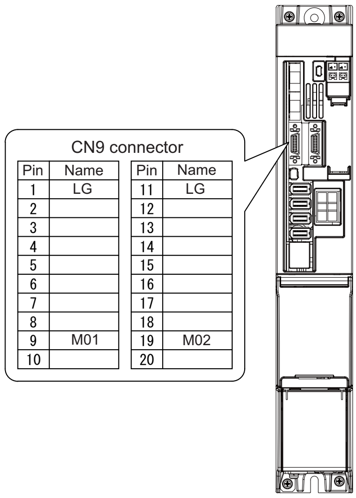
With this function, the charging time during READY ON is shortened according to the remaining charge capacity of the power supply unit. When returning to READY ON status immediately after the emergency stop input, the charging time can be shortened according to the remaining charge capacity and the time to READY ON is shortened.

3.6 Diagnosis Function

3.6.1 Monitor Output Function

Drive unit has a function to D/A output the various control data. The servo and spindle adjustment data required for setting the servo and spindle parameters to match the machine can be D/A output. Measure using a high-speed waveform recorder, oscilloscope, etc.
Note that the output pins differ between MDS-EJ/EJH-V1, MDS-EJ-SP and MDS-EJ-V2/SP2.

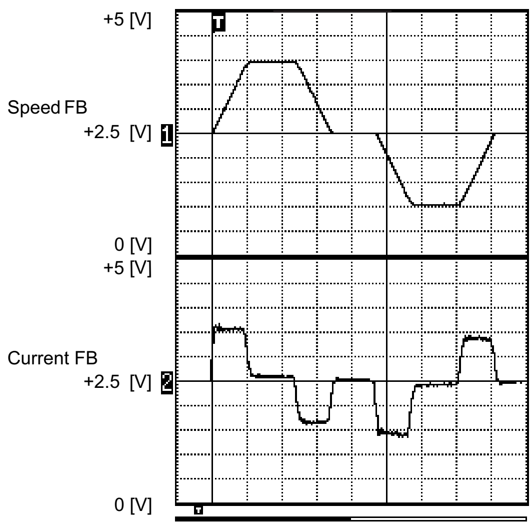
D/A output specifications



MDS-E/EH

Item	Explanation
No. of channels	2ch
Output cycle	0.8ms (min. value)
Output precision	12bit
Output voltage range	0V to 2.5V (zero) to +5V
Output magnification setting	-32768 to 32767 (1/100-fold)
Output pin (CN9 connector)	MO1 = Pin 9, MO2 = Pin 19, LG = Pin 1,11
Others	The D/A output for the 2-axis or 3-axis unit is also 2ch. When using the 2-axis or 3-axis unit, always set -1 for the output data (SV061, SV062 / SP125,SP126) of the axis that is not to be measured.

When the output data is 0, the offset voltage is 2.5V. If there is an offset voltage, adjust the zero level position in the measuring instrument side.



Example of D/A output waveform

3.6.2 Machine Resonance Frequency Display Function

If resonance is generated and it causes vibrations of the current commands, this function estimates the vibration frequency and displays it on the NC monitor screen (AFLT frequency).
This is useful in setting the notch filter frequencies during servo adjustment. This function constantly operates with no need of parameter setting.

3.6.3 Machine Inertia Display Function

With this function, the load current and acceleration rate during motor acceleration are measured to estimate the load inertia.
According to the parameter setting, the estimated load inertia is displayed on the NC monitor screen, expressed as its percentage to the motor inertia.

3.6.4 Motor Temperature Display Function

The temperature sensed by the thermal sensor attached to the motor coil is displayed on the NC screen.
(Note) This function is only compatible with Spindle motor.

3.6.5 Load Monitor Output Function

A spindle motor's load is output as an analog voltage of 0 to 3V (0 to 120%). To use this function, connect a load meter that meets the specifications.

3.6.6 Power Supply Diagnosis Display Function

The diagnosis information of the power supply(bus voltage and current) is displayed on the NC monitor screen.

3.6.7 Drive Unit Diagnosis Display Function

The diagnosis information of the servo and spindle drive unit (cooling fan rotation status and battery voltage) is displayed on the NC monitor screen.

4

Characteristics

4.1 Servo Motor

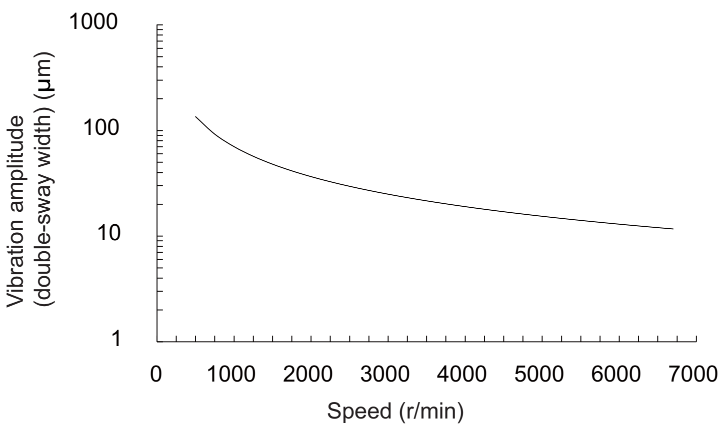
4.1.1 Environmental Conditions

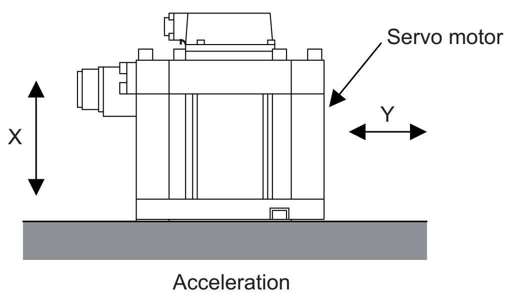
Environment	Conditions
Ambient temperature	0°C to +40°C (with no freezing)
Ambient humidity	80% RH or less (with no dew condensation) HK(-H) Series: 10 to 90% RH or less (with no dew condensation)
Storage temperature	-15°C to +70°C (with no freezing)
Storage humidity	90% RH or less (with no dew condensation) HK(-H) Series: 10 to 90% RH or less (with no dew condensation)
Atmosphere	Indoors (no direct sunlight) No corrosive gas, inflammable gas, oil mist or dust No object generating a strong magnetic field External magnetic field: 10 mT or less
Altitude	Operation / storage: 1000m or less above sea level Transportation: 10000m or less above sea level

4.1.2 Quakeproof Level

Series	Motor type	Acceleration direction	
		Axis direction (X)	Direction at right angle to axis (Y)
200V series	HG46, 56, 96	$49m/s^2$ (5G) or less	$49m/s^2$ (5G) or less
	HG75, 105 HG54, 104, 154, 224, 123, 223, 142, 1103 HK105	$24.5m/s^2$ (2.5G) or less	$24.5m/s^2$ (2.5G) or less
	HG204, 354, 303, 453, 603, 702, 703, 302 HK302, 303, 354, 453, 603, 702, 703	$24.5m/s^2$ (2.5G) or less	$29.4m/s^2$ (3G) or less
	HG903	$9.8m/s^2$ (1G) or less	$9.8m/s^2$ (1G) or less
	HK76, 55, 104, 123, 142, 154, 223, 224, 204	$24.5m/s^2$ (2.5G) or less	$49m/s^2$ (5G) or less
400V series	HG-H75, 105 HG-H54, 104, 154 HK-H105	$24.5m/s^2$ (2.5G) or less	$24.5m/s^2$ (2.5G) or less
	HG-H224, 204, 354, 453, 703 HK-H302, 303, 354, 453, 603, 702, 703	$24.5m/s^2$ (2.5G) or less	$29.4m/s^2$ (3G) or less
	HG-H903 HQ-H903, 1103	$9.8m/s^2$ (1G) or less	$9.8m/s^2$ (1G) or less
	HG-H1502	$24.5m/s^2$ (2.5G) or less	$24.5m/s^2$ (2.5G) or less
	HK-H76, 55, 104, 123, 154, 223, 224, 204	$24.5m/s^2$ (2.5G) or less	$49m/s^2$ (5G) or less

The vibration conditions are as shown below.





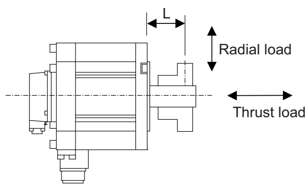
4.1.3 Shaft Characteristics

There is a limit to the load that can be applied on the motor shaft. Make sure that the load applied on the radial direction and thrust direction, when mounted on the machine, is below the tolerable values given below. These loads may affect the motor output torque, so consider them when designing the machine.

Series	Servo motor	Tolerable radial load	Tolerable thrust load
200V series	**HG46S, HG56S (Straight shaft)**	245N (L=30)	98N
	HG96S (Straight shaft)	392N (L=40)	147N
	HG75T, 105T (Taper shaft)	245N (L=33)	147N
	HG75S, 105S (Straight shaft)	245N (L=33)	147N
	HG54T, 104T, 154T, 224T, 123T, 223T, 142T (Taper shaft)	392N (L=58)	490N
	HG54S, 104S, 154S, 224S, 123S, 223S, 142S (Straight shaft)	980N (L=55)	490N
	HG204S, 354S, 303S, 453S, 603S, 702S, 703S, 302S HK204S, 302S, 303S, 354S, 453S, 603S, 702S, 703S (Straight shaft)	2058N (L=79)	980N
	HG903S (Straight shaft)	2450N (L=85)	980N
	HG1103S (Straight shaft)	2940N (L=116)	980N
	HK76T, 105T (Taper shaft)	245N (L=35)	147N
	HK76S, 105S (Straight shaft)	392N (L=36)	147N
	HK55T, 104T, 123T, 142T, 154T, 223T, 224T (Taper shaft)	392N (L=46)	490N
	HK55S, 104S, 123S, 142S, 154S, 223S, 224S (Straight shaft)	980N (L=55)	490N
400V series	**HG-H75T, 105T (Taper shaft)**	245N (L=33)	147N
	HG-H75S, 105S (Straight shaft)	245N (L=33)	147N
	HG-H54T, 104T, 154T, 224T (Taper shaft)	392N (L=58)	490N
	HG-H54S, 104S, 154S, 224S (Straight shaft)	980N (L=55)	490N
	HG-H204S, 354S, 453S, 703S HK-H204S, 302S, 303S, 354S, 453S, 603S, 702S, 703S (Straight shaft)	2058N (L=79)	980N
	HG-H903S (Straight shaft)	2450N (L=85)	980N
	HG-H1502S (Straight shaft)	3234N (L=140)	1470N
	HQ-H903S (Straight shaft)	2500N (L=52.7)	1100N
	HQ-H1103S (Straight shaft)	2700N (L=52.7)	1500N
	HK-H76T, 105T (Taper shaft)	245N (L=35)	147N
	HK-H76S, 105S (Straight shaft)	392N (L=36)	147N
	HK-H55T, 104T, 123T, 154T, 223T, 224T (Taper shaft)	392N (L=46)	490N
	HK-H55S, 104S, 123S, 154S, 223S, 224S (Straight shaft)	980N (L=55)	490N

(Note 1) The tolerable radial load and thrust load in the above table are values applied when each motor is used independently.

(Note 2) The symbol L in the table refers to the value of L below.



L: Length from flange installation surface to center of load mass [mm]

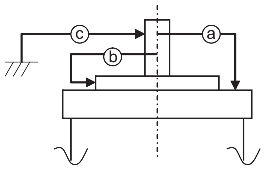
⚠ CAUTION

1. Use a flexible coupling when connecting with a ball screw, etc., and keep the shaft core deviation to below the tolerable radial load of the shaft.
2. When directly installing the gear on the motor shaft, the radial load increases as the diameter of the gear decreases. This should be carefully considered when designing the machine.
3. When directly installing the pulley on the motor shaft, carefully consider so that the radial load (double the tension) generated from the timing belt tension is less than the values shown in the table above.
4. In machines where thrust loads such as a worm gear are applied, carefully consider providing separate bearings, etc., on the machine side so that loads exceeding the tolerable thrust loads are not applied to the motor.
5. Do not apply the loads exceeding the tolerable level. Failure to observe this may lead to the axis or bearing damage.

4.1.4 Machine Accuracy

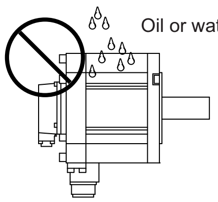
Machine accuracy of the servo motor's output shaft and around the installation part is as below.
(Excluding special products)

Accuracy	Measurement point	Flange size [mm]			
		Less than 100 SQ.	100 SQ., 130 SQ.	176 SQ. - 250 SQ.	280 SQ. or over
Run-out of the flange surface to the output shaft	a	0.05mm	0.06mm	0.08mm	0.08mm
Run-out of the flange surface's fitting outer diameter	b	0.04mm	0.04mm	0.06mm	0.08mm
Run-out of the output shaft end	c	0.02mm	0.02mm	0.03mm	0.03mm



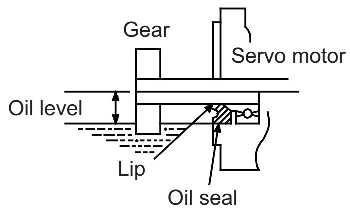
4.1.5 Oil/Water Standards

(1) The motor protective format uses the IP type, which complies with IEC Standard. (Refer to the section "Specifications List".)
However, these Standards are short-term performance specifications. They do not guarantee continuous environmental protection characteristics. Measures such as covers, etc., must be taken if there is any possibility that oil or water will fall on the motor, and the motor will be constantly wet and permeated by water. Note that the motor's IP-type is not indicated as corrosion-resistant.

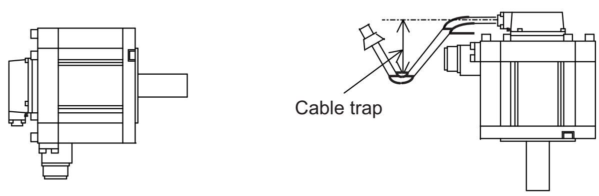


(2) When a gear box is installed on the servo motor, make sure that the oil level height from the center of the shaft is higher than the values given below. Open a breathing hole on the gear box so that the inner pressure does not rise.

Series	Servo motor	Oil level (mm)
200V series	HG46, 56	12.5
	HG96	15
	HG75, 105	15
	HK76, 105	16
	HG54, 104, 154, 224, 123, 223, 142 HK55, 104, 123, 142, 154, 223, 224	22.5
	HG204, 354, 303, 453, 603, 702, 703, 302 HK204, 302, 303, 354, 453, 603, 702, 703	30
	HG903	34
	HG1103	40
400V series	HG-H75, 105	15
	HK-H76, 105	16
	HG-H54, 104, 154, 224 HK-H55, 104, 123, 154, 223, 224	22.5
	HG-H204, 354, 453, 703 HK-H204, 302, 303, 354, 453, 603, 702, 703	30
	HG-H903	34
	HG-H1502	45
	HQ-H903, 1103	30



(3) When installing the servo motor horizontally, set the connector to face downward. When installing vertically or on an inclination, provide a cable trap because the liquid such as oil or water may enter the motor from the connector by running along the cable.



⚠ CAUTION

1. The servo motors, including those having IP67 specifications, do not have a completely waterproof (oil-proof) structure. Do not allow oil or water to constantly contact the motor, enter the motor, or accumulate on the motor. Oil can also enter the motor through cutting chip accumulation, so be careful of this also.
2. Oil may enter the motor from the clearance between the cable and connector. Protect with silicon not to make the clearance.
3. When the motor is installed facing upwards, take measures on the machine side so that gear oil, etc., does not flow onto the motor shaft.

4.1.6 Installation of Servo Motor

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

Flange size (mm)	Servo motor capacity
150×150×6	100W
250×250×6	200 to 400W
250×250×12	0.5 to 1.5kW
300×300×12	0.75 to 2.2kW
300×300×20	1.0 to 7.0kW
650×650×35	3.0 to 7.0kW
800×800×35	9.0 to 11.0kW

(Note 1) These flange sizes are recommended dimensions when the flange material is an aluminum.

(Note 2) If enough flange size cannot be ensured, ensure the cooling performance by a cooling fan or operate the motor in the state that the motor overheat alarm does not occur.

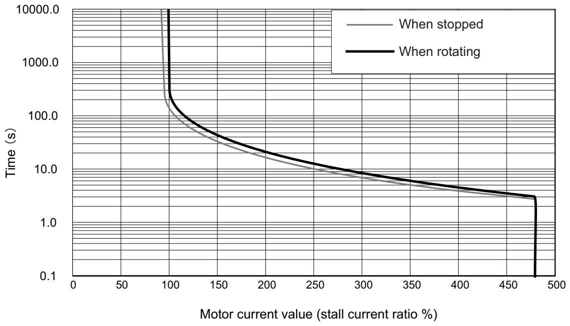
4.1.7 Overload Protection Characteristics

The servo drive unit has an electronic thermal relay to protect the servo 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.

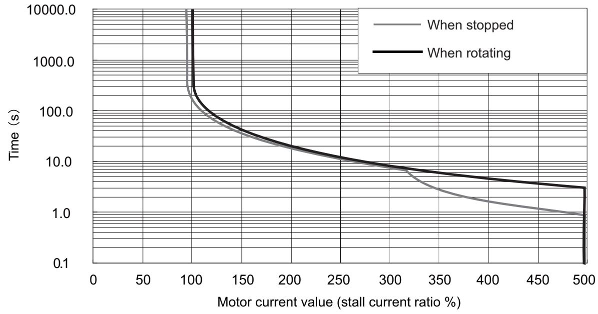
(1) 200V series

< HG Series >

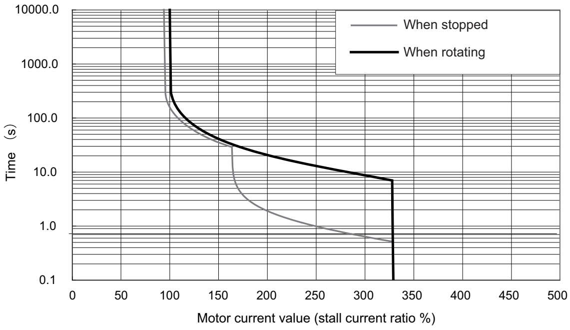
HG46



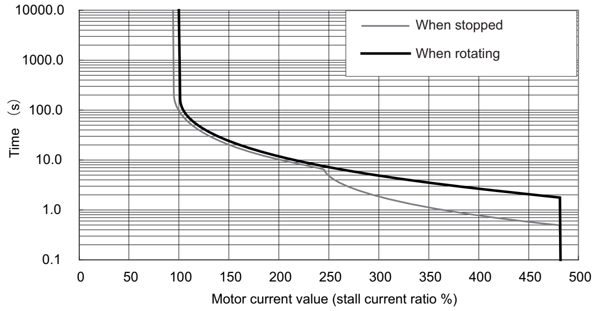
HG56



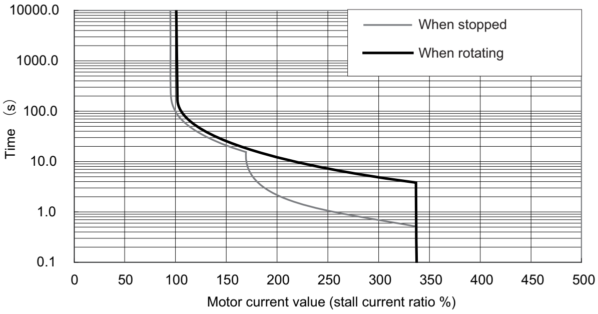
HG96



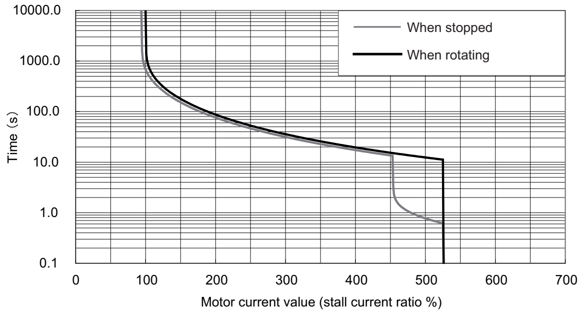
HG75



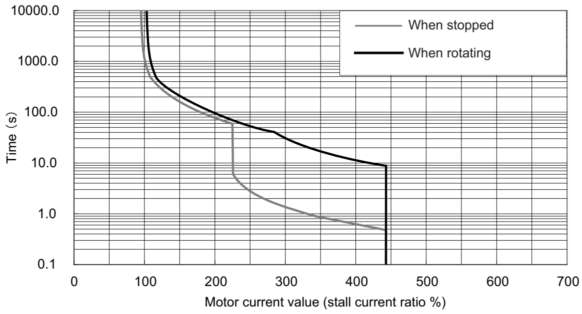
HG105



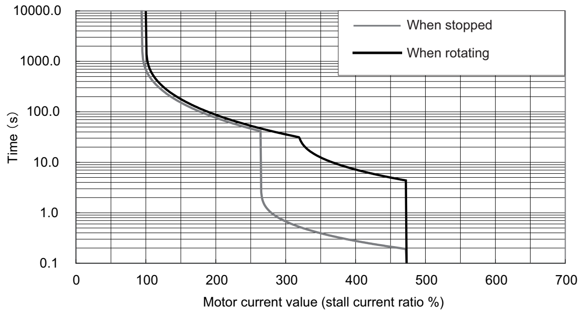
HG54



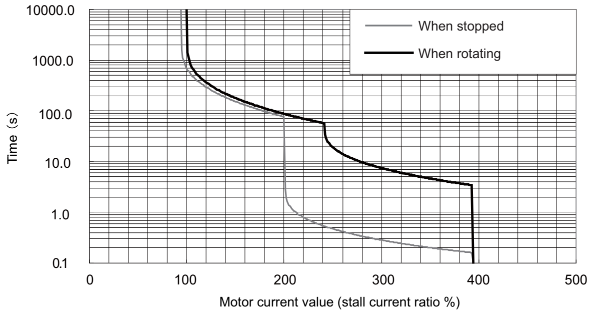
HG104



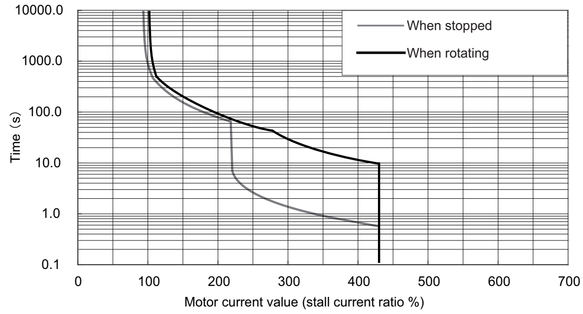
HG154



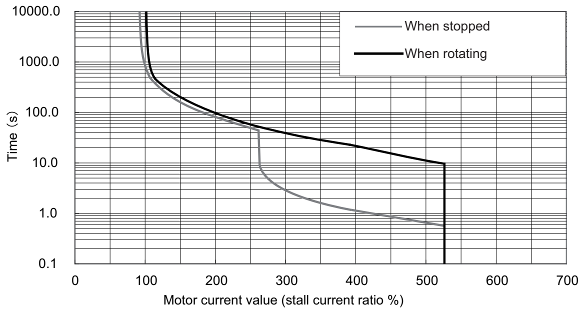
HG224



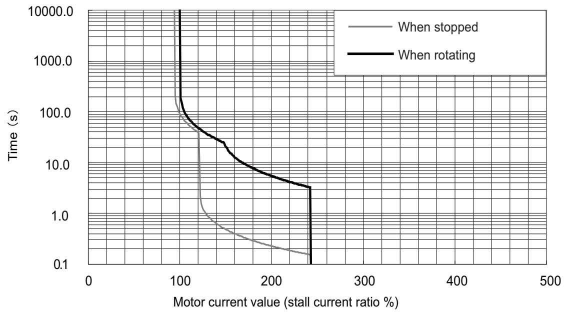
HG204



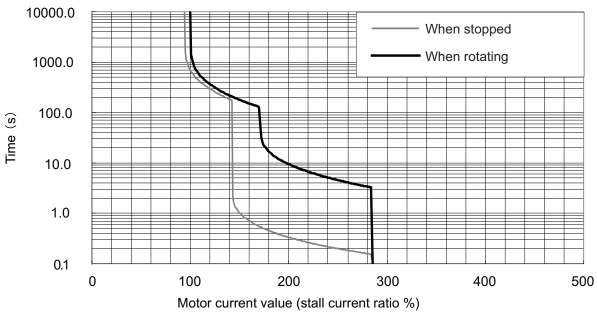
HG354



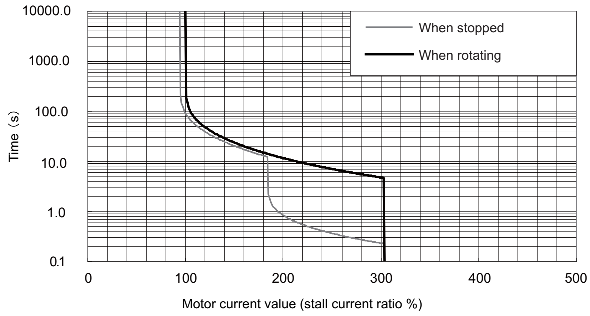
HG123



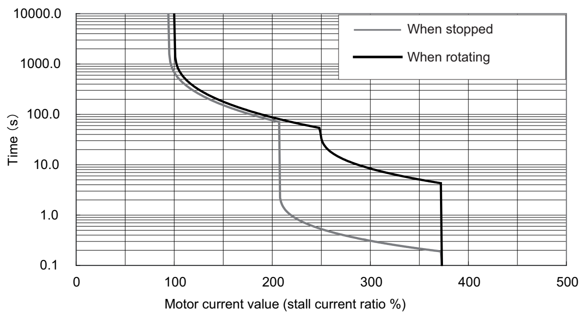
HG223



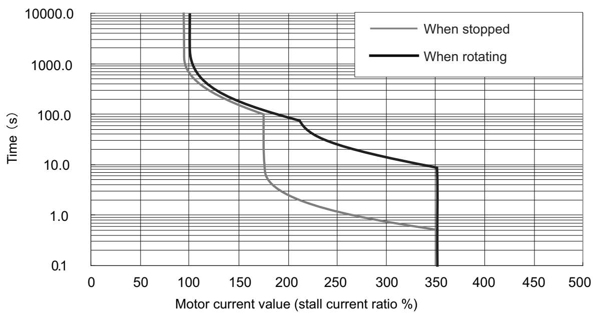
HG303



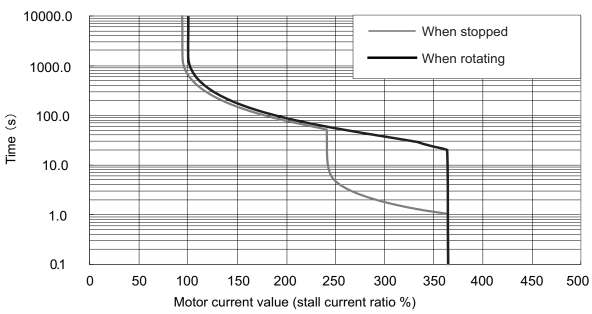
HG453



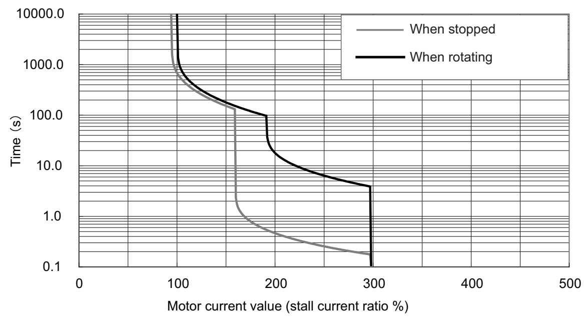
HG603



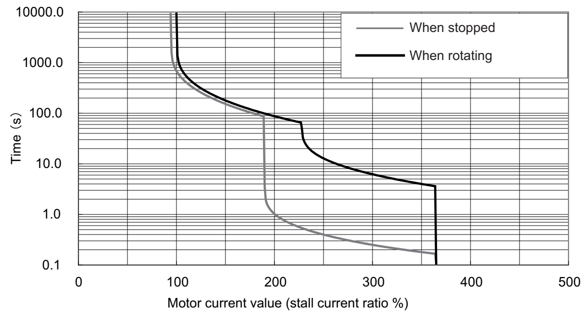
HG702



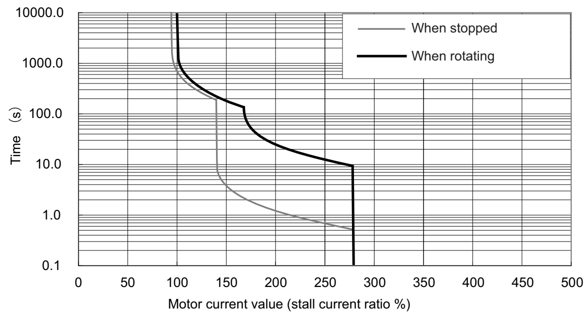
HG703



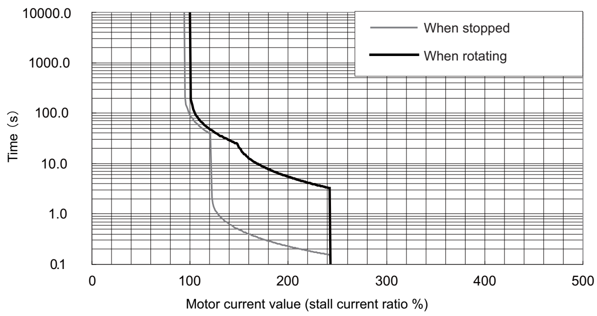
HG903



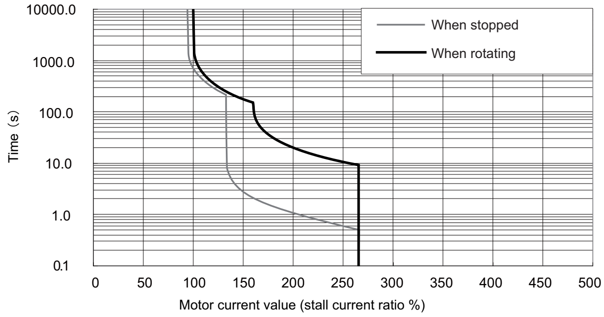
HG1103



HG142

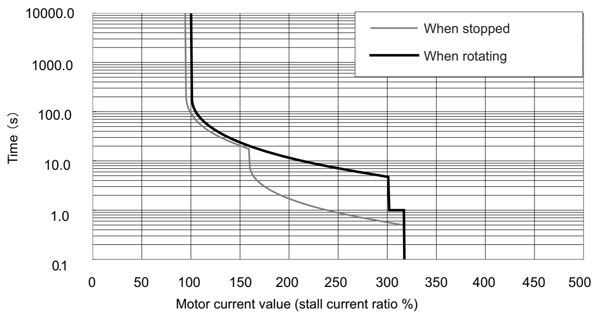


HG302

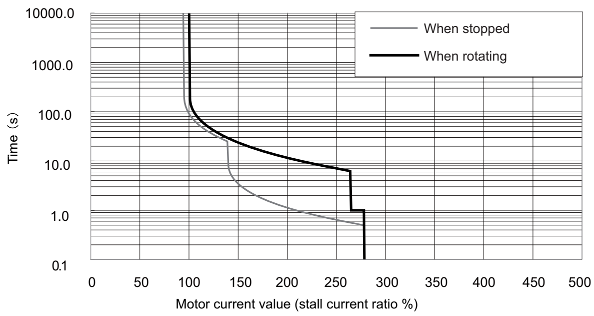


< HK Series >

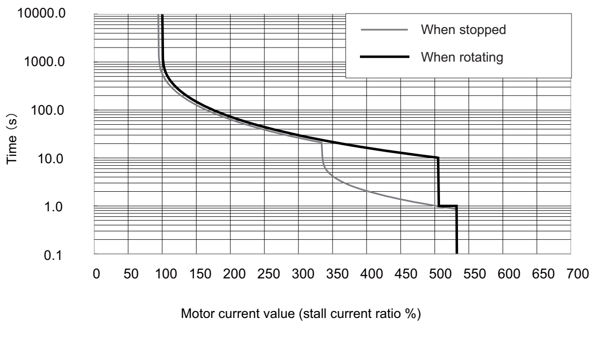
HK76



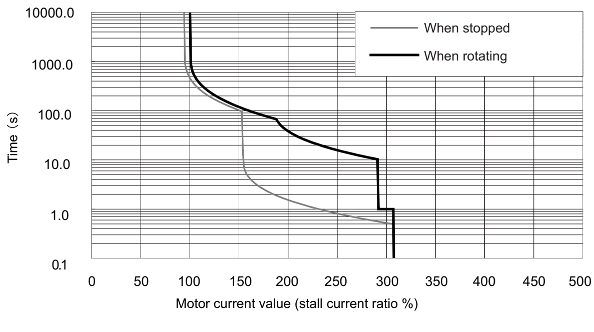
HK105



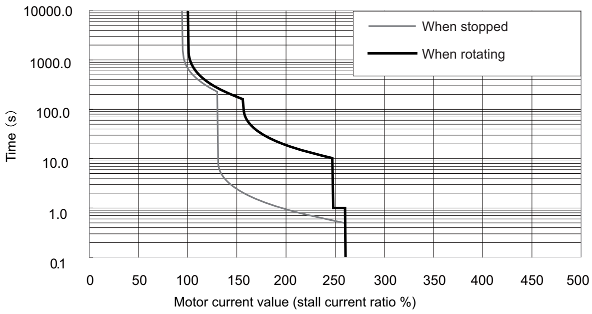
HK55



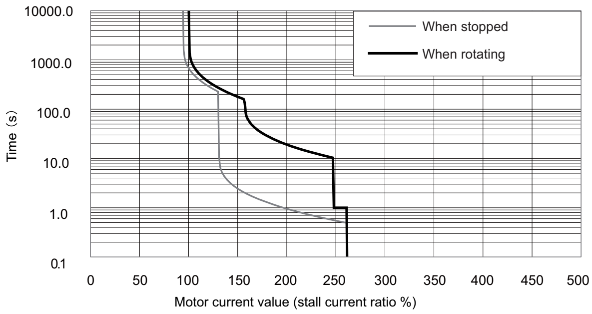
HK104



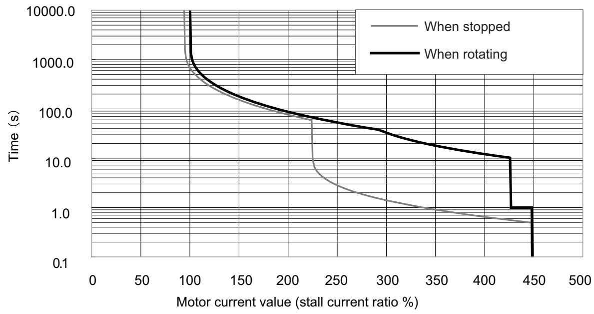
HK123



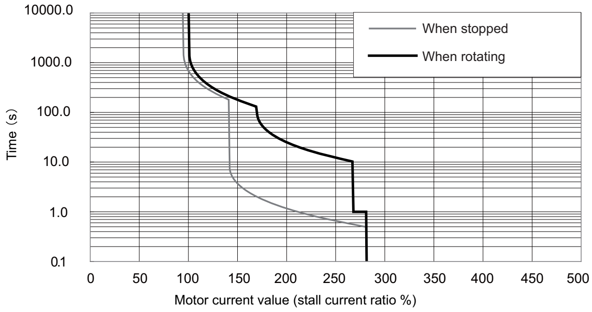
HK142



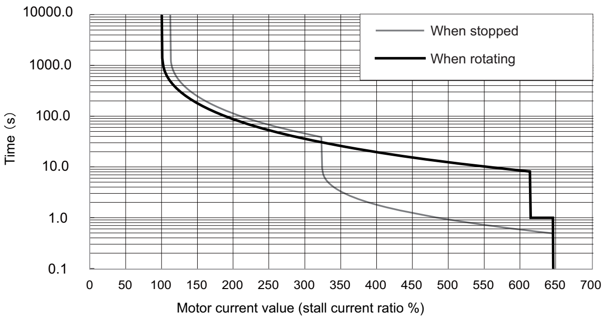
HK154



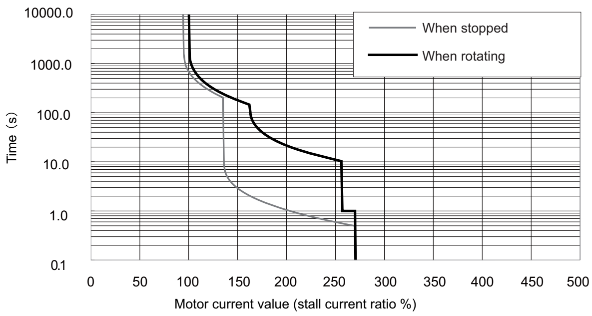
HK154 (E-V3-40)



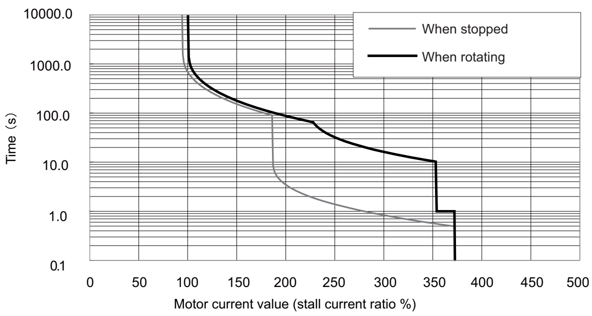
HK154 (E-V3-80)



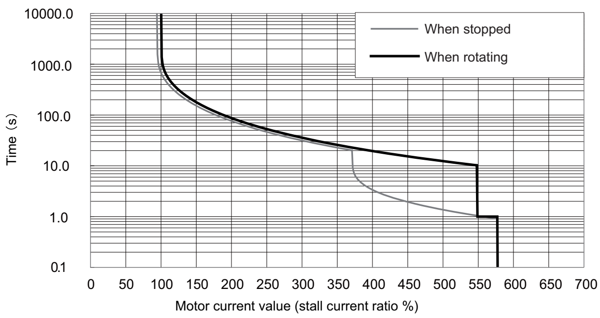
HK223



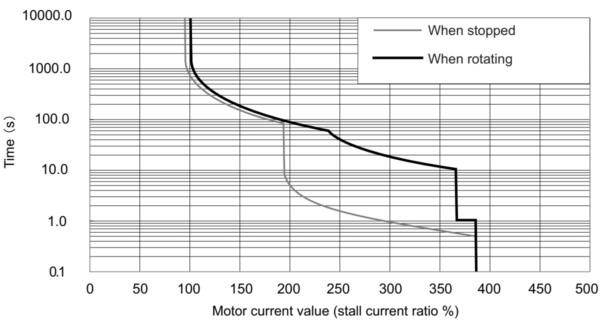
HK224 (E-V1/V2/V3-80)



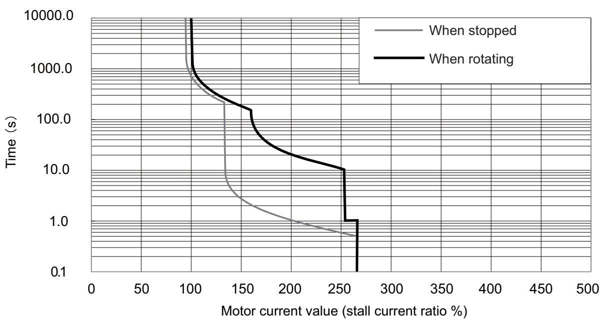
HK224 (E-V1/V2-160)



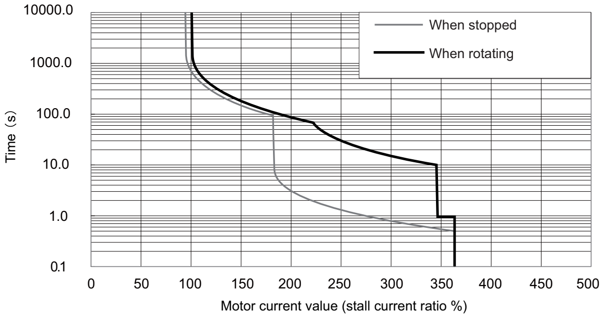
HK204



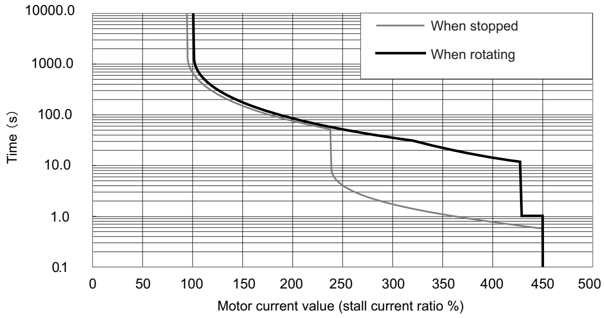
HK302



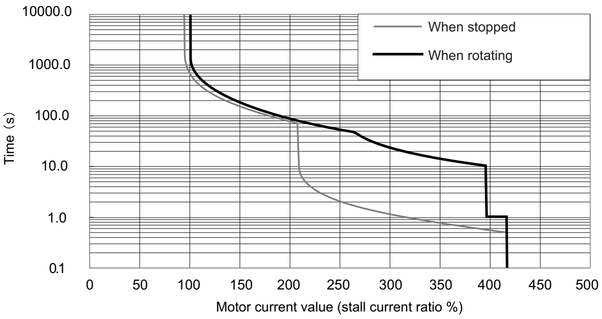
HK303



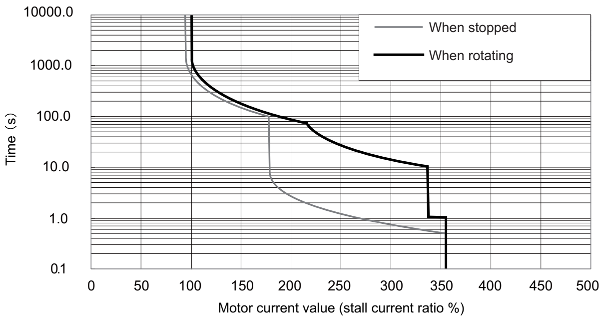
HK354



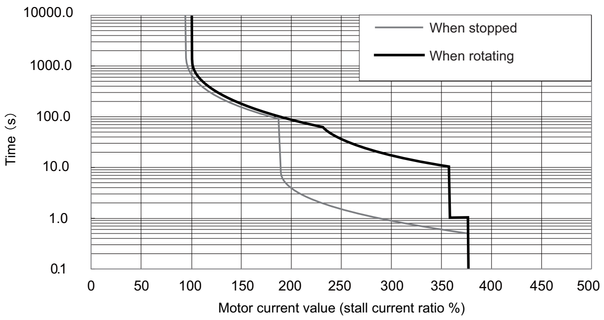
HK453



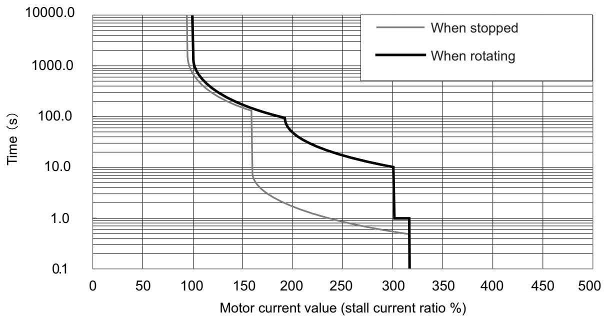
HK603



HK702



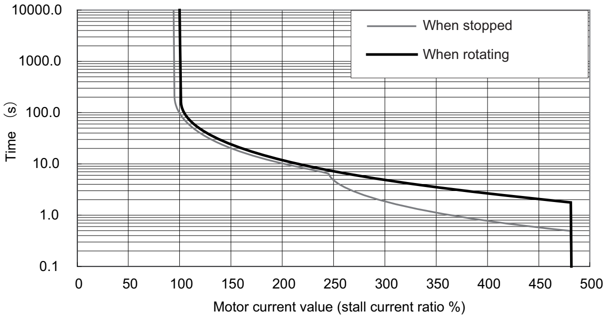
HK703



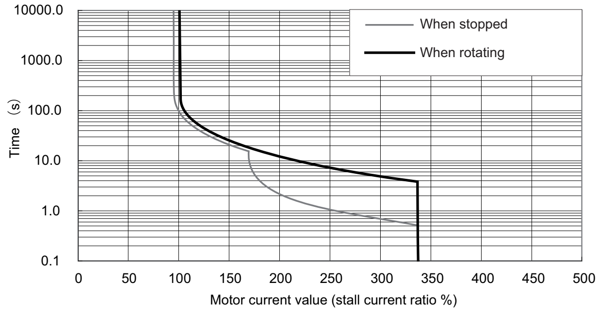
(2) 400V series

< HG-H Series >

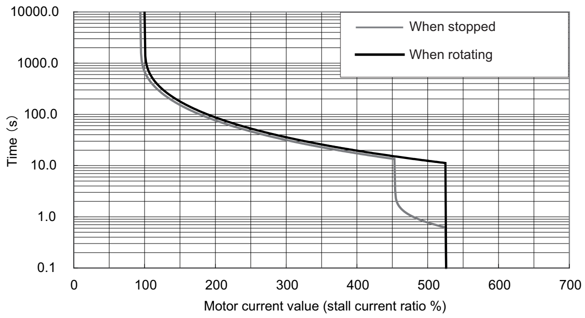
HG-H75



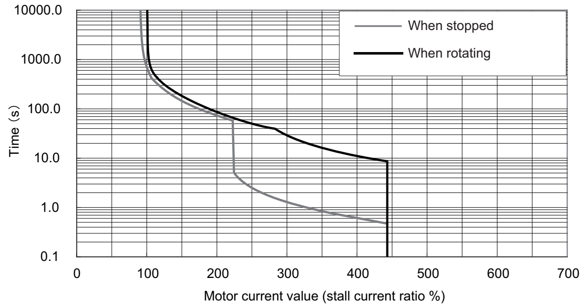
HG-H105



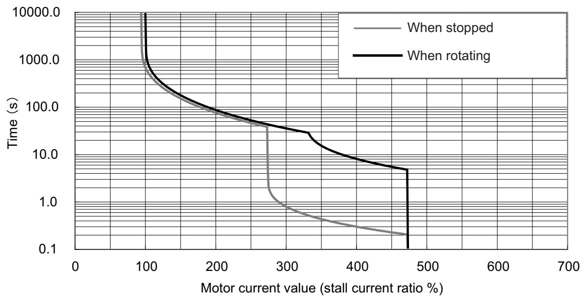
HG-H54



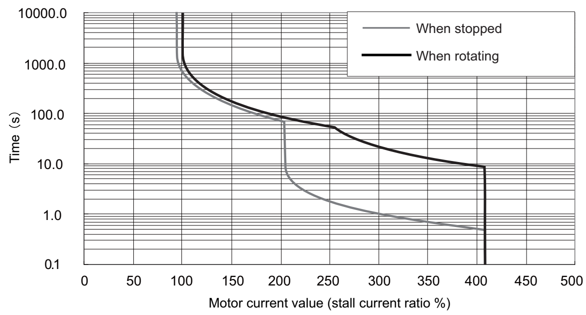
HG-H104



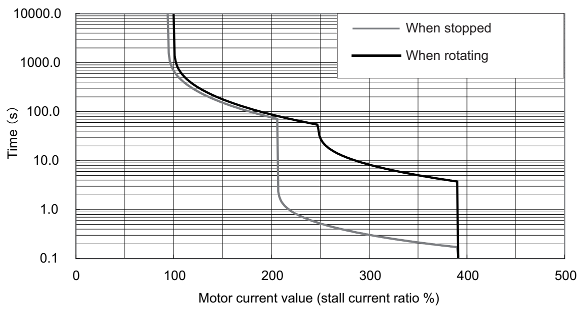
HG-H154



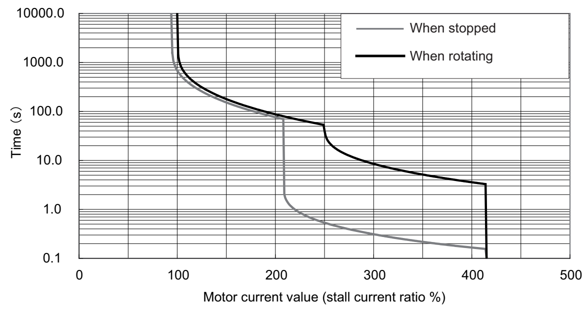
HG-H224



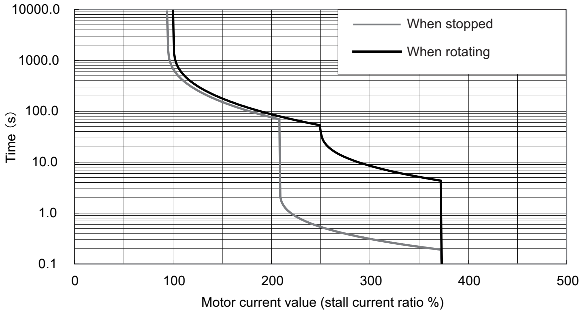
HG-H204



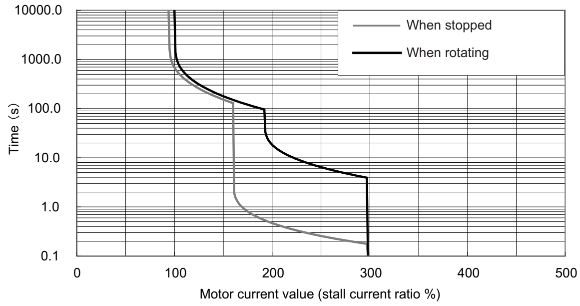
HG-H354



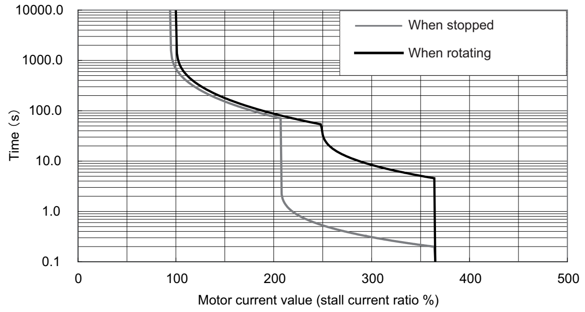
HG-H453



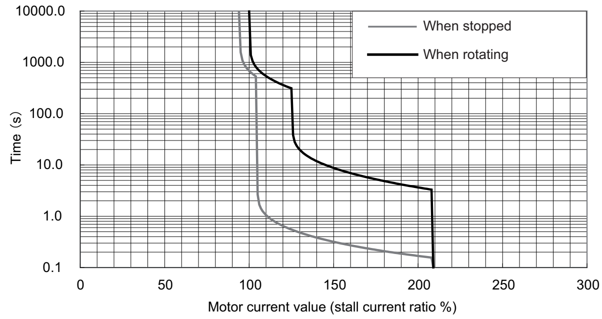
HG-H703



HG-H903

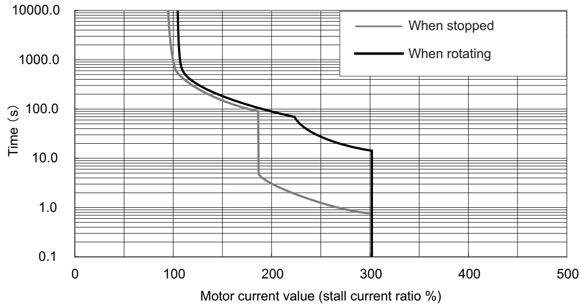


HG-H1502

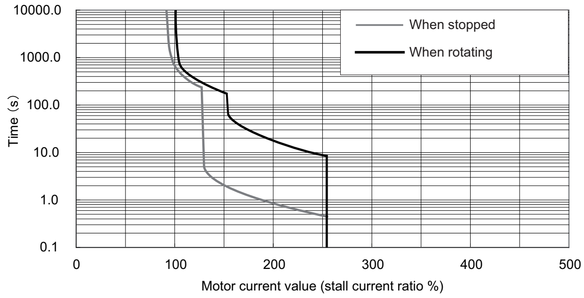


< HQ-H Series >

HQ-H903

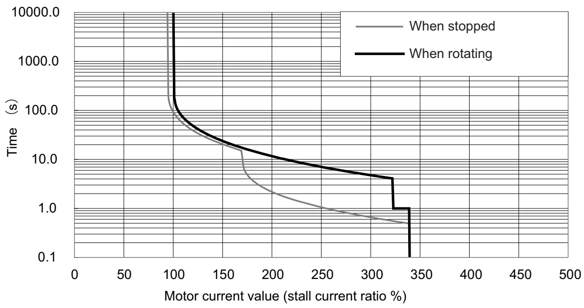


HQ-H1103

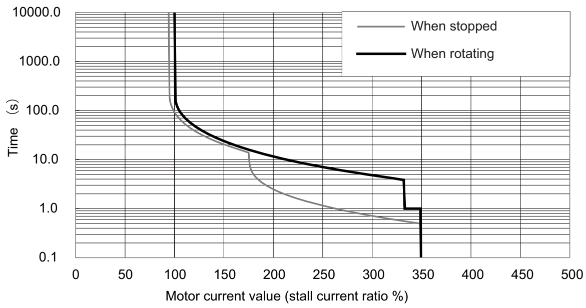


< HK-H Series >

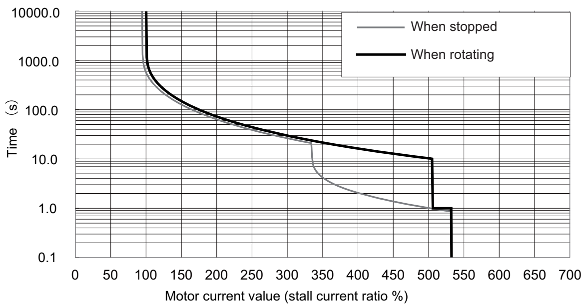
HK-H76



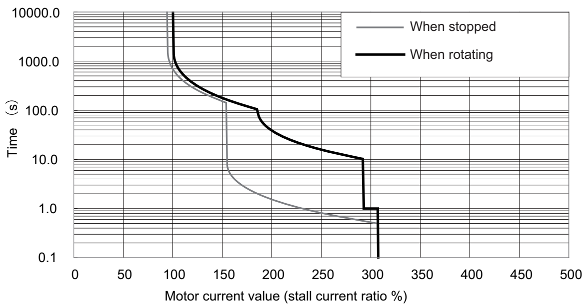
HK-H105



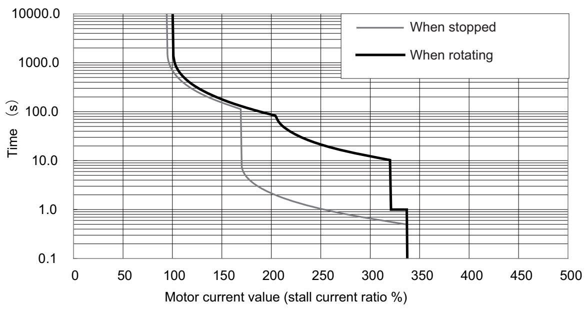
HK-H55



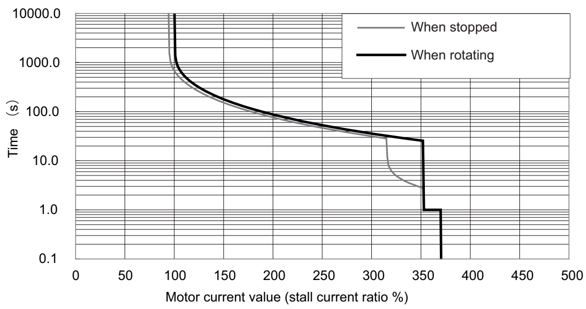
HK-H104



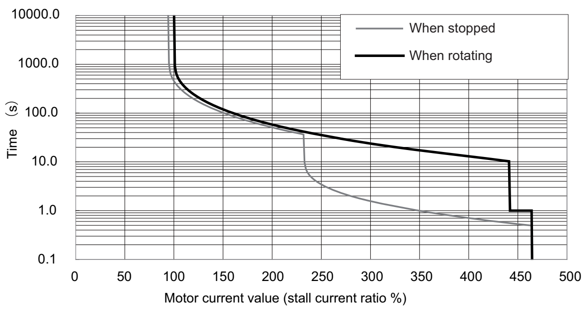
HK-H123 (EH-V1/V2-10)



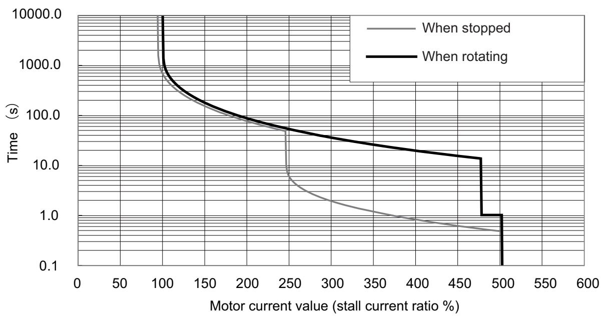
HK-H123 (EH-V2-20)



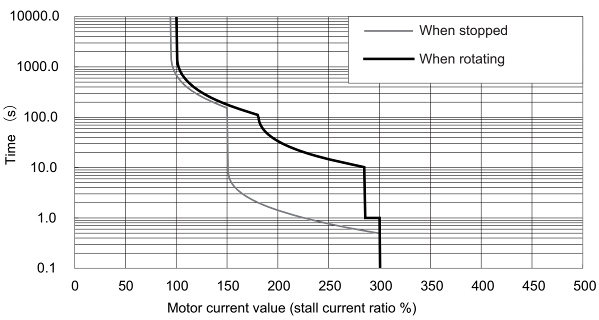
HK-H154 (EH-V1/V2)



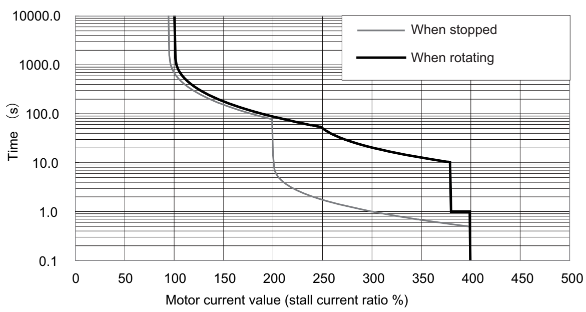
HK-H154 (EH-V3-40)



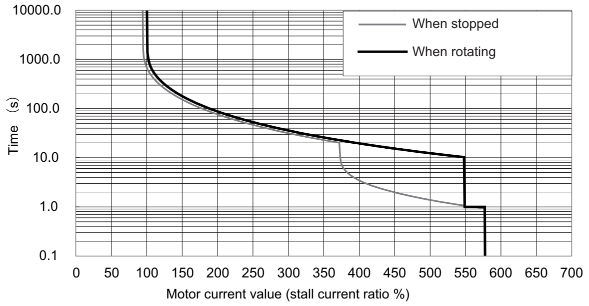
HK-H223



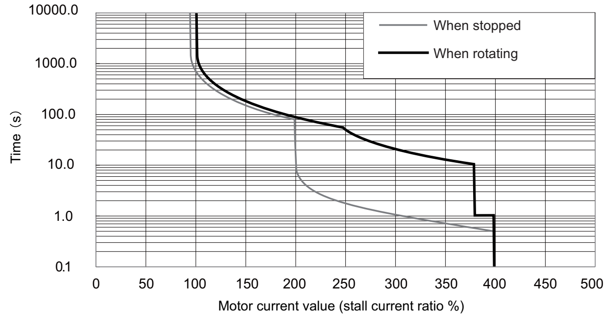
HK-H224 (EH-V1/V2/V3-40)



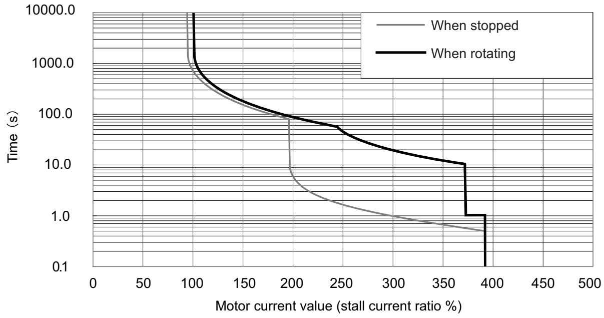
HK-H224 (EH-V1/V2-80)



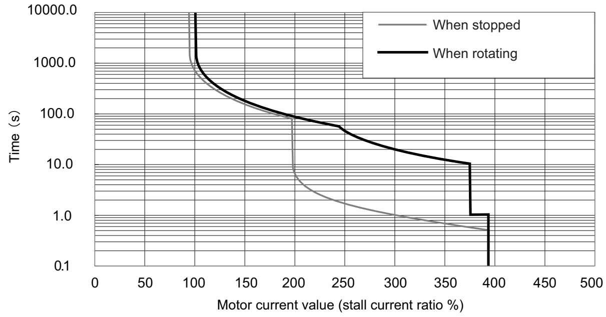
HK-H204



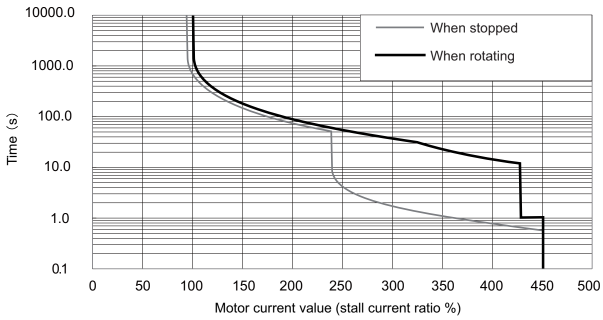
HK-H302



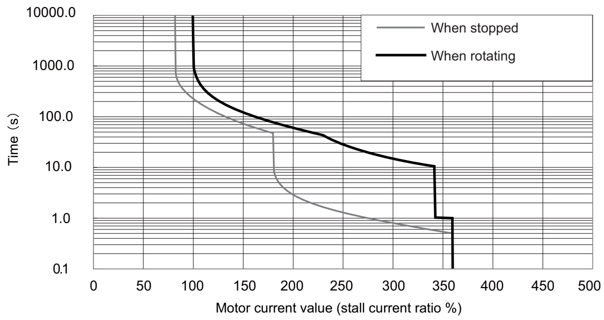
HK-H303



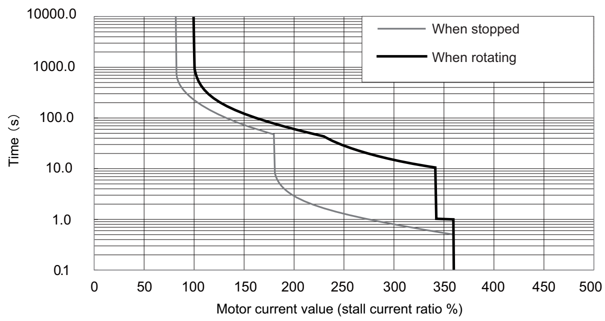
HK-H354



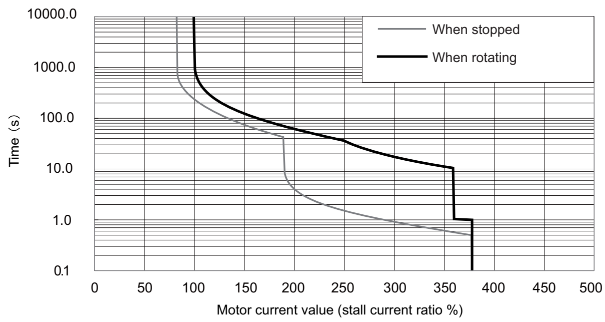
HK-H453



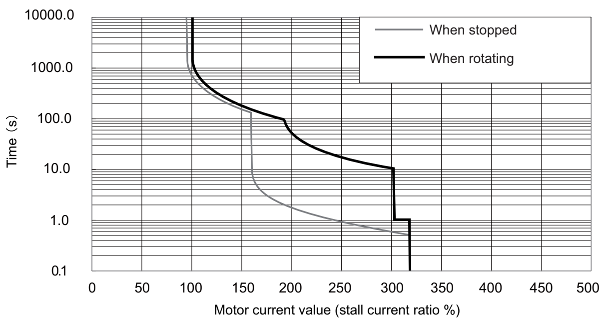
HK-H603



HK-H702



HK-H703



4.1.8 Magnetic Brake

> **⚠ CAUTION**
>
> 1. The axis will not be mechanically held even when the dynamic brakes are used. If the machine could drop when the power fails, use a servo motor with magnetic brakes or provide an external brake mechanism as holding means to prevent dropping.
> 2. The magnetic brakes are used for holding, and must not be used for normal braking. There may be cases when holding is not possible due to the life or machine structure (when ball screw and servo motor are coupled with a timing belt, etc.). Provide a stop device on the machine side to ensure safety.
> 3. When operating the brakes, always turn the servo OFF (or ready OFF). When releasing the brakes, always confirm that the servo is ON first. Sequence control considering this condition is possible by using the brake contact connection terminal on the servo drive unit.
> 4. When the vertical axis drop prevention function is used, the drop of the vertical axis during an emergency stop can be suppressed to the minimum.

(1) Motor with magnetic brake

(a) Types

The motor with a magnetic brake is set for each motor. The "B" following the standard motor model stands for the motor with a brake.

(b) Applications

When this type of motor is used for the vertical feed axis in a machining center, etc., slipping and dropping of the spindle head can be prevented even when the hydraulic balancer's hydraulic pressure reaches zero when the power turns OFF. When used with a robot, deviation of the posture when the power is turned OFF can be prevented.

When used for the feed axis of a grinding machine, a double safety measures is formed with the deceleration stop (dynamic brake stop) during emergency stop, and the risks of colliding with the grinding stone and scattering can be prevented.

This motor cannot be used for the purposes other than holding and braking during a power failure (emergency stop). (This cannot be used for normal deceleration, etc.)

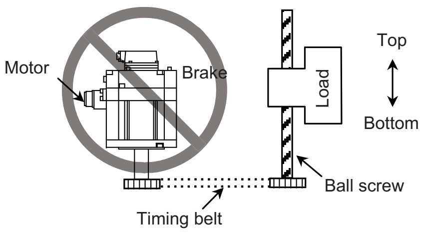
(c) Features

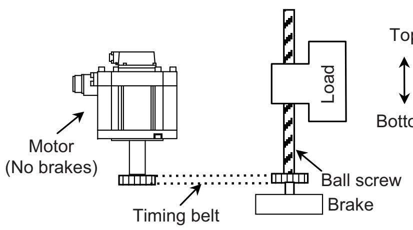
[1] The magnetic brakes use a DC excitation method, thus:
- The brake mechanism is simple and the reliability is high.
- There is no need to change the brake tap between 50Hz and 60Hz.
- There is no rush current when the excitation occurs, and shock does not occur.
- The brake section is not larger than the motor section.

[2] The magnetic brake is built into the motor, and the installation dimensions are the same as the motor without brake.

(d) Cautions for using a timing belt

Connecting the motor with magnetic brakes and the load (ball screw, etc.) with a timing belt as shown on the left below could pose a hazard if the belt snaps. Even if the belt's safety coefficient is increased, the belt could snap if the tension is too high or if cutting chips get imbedded. Safety can be maintained by using the method shown on the right below.





(2) Magnetic brake characteristics

(a) 200V series

< HG Series >

Item		Motor type	
		HG46B, HG56B	HG96B
Type (Note 1)		Spring closed non-exciting operation magnetic brakes (for maintenance and emergency braking)	
Rated voltage		24VDC 0V-10%	
Power consumption at 20°C (W)		7.9	10
Static friction torque (N•m)		1.3 or more	2.4 or more
Release delay time (Note 2) (s)		0.03	0.04
Braking delay time (DC OFF) (Note 2) (s)		0.02	0.02
Tolerable braking work amount	Per braking (J)	22	64
	Per hour (J)	220	640
Brake play at motor axis (degree)		1.2	0.9
Brake life (Note 3)	No. of braking operations (times)	20,000	20,000
	Work amount per braking (J)	22	64

Item		Motor type			
		HG75B, HG105B	HG54B, HG104B HG154B,HG224B HG123B, HG223B HG142B	HG204B, HG354B HG303B, HG453B HG603B, HG702B HG703B, HG903B HG302B	HG1103B
Type (Note 1)		Spring closed non-exciting operation magnetic brakes (for maintenance and emergency braking)			
Rated voltage		24VDC 0V-10%			
Power consumption at 20°C (W)		9	19	34	32
Static friction torque (N•m)		2.4 or more	8.5 or more	44 or more	126 or more
Release delay time (Note 2) (s)		0.03	0.04	0.1	0.5
Braking delay time (DC OFF) (Note 2) (s)		0.03	0.03	0.03	0.2
Tolerable braking work amount	Per braking (J)	64	400	4,500	5,000
	Per hour (J)	640	4,000	45,000	45,200
Brake play at motor axis (degree)		0.1 to 0.9	0.2 to 0.6	0.2 to 0.6	0.01 to 0.6
Brake life (Note 3)	No. of braking operations (times)	20,000	20,000	20,000	20,000
	Work amount per braking (J)	32	200	1,000	400

(Note 1) There is no manual release mechanism. If handling is required such as during the machine core alignment work, prepare a separate 24VDC power supply, and electrically release a brake.
(Note 2) This is the representative value for the initial attraction gap at 20°C.
(Note 3) The brake gap will widen through brake lining wear caused by braking. However, the gap cannot be adjusted. Thus, the brake life is considered to be reached when adjustments are required.
(Note 4) A leakage flux will be generated at the shaft end of the servo motor with a magnetic brake.
(Note 5) When operating in low speed regions, the sound of loose brake lining may be heard. However, this is not a problem in terms of function.

< HK Series >

Item		Motor type		
		HK76B, HK105B	HK55B, HK104B HK123B, HK142B HK154B, HK223B HK224B	HK204B, HK302B HK303B, HK354B HK453B, HK603B HK702B, HK703B
Type (Note 1)		Spring closed non-exciting operation magnetic brakes (for maintenance and emergency braking)		
Rated voltage		24VDC 0V-10%		
Power consumption at 20°C (W)		10	20	34
Static friction torque (N•m)		3.2 or more	8.5 or more	44 or more
Release delay time (Note 2) (s)		0.04	0.04	0.1
Braking delay time (DC OFF) (Note 2) (s)		0.02	0.03	0.03
Tolerable braking work amount	Per braking (J)	64	400	4,500
	Per hour (J)	640	4,000	45,000
Brake play at motor axis (degree)		0.9	0.2 to 0.6	0.2 to 0.6
Brake life (Note 3)	No. of braking operations (times)	20,000	20,000	20,000
	Work amount per braking (J)	64	200	1,000

(Note 1) There is no manual release mechanism. If handling is required such as during the machine core alignment work, prepare a separate 24VDC power supply, and electrically release a brake.

(Note 2) This is the representative value for the initial attraction gap at 20°C.

(Note 3) The brake gap will widen through brake lining wear caused by braking. However, the gap cannot be adjusted. Thus, the brake life is considered to be reached when adjustments are required.

(Note 4) A leakage flux will be generated at the shaft end of the servo motor with a magnetic brake.

(Note 5) When operating in low speed regions, the sound of loose brake lining may be heard. However, this is not a problem in terms of function.

(b) 400V series

< HG-H Series >

Item		Motor type		
		HG-H75B, HG-H105B	HG-H54B, HG-H104B HG-H154B, HG-H224B	HG-H204B, HG-H354B HG-H453B, HG-H703B HG-H903B
Type (Note 1)		Spring closed non-exciting operation magnetic brakes (for maintenance and emergency braking)		
Rated voltage		24VDC 0V-10%		
Power consumption at 20°C (W)		9	19	34
Static friction torque (N•m)		2.4 or more	8.5 or more	44 or more
Release delay time (Note 2) (s)		0.03	0.04	0.1
Braking delay time (DC OFF) (Note 2) (s)		0.03	0.03	0.03
Tolerable braking work amount	Per braking (J)	64	400	4,500
	Per hour (J)	640	4,000	45,000
Brake play at motor axis (degree)		0.1 to 0.9	0.2 to 0.6	0.2 to 0.6
Brake life (Note 3)	No. of braking operations (times)	20,000	20,000	20,000
	Work amount per braking (J)	32	200	1,000

< HQ-H Series >

Item		Motor type
		HQ-H903B HQ-H1103B
Type (Note 1)		Spring closed non-exciting operation magnetic brakes (for maintenance and emergency braking)
Rated voltage		24VDC 0V-10%
Power consumption at 20°C (W)		41
Static friction torque (N•m)		90 or more
Release delay time (Note 2) (s)		0.3
Braking delay time (DC OFF) (Note 2) (s)		0.1
Tolerable braking work amount	Per braking (J)	4,500
	Per hour (J)	45,000
Brake play at motor axis (degree)		0.2 to 0.6
Brake life (Note 3)	No. of braking operations (times)	20,000
	Work amount per braking (J)	1,000

(Note 1) There is no manual release mechanism. If handling is required such as during the machine core alignment work, prepare a separate 24VDC power supply, and electrically release a brake.
(Note 2) This is the representative value for the initial attraction gap at 20°C.
(Note 3) The brake gap will widen through brake lining wear caused by braking. However, the gap cannot be adjusted. Thus, the brake life is considered to be reached when adjustments are required.
(Note 4) A leakage flux will be generated at the shaft end of the servo motor with a magnetic brake.
(Note 5) When operating in low speed regions, the sound of loose brake lining may be heard. However, this is not a problem in terms of function.

< HK-H Series >

Item		Motor type		
		HK-H76B, HK-H105B	HK-H55B, HK-H104B HK-H123B, HK-H154B HK-H223B, HK-H224B	HK-H204B, HK-H302B HK-H303B, HK-H354B HK-H453B, HK-H603B HK-H702B, HK-H703B
Type (Note 1)		Spring closed non-exciting operation magnetic brakes (for maintenance and emergency braking)		
Rated voltage		24VDC 0V-10%		
Power consumption at 20°C (W)		10	20	34
Static friction torque (N•m)		3.2 or more	8.5 or more	44 or more
Release delay time (Note 2) (s)		0.04	0.04	0.1
Braking delay time (DC OFF) (Note 2) (s)		0.02	0.03	0.03
Tolerable braking work amount	Per braking (J)	64	400	4,500
	Per hour (J)	640	4,000	45,000
Brake play at motor axis (degree)		0.9	0.2 to 0.6	0.2 to 0.6
Brake life (Note 3)	No. of braking operations (times)	20,000	20,000	20,000
	Work amount per braking (J)	64	200	1,000

(Note 1) There is no manual release mechanism. If handling is required such as during the machine core alignment work, prepare a separate 24VDC power supply, and electrically release a brake.
(Note 2) This is the representative value for the initial attraction gap at 20°C.
(Note 3) The brake gap will widen through brake lining wear caused by braking. However, the gap cannot be adjusted. Thus, the brake life is considered to be reached when adjustments are required.
(Note 4) A leakage flux will be generated at the shaft end of the servo motor with a magnetic brake.
(Note 5) When operating in low speed regions, the sound of loose brake lining may be heard. However, this is not a problem in terms of function.

(3) Magnetic brake power supply

⚠ CAUTION

1. When using the DO output of motor brake control connector CN9 to provide brake excitation circuit, be sure to install a surge absorber on the brake terminal. CN20 requires no surge absorber.
2. Do not pull out the cannon plug while the brake power is ON. The cannon plug pins could be damaged by sparks.

(a) Brake excitation power supply

[1] Prepare a brake excitation power supply that can accurately ensure the attraction current in consideration of the voltage fluctuation and excitation coil temperature.

[2] The brake terminal polarity is random. Make sure not to mistake the terminals with other circuits.

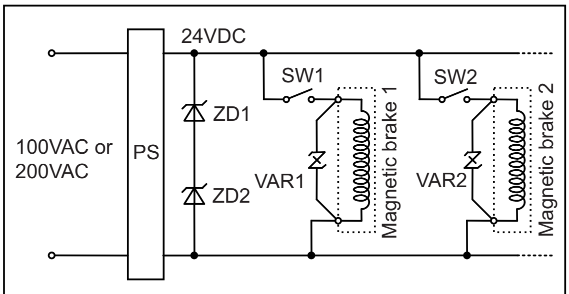
(b) Brake excitation circuit

When turning OFF the brake excitation power supply (to apply the brake), DC OFF is used to shorten the braking delay time.

A surge absorber will be required. Pay attention to the relay cut off capacity.

<Cautions>

- Provide sufficient DC cut off capacity at the contact.
- Always use a surge absorber.
- When using the cannon plug type, the surge absorber will be further away, so use shielded wires between the motor and surge absorber.



(b) Example of DC OFF

PS : 24VDC stabilized power supply
ZD1,ZD2 : Zener diode for power supply protection (1W, 24V)
VAR1,VAR2 : Surge absorber

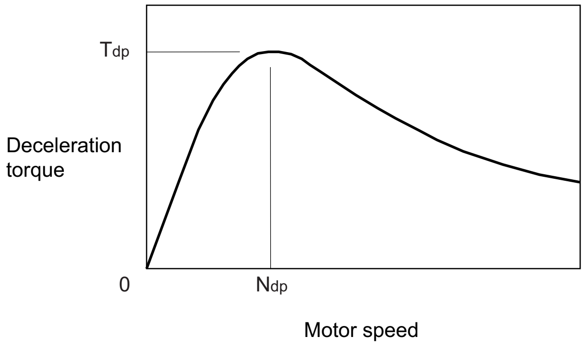
Magnetic brake circuits

4.1.9 Dynamic Brake Characteristics

If a servo alarm that cannot control the motor occurs, the dynamic brakes will function to stop the servo 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

Max. deceleration torque of a dynamic brake

Motor type (200V series)	Stall torque (N•m)	Tdp (N•m)	Ndp (r/min)	Motor type (400V series)	Stall torque (N•m)	Tdp (N•m)	Ndp (r/min)
HG46	0.64	1.61	1324	**HG-H75**	2.0	5.11	1685
HG56	1.3	3.09	1447	**HG-H105**	3.0	10.19	1740
HG96	2.4	5.66	1659	**HG-H54**	2.9	3.96	690
HG75	2.0	5.43	1825	**HG-H104**	5.9	10.03	897
HG105	3.0	10.21	1967	**HG-H154**	9.0	15.05	1073
HG54	2.9	3.97	758	**HG-H154(V2-80)**			586
HG104	5.9	10.02	1060	**HG-H224**	12.0	21.78	1520
HG154	9.0	15.64	1356	**HG-H224(V2-80)**			734
HG154 (V2-160)			850	**HG-H204**	13.7	15.82	419
HG224	12.0	20.07	1765	**HG-H204(V2-80)**			835
HG224 (V2-160)	12.0	20.07	1042	**HG-H354**	22.5	37.33	657
HG204	13.7	15.95	1029	**HG-H354 (V2-80W)**			421
HG204 (V2-160)			617	**HG-H453**	30.0	52.91	619
HG354	22.5	35.25	908	**HG-H453 (V2-80W)**			389
HG123	7.0	9.80	750	**HG-H703**	49.0	71.76	374
HG223	12.0	19.93	1059	**HG-H903**	58.8	89.63	1044
HG303	22.5	30.40	955	**HG-H1502**	152.1	206.55	652
HG303 (V2-160)			550	**HQ-H903**	70.0	111.25	1022
HG453	30.0	52.94	1080	**HQ-H1103**	110.0	190.83	767
HG603	45.0	71.34	1067				
HG702	41.0	76.88	897				
HG703	49.0	71.90	1070				
HG903	58.8	89.29	3755				
HG1103	95.5	137.68	2373				
HG142	11.0	14.43	547				
HG302	20.0	29.42	635				

Max. deceleration torque of a dynamic brake

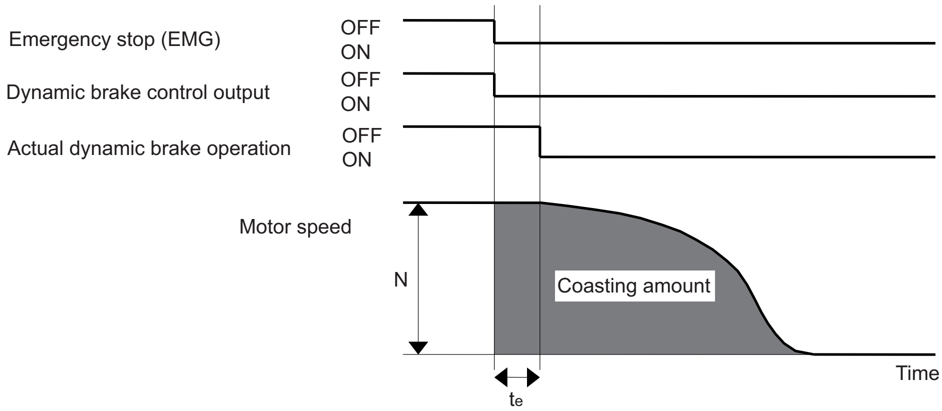
Motor type (200V series)	Stall torque (N•m)	Tdp (N•m)	Ndp (r/min)	Motor type (400V series)	Stall torque (N•m)	Tdp (N•m)	Ndp (r/min)
HK76	3.0	5.74	1511	**HK-H76**	2.8	5.73	1318
HK105	4.8	12.35	1600	**HK-H105**	3.8	12.38	1381
HK55	3.5	4.92	720	**HK-H55**	3.5	4.93	623
HK104	8.6	10.72	912	**HK-H104**	8.6	10.74	750
HK123	7.5	10.74	615	**HK-H123**	5.7	10.75	526
HK142	11.0	16.62	518	**HK-H154**	12.0	16.62	1013
HK154	12.0	16.62	1262	**HK-H154 (V2-80)**			518
HK154 (V2-160)			767	**HK-H154 (V3-40)**	9.0		1013
HK223	15.0	22.46	798	**HK-H223**	13.5	22.48	654
HK224	14.0	22.47	1617	**HK-H224**	13.5	22.47	1269
HK224 (V1/V2-160)			920	**HK-H224 (V1/V2-80)**	14.0		572
HK204	15.0	18.70	1148	**HK-H204**	15.0	18.65	896
HK204 (V2-160)			647	**HK-H204 (V2-80)**			395
HK302	20.0	39.67	733	**HK-H302**	28.0	39.69	599
HK303	22.5	39.65	1164	**HK-H303**	21.5	39.69	905
HK303 (V2-160)			642	**HK-H303 (V2-80)**			384
HK354	27.0	39.77	997	**HK-H354**	27.0	39.68	573
HK453	33.5	60.62	1208	**HK-H354 (V2-80W)**			363
HK603	45.5	82.30	1228	**HK-H453**	39.0	60.87	671
HK702	57.0	82.11	742	**HK-H453 (V2-80W)**			400
HK703	51.0	82.30	1228	**HK-H603**	45.0	81.97	671
				HK-H603 (V2-80W)			394
				HK-H702	57.0	81.97	425
				HK-H702 (V2-80W)			267
				HK-H703	51.0	81.97	394
				HK-H703 (V2-160)			671

(2) Coasting rotation distance during emergency stop

The distance that the motor coasts (angle for rotary axis) when stopping with the dynamic brakes can be approximated with the following expression.

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

L_{MAX}	: Motor coasting distance (angle)	[mm, (deg)]
F	: Axis feedrate	[mm/min, (deg/min)]
N	: Motor speed	[r/min]
J_M	: Motor inertia	[$\times 10^{-4}$kg•m^2]
J_L	: Motor shaft conversion load inertia	[$\times 10^{-4}$kg•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)	



Dynamic brake braking diagram

Coasting amount calculation coefficients table

Motor type (200V series)	J_M ($\times10^{-4}$kg•m^2)	A	B	Motor type (400V series)	J_M ($\times10^{-4}$kg•m^2)	A	B
HG46	0.234	0.30×10^{-9}	1.01×10^{-3}	**HG-H75**	2.62	0.53×10^{-9}	4.49×10^{-3}
HG56	0.379	0.23×10^{-9}	0.93×10^{-3}	**HG-H105**	5.12	0.50×10^{-9}	4.56×10^{-3}
HG96	1.27	0.37×10^{-9}	1.95×10^{-3}	**HG-H54**	6.13	3.90×10^{-9}	5.56×10^{-3}
HG75	2.62	0.46×10^{-9}	4.61×10^{-3}	**HG-H104**	11.9	2.31×10^{-9}	5.57×10^{-3}
HG105	5.12	0.44×10^{-9}	5.17×10^{-3}	**HG-H154**	17.8	0.50×10^{-9}	4.56×10^{-3}
HG54	6.13	3.56×10^{-9}	6.13×10^{-3}	**HG-H224**	23.7	1.25×10^{-9}	8.66×10^{-3}
HG104	11.9	1.95×10^{-9}	6.59×10^{-3}	**HG-H224(V2-80)**		2.59×10^{-9}	4.18×10^{-3}
HG154	17.8	1.47×10^{-9}	8.08×10^{-3}	**HG-H204**	38.3	5.06×10^{-9}	10.59×10^{-3}
HG154 (V2-160)		2.34×10^{-9}	5.06×10^{-3}	**HG-H204(V2-80)**		10.09×10^{-9}	5.31×10^{-3}
HG224	23.7	1.17×10^{-9}	10.91×10^{-3}	**HG-H354**	75.0	5.34×10^{-9}	6.91×10^{-3}
HG224 (V2-160)		1.98×10^{-9}	6.44×10^{-3}	**HG-H354 (V2-80W)**		8.33×10^{-9}	4.43×10^{-3}
HG204	38.3	4.07×10^{-9}	12.94×10^{-3}	**HG-H453**	112.0	5.97×10^{-9}	6.86×10^{-3}
HG204 (V2-160)		6.79×10^{-9}	7.76×10^{-3}	**HG-H453 (V2-80W)**		9.49×10^{-9}	4.32×10^{-3}
HG354	75.0	4.09×10^{-9}	10.12×10^{-3}	**HG-H703**	154.0	10.01×10^{-9}	4.20×10^{-3}
HG123	11.9	2.82×10^{-9}	4.77×10^{-3}	**HG-H903**	196.0	3.66×10^{-9}	11.95×10^{-3}
HG223	23.7	1.96×10^{-9}	6.60×10^{-3}	**HG-H1502**	489	9.91×10^{-9}	8.08×10^{-3}
HG303	75.0	4.51×10^{-9}	12.33×10^{-3}	**HQ-H903**	230.0	5.52×10^{-9}	11.06×10^{-3}
HG303 (V2-160)		7.82×10^{-9}	7.11×10^{-3}	**HQ-H1103**	350.0	6.52×10^{-9}	7.36×10^{-3}
HG453	112.0	3.42×10^{-9}	11.96×10^{-3}				
HG603	154.0	3.53×10^{-9}	12.06×10^{-3}				
HG702	154.0	3.90×10^{-9}	9.41×10^{-3}				
HG703	154.0	3.50×10^{-9}	12.00×10^{-3}				
HG903	196.0	1.02×10^{-9}	43.15×10^{-3}				
HG1103	315	1.68×10^{-9}	28.43×10^{-3}				
HG142	17.8	3.94×10^{-9}	3.53×10^{-3}				
HG302	75.0	7.01×10^{-9}	8.48×10^{-3}				

Coasting amount calculation coefficients table

Motor type (200V series)	J_M ($\times10^{-4}$kg•m^2)	A	B	Motor type (400V series)	J_M ($\times10^{-4}$kg•m^2)	A	B
HK76	2.08	0.42×10^{-9}	2.86×10^{-3}	**HK-H76**	2.08	0.48×10^{-9}	2.50×10^{-3}
HK105	4.36	0.39×10^{-9}	2.96×10^{-3}	**HK-H105**	4.36	0.45×10^{-9}	2.55×10^{-3}
HK55	5.90	2.91×10^{-9}	4.52×10^{-3}	**HK-H55**	5.90	3.35×10^{-9}	3.91×10^{-3}
HK104	11.4	2.03×10^{-9}	5.08×10^{-3}	**HK-H104**	11.4	2.47×10^{-9}	4.17×10^{-3}
HK123	11.4	3.01×10^{-9}	3.42×10^{-3}	**HK-H123**	11.4	3.52×10^{-9}	2.92×10^{-3}
HK142	16.9	3.43×10^{-9}	2.76×10^{-3}	**HK-H154**	16.9	1.75×10^{-9}	5.40×10^{-3}
HK154	16.9	1.41×10^{-9}	6.72×10^{-3}	**HK-H154 (V2-80)**		3.43×10^{-9}	2.76×10^{-3}
HK154 (V2-160)		2.32×10^{-9}	4.09×10^{-3}	**HK-H223**	22.4	2.66×10^{-9}	3.41×10^{-3}
HK223	22.4	2.18×10^{-9}	4.17×10^{-3}	**HK-H224**	22.4	1.37×10^{-9}	6.62×10^{-3}
HK224	22.4	1.08×10^{-9}	8.44×10^{-3}	**HK-H224 (V1/V2-80)**		3.05×10^{-9}	2.98×10^{-3}
HK224 (V1/V2-160)		1.89×10^{-9}	4.80×10^{-3}	**HK-H204**	36.4	3.80×10^{-9}	9.15×10^{-3}
HK204	36.4	2.96×10^{-9}	11.69×10^{-3}	**HK-H204 (V2-80)**		8.61×10^{-9}	4.04×10^{-3}
HK204 (V2-160)		5.25×10^{-9}	6.59×10^{-3}	**HK-H302**	70.8	5.20×10^{-9}	5.60×10^{-3}
HK302	70.8	4.25×10^{-9}	6.86×10^{-3}	**HK-H303**	70.8	3.44×10^{-9}	8.46×10^{-3}
HK303	70.8	2.68×10^{-9}	10.89×10^{-3}	**HK-H303 (V2-80)**		8.12×10^{-9}	3.58×10^{-3}
HK303 (V2-160)		4.86×10^{-9}	6.00×10^{-3}	**HK-H354**	70.8	5.43×10^{-9}	5.36×10^{-3}
HK354	70.8	3.12×10^{-9}	9.30×10^{-3}	**HK-H354 (V2-80W)**		8.59×10^{-9}	3.39×10^{-3}
HK453	105	2.51×10^{-9}	10.99×10^{-3}	**HK-H453**	105	4.50×10^{-9}	6.08×10^{-3}
HK603	140	2.42×10^{-9}	10.94×10^{-3}	**HK-H453 (V2-80W)**		7.54×10^{-9}	3.63×10^{-3}
HK702	140	4.01×10^{-9}	6.63×10^{-3}	**HK-H603**	140	4.44×10^{-9}	6.00×10^{-3}
HK703	140	2.42×10^{-9}	10.94×10^{-3}	**HK-H603 (V2-80W)**		7.56×10^{-9}	3.52×10^{-3}
				HK-H702	140	7.01×10^{-9}	3.80×10^{-3}
				HK-H702 (V2-80W)		11.15×10^{-9}	2.39×10^{-3}
				HK-H703	140	7.56×10^{-9}	3.52×10^{-3}
				HK-H703 (V2-160)		4.44×10^{-9}	6.00×10^{-3}

4.2 Spindle Motor

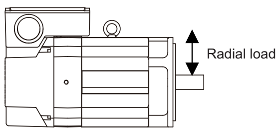
4.2.1 Environmental Conditions

Environment	Conditions
Ambient temperature	0°C to +40°C (with no freezing)
Ambient humidity	90%RH or less (with no dew condensation)
Storage temperature	-20°C to +65°C (with no freezing)
Storage humidity	90%RH or less (with no dew condensation)
Atmosphere	Indoors (Where unit is not subject to direct sunlight) No corrosive gases, flammable gases, oil mist or dust
Altitude	Operation/storage: 1000m or less above sea level Transportation: 10000m or less above sea level
Vibration	X:29.4m/s^2 (3G) Y:29.4m/s^2 (3G)

4.2.2 Shaft Characteristics

There is a limit to the load that can be applied on the motor shaft. Make sure that the load applied on the radial direction, when mounted on the machine, is below the tolerable values given below. These loads may affect the motor output torque, so consider them when designing the machine.

Series	Spindle motor	Tolerable radial load
200V series	SJ-D5.5/120-02T-S, SJ-DL3.7/240-01T, SJ-DL5.5/200-01T-S, SJ-DG11/120-03T-S, SJ-DG11/120-12T-KS, SJ-DG11/150-06T-S, SJ-DG11/150-15T-KS, SJ-DG15/120-02T-KS	Not permitted
	SJ-VL11-05FZT-S01	98N
	SJ-VL2.2-02ZT	196N
	SJ-DL5.5/150-01T, SJ-DL5.5/200-01T, SJ-DL5.5/240-05T, SJ-V3.7-02ZT, SJ-VL11-02FZT	245N
	SJ-DL0.75/100-01T, SJ-DL1.5/100-01, SJ-DM11/120-01T	490N
	SJ-D3.7/100-01, SJ-D5.5/120-02, SJ-DJ5.5/100-01, SJ-DJ5.5/120-01, SJ-DL7.5/150-01T, SJ-V2.2-01T, SJ-DG3.7/120-03T, SJ-DG11/150-06T, SJ-DG11/150-15T-K	980N
	SJ-D5.5/100-01, SJ-D5.5/120-01, SJ-DJ7.5/100-01, SJ-DJ7.5/120-01, SJ-DG5.5/120-04T	1470N
	SJ-D7.5/100-01, SJ-D7.5/120-01, SJ-D11/100-01, SJ-DJ11/100-01, SJ-DJ15/80-01, SJ-V11-01T, SJ-DG7.5/120-05T, SJ-DG11/100-03T, SJ-DG11/120-03T, SJ-DG15/120-02T-K, SJ-DG11/120-12T-K, SJ-DN7.5/80-01	1960N
	SJ-V22-06ZT	2450N
	SJ-V15-09ZT, SJ-V18.5-01ZT, SJ-V18.5-04ZT, SJ-V22-01ZT, SJ-V22-04ZT, SJ-V26-01ZT, SJ-V11-09T, SJ-V15-03T, SJ-V18.5-03T, SJ-V22-05T	2940N
	SJ-D15/80-01, SJ-D18.5/80-01, SJ-DN11/80-01	3430N
	SJ-D22/80-01, SJ-D26/80-01, SJ-V37-01ZT, SJ-V45-01ZT, SJ-V22-09T, SJ-VK22-19ZT, SJ-DN15/80-01, SJ-DN18.5/80-01	3920N
	SJ-V55-01ZT	5880N
400V series	SJ-4-V2.2-03T, SJ-4-V3.7-03T, SJ-4-V7.5-13ZT	980N
	SJ-4-V5.5-07T	1470N
	SJ-4-V7.5-12T, SJ-4-V11-18T	1960N
	SJ-4-V26-08ZT	2450N
	SJ-4-V18.5-14T, SJ-4-V22-15T, SJ-4-V22-18ZT, SJ-4-V15-20T, SJ-4-V22-16T	2940N
	SJ-4-V37-04ZT, SJ-4-V45-02T	3920N
	SJ-4-V55-03T	5880N



(Note) The load point is at the one-half of the shaft length.

⚠ CAUTION

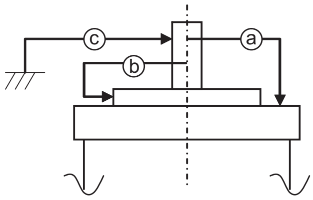
Consider on the machine side so that the thrust loads are not applied to the spindle motor.

4.2.3 Machine Accuracy

Machine accuracy of the spindle motor's output shaft and around the installation part is as below.
(Excluding special products)

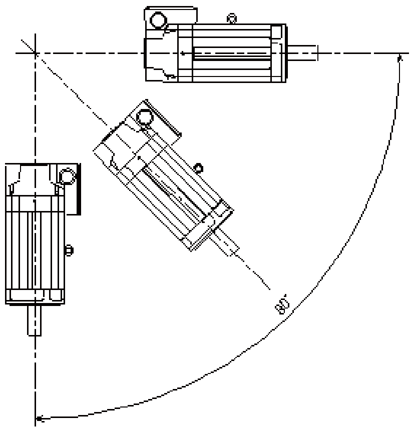
Accuracy	Measurement point	Frame No.	
		A71, B71, C71, A90, B90, C90,D90, E90, A112, B112	A160, B160, C160, D160, A180, B180, A225
Run-out of the flange surface to the output shaft	a	0.03mm	0.05mm
Run-out of the flange surface's fitting outer diameter	b	0.02mm	0.04mm
Run-out of the output shaft end	c	0.01mm	0.02mm

(Note) Refer to Specifications Manual for the frame number of each spindle motor.



4.2.4 Installation of Spindle Motor

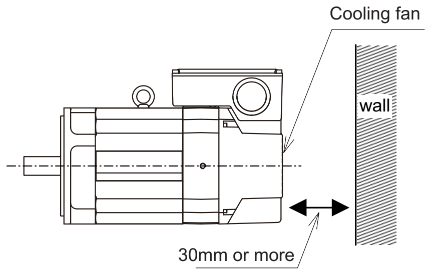
Make sure that the spindle motor is installed so that the motor shaft points from downward to 90° as shown below. When installing upward more than 90°, contact your Mitsubishi Electric dealer.



⚠ CAUTION

1. Rubber packing for waterproof is attached on the inner surface of the top cover of terminal block, and on the fan lead. After checking that the packing is installed, install the top cover so that no foreign objects are stuck in between.
2. When installing a motor on a flange, chamfer(C1) the part of flange that touches inside low part of the motor.

To yield good cooling performance, provide a space of at least 30mm between the cooling fan and wall. If the motor is covered by a structure and the air is not exchanged, its cooling performance degrades and the motor is unable to fully exercise its performance, which may cause the spindle motor overheat alarm. Do not use the spindle motor in an enclosed space with little ventilation.



4.3 Tool Spindle Motor

4.3.1 Environmental Conditions

Environment	Conditions
Ambient temperature	0°C to +40°C (with no freezing)
Ambient humidity	80% RH or less (with no dew condensation)
Storage temperature	-15°C to +70°C (with no freezing)
Storage humidity	90% RH or less (with no dew condensation)
Atmosphere	Indoors (no direct sunlight) No corrosive gas, inflammable gas, oil mist or dust
Altitude	Operation/storage: 1000m or less above sea level Transportation: 10000m or less above sea level
Vibration	X:19.6m/s^2 (2G) Y:19.6m/s^2 (2G)

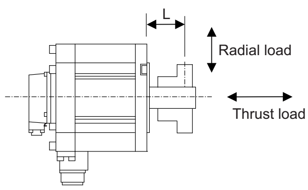
4.3.2 Shaft Characteristics

There is a limit to the load that can be applied on the motor shaft. Make sure that the load applied on the radial direction, when mounted on the machine, is below the tolerable values given below. These loads may affect the motor output torque, so consider them when designing the machine.

Series	Tool spindle motor	Tolerable radial load	Tolerable thrust load
200V series	**HG46S, HG46K, HG56S, HG56K**	245N (L=30)	98N
	HG-JR73, 153	323N (L=40)	284N
	HG96S, HG96K	392N (L=40)	147N
	HG75S, 105S	245N (L=33)	147N
	HG54S, 104S, 154S, 224S	980N (L=55)	490N
	HG204S, 354S, 453S, 703S	2058N (L=79)	980N
	HG903S	2450N (L=85)	980N
400V series	**HG-JR734, 1534**	323N (L=40)	284N

(Note 1) The tolerable radial load and thrust load in the above table are values applied when each motor is used independently.

(Note 2) The symbol L in the table refers to the value of L below.



L: Length from flange installation surface to center of load mass [mm]

4.3.3 Tool Spindle Temperature Characteristics

The tool spindle motor temperature tends to rise in a high-speed rotation even if the load rate is low. At the rotation speed of 6000r/min, even if the load rate is 0%, temperature rises about 50 to 60°C.

4.3.4 Installation of Tool Spindle Motor

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

Flange size (mm)	Tool spindle motor capacity
250×250×6	400W
250×250×12	0.5 to 1.5kW
300×300×20	2.0 to 7.0kW
800×800×35	9.0kW

4.4 Drive Unit

4.4.1 Environmental Conditions

Environment	Conditions
Ambient temperature	0°C to +55°C (with no freezing)
Ambient humidity	90% RH or less (with no dew condensation)
Storage temperature	-15°C to +70°C (with no freezing)
Storage humidity	90% RH or less (with no dew condensation)
Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, dust or conductive fine particles
Altitude	Operation/storage: 1000m or less above sea level Transportation: 13000m or less above sea level
Vibration	Operation/storage: 4.9m/s^2 (0.5G) or less Transportation: 49m/s^2(5G) or less

(Note) When installing the machine at 1,000m or more above sea level, the heat dissipation characteristics will drop as the altitude increases in proportion to the air density. The ambient temperature drops 1% with every 100m increase in altitude.
When installing the machine at 1,800m altitude, the heating value of the drive unit must be reduced to 92% or less. The heating value is proportional to the square of the current, and required current decreasing rate follows the expression below.

$$\text{Required current decreasing rate} = \sqrt{0.92} = 0.95$$

Therefore, use the unit with the reduced effective load rate to 95% or less.

4.4.2 Heating Value

The values for the servo drive unit apply for load rate 50%. The values for the spindle drive unit apply for the continuous rated output. The values for the power supply unit include the AC reactor's heating value.

< MDS-E Series >

Servo drive unit						Spindle drive unit						Power supply unit			Power backup unit	
Type MDS-E-	Heating value [W]		Type MDS-E-	Heating value [W]		Type MDS-E-	Heating value [W]		Type MDS-E-	Heating value [W]		Type MDS-E-	Heating value [W]		Type MDS-D-	Heating value [W]
	In-side panel	Out-side panel		In-side panel	Out-side panel		In-side panel	Out-side panel		In-side panel	Out-side panel		In-side panel	Out-side panel		
V1-20	18	22	**V2-20**	26	44	**SP-20**	24	31	**SP2-20**	28	62	**CV-37**	20	34	**PFU**	15
V1-40	20	38	**V2-40**	31	75	**SP-40**	29	65	**SP2-40**	38	130	**CV-75**	24	55		
V1-80	25	71	**V2-80**	40	142	**SP-80**	37	121	**SP2-80**	54	242	**CV-110**	25	99		
V1-160	36	148	**V2-160**	62	296	**SP-160**	54	236	**SP2-16080**	70	358	**CV-185**	32	161		
V1-160W	44	201	**V2-160W**	77	403	**SP-200**	78	404				**CV-300**	45	272		
V1-320	59	307	**V3-20**	60	71	**SP-240**	100	520				**CV-370**	53	343		
V1-320W	72	399	**V3-40**	102	123	**SP-320**	118	688				**CV-450**	104	392		
			V3-80	139	111	**SP-400**	148	897				**CV-550**	164	431		
						SP-640	196	1231								

< MDS-EH Series >

Servo drive unit						Spindle drive unit			Power supply unit			Power backup unit	
Type MDS-EH-	Heating value [W]		Type MDS-EH-	Heating value [W]		Type MDS-EH-	Heating value [W]		Type MDS-EH-	Heating value [W]		Type MDS-DH-	Heating value [W]
	Inside panel	Outside panel		Inside panel	Outside panel		Inside panel	Outside panel		Inside panel	Outside panel		
V1-10	19	27	**V2-10**	28	54	**SP-20**	32	88	**CV-37**	20	34	**PFU**	15
V1-20	22	46	**V2-20**	33	93	**SP-40**	42	158	**CV-75**	24	55		
V1-40	27	87	**V2-40**	45	173	**SP-80**	54	237	**CV-110**	25	99		
V1-80	40	175	**V2-80**	70	350	**SP-100**	73	369	**CV-185**	32	161		
V1-80W	47	222	**V2-80W**	83	445	**SP-160**	110	639	**CV-300**	45	272		
V1-160	62	328	**V2-160**	111	656	**SP-200**	126	746	**CV-370**	53	343		
V1-160W	81	461	**V3-40**	125	83	**SP-320**	168	1034	**CV-450**	104	392		
V1-200	105	630				**SP-480**	232	1488	**CV-550**	164	431		
						SP-600	310	2039	**CV-750**	228	614		

POINT

1. Design the panel's heating value taking the actual axis operation (load rate) into consideration.
2. The heating values in the above tables are calculated with the following load rates.

Unit	Load rate
Servo drive unit	50%
Spindle drive unit	100%
Power supply unit	100%

5

Dedicated Options

5.1 Servo Options

The interface units or battery options are required depending on the type of machine end encoder in the full closed loop control system. Check the options to be required referring the following lists.

POINT

The scales shown in this manual are examples which the connectivity is verified by Mitsubishi Electric.
Connectable scales besides these are also marketed. Contact each scale manufacturer for details.
For the specifications of the scale, including the scales shown in this manual, refer to the manuals issued by the manufacturer.

(a) Full closed loop control for linear axis

Machine side encoder to be used			Encoder signal output	Interface unit	Drive unit input signal	Battery option	Remarks
Incre-mental encoder	Rectangular wave signal output	SR74, SR84 (Magnescale)	Rectangular wave signal	-	Rectangular wave signal	-	
		Various scale	Rectangular wave signal	-	Rectangular wave signal	-	
	SIN wave signal output	LS187, LS487 (HEIDENHAIN)	SIN wave signal	IBV Series (HEIDENHAIN)	Rectangular wave signal	-	
				EIB Series (HEIDENHAIN)	Mitsubishi serial signal	-	
		LS187C, LS487C (HEIDENHAIN)	SIN wave signal	EIB Series (HEIDENHAIN)	Mitsubishi serial signal	(Required) (Note 1)	Distance-coded reference scale (Note 2)
		Various scale	SIN wave signal	MDS-EX-HR-11 (Mitsubishi Electric)	Mitsubishi serial signal	(Required) (Note 1)	Distance-coded reference scale is also available (Note 2) (Note 4)
	Mitsubishi serial signal output	SR75, SR85 (Magnescale)	Mitsubishi serial signal	-	Mitsubishi serial signal	-	
Abso-lute position encoder	Mitsubishi serial signal output	OSA405ET2AS OSA676ET2AS (Note 3) (Mitsubishi Electric)	Mitsubishi serial signal	-	Mitsubishi serial signal	Required	Ball screw side encoder
		SR27,SR77, SR87, SR67A (Magnescale)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	
		LIC2197M, LIC2199M (HEIDENHAIN)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	Mitsu03-4
		MC15M (HEIDENHAIN)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	Mitsu03-4
		LC195M, LC495M, LC291M (HEIDENHAIN)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	Mitsu03-4
		AT343, AT543, AT545, ST748, AT1143 (Mitutoyo)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	
		SAM Series, SVAM Series GAM Series, G2AM Series, LAM Series, G3BM Series (FAGOR)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	
		RL40N Series, FORTiS Series (Renishaw)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	
		AMS-ABS-3B Series (Schneeberger)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	
		LMFA Series, LMBA Series (AMO)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	

(Note 1) When using the distance-coded reference scale, it is recommended to use with distance-coded reference check function. In this case, the battery option may be required.

(Note 2) The distance-coded reference scale is the supported option for M800 Series. It cannot be used with the speed command synchronous control.

(Note 3) OSA676ET2AS is not supported by MDS-EJ/EJH,EM/EMH.

(Note 4) Calculate the available scale length when using the distance-coded reference scale from the following expression.

Available scale length [m] = (2^{31}-1)/interpolation division number (16384) × auxiliary reference mark interval [μm] (SV131)/1000000

(Example) When the auxiliary reference mark interval is 4 [μm]

Available scale length = (2^{31}-1)/16384 × 4/1000000 = 0.524 [m]

According to this expression, the available scale length is 52 cm or less.

When compared to the previous model MDS-B-HR, the available scale length is 1/32 times when using MDS-EX-HR.

(b) Full closed loop control for rotary axis

Machine side encoder to be used			Encoder signal output	Interface unit	Output signal	Battery option	Remarks
Incre-mental encoder	Rectangular wave signal output	Various scale	Rectangular wave signal	-	Rectangular wave signal	-	
	SIN wave signal output	ERM280 Series (HEIDENHAIN)	SIN wave signal	EIB Series (HEIDENHAIN)	Mitsubishi serial signal	-	
		Various scale	SIN wave signal	MDS-EX-HR-11 (Mitsubishi Electric)	Mitsubishi serial signal	(Required) (Note 1)	Distance-coded reference scale is also available (Note 2)
	Mitsubishi serial signal output	MHS-04B Series (GUBOA)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	
Abso-lute position encoder	Mitsubishi serial signal output	RU77, RS87 (Magnescale)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	
		RCN2590M, RCN5390M, RCN5590M, RCN8390M (HEIDENHAIN)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	Mitsu03-4
		ROC425M, ROC2390M ECA4000 Series (HEIDENHAIN)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	Mitsu03-4
		RA Series (Renishaw)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	
		HAM Series H2AM Series (FAGOR)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	
		WMFA Series WMBA Series WMRA Series (AMO)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	
	SIN wave signal output	MPRZ Series (NIDEC MACHINE TOOL)	SIN wave signal	ADB-K70M (NIDEC MACHINE TOOL)	Mitsubishi serial signal	Not required	

(Note 1) When using the distance-coded reference scale, it is recommended to use with distance-coded reference check function. In this case, the battery option may be required.

(Note 2) The distance-coded reference scale is the supported option for M800 Series. It cannot be used with the speed command synchronous control.

<Contact information about machine side encoder>

- Magnescale Co., Ltd: http://www.mgscale.com/mgs/language/english/
- HEIDENHAIN CORPORATION: http://www.heidenhain.com/
- Mitutoyo Corporation: http://www.mitutoyo.co.jp/eng/
- NIDEC MACHINE TOOL CORPORATION: http://www.nidec.com/en/nidec-machinetool/
- FAGOR Automation: http://www.fagorautomation.com/
- Renishaw plc.: http://www.renishaw.com/
- SCHNEEBERGER AG: https://www.schneeberger.com
- AMO (Automatisierung Messtechnik Optik) GmbH : http://www.amo-gmbh.com/en/
- GUBOA Technology Co. : https://www.guboa.com/index/en/

POINT

The absolute position system cannot be established in combination with the relative position (incremental) machine side encoder and absolute position motor side encoder.

(2) System establishment in the synchronous control

(a) Position command synchronous control

The synchronous control is all executed in the NC, and the each servo is controlled as an independent axis. Therefore, preparing special options for the synchronous control is not required on the servo side.

(b) Speed command synchronization control

The common position control in two axes is performed by one linear scale. Basically, the multi axes integrated type drive unit (MDS-E/EH-V2/V3) is used, and the feedback signal is divided for two axes inside the drive unit.
When the two 1-axis type drive units are used in driving the large capacity servo motor, the linear scale feedback signal must be divided outside.

< Required option in the speed command synchronous control >

Machine side encoder to be used	For MDS-E/EH-V2/V3	For MDS-E/EH-V1×2units	Remarks
SIN wave signal output scale	MDS-EX-HR-11 (Serial conversion)	Not available	
Mitsubishi serial signal output scale	Direct connection	MDS-B-SD (Signal division)	Including the case that an interface unit of the scale manufacturer is used with SIN wave output scale.

(Note) The distance-coded reference scale speed command synchronous control and the rectangular wave signal output scale speed command synchronous control are not available.

POINT

1. When executing the synchronous control, use the servo motors of which the type and encoder specifications are same.
2. When performing the speed command synchronous control with 2-axis drive unit (MDS-E/EH-V2), make sure to set L-axis as primary axis. When performing the speed command synchronous control with 3-axis drive unit (MDS-E-V3), make sure to set L-axis as primary axis and M-axis as secondary axis. Other settings cause the initial parameter error alarm.

(c) Common encoder current command synchronous control

Common encoder current command synchronous control is performed in two axes to control torque interference between axes. When the multi axes integrated type drive unit (MDS-E/EH-V2/V3) is used, the feedback signal is divided into two axes inside the drive unit.
When two 1-axis type drive units are used, the feedback signal must be divided outside the drive units.

< Feedback signal division options for common encoder current command synchronous control >

Machine side encoder to be used	For MDS-E/EH-V2/V3	For MDS-E/EH-V1×2units
Mitsubishi serial signal output scale	Direct connection	MDS-B-SD (Signal division)

POINT

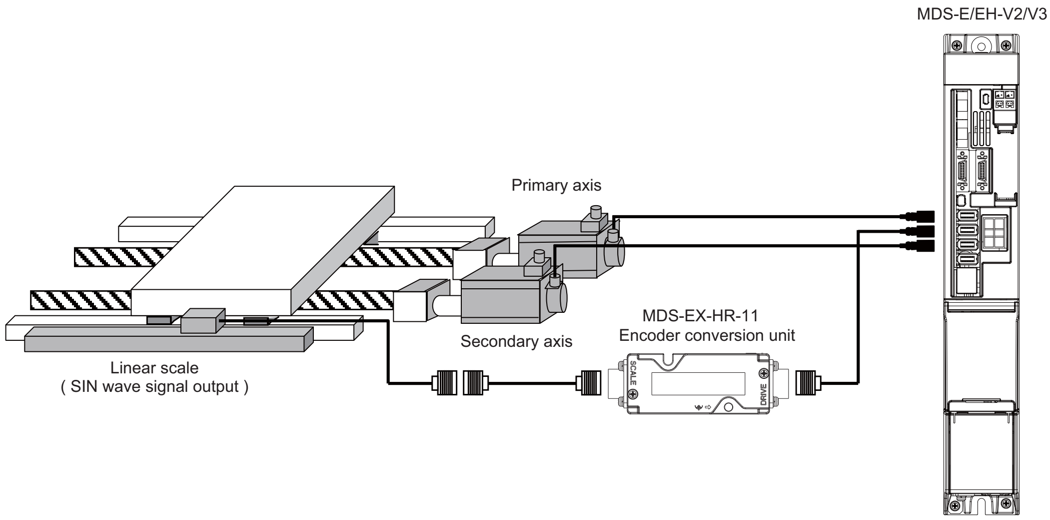
1. Since the position of the secondary axis is not controlled, the stop accuracy of the secondary axis depends on the axis accuracy (machine rigidity).
2. Common encoder current command synchronous control cannot be used for the standard motor series (SV017/bitC-F=0,1,2,3).
3. An NC and drive unit must both be set for common encoder current command synchronous control.
4. When using common encoder current command synchronous control with a single axis type drive unit, use an absolute position system.
5. When using the multi axes integrated type drive unit, only M-axis can be set as the secondary axis.
6. The thermal protection function of drive units cannot be used for a motor on the secondary axis. Protect the motor using another method such as incorporating a thermistor signal in the remote I/O to enable monitoring.

< Speed command synchronization control system configuration >

1) SIN wave signal output scale

< When using MDS-E/EH-V2/V3 >

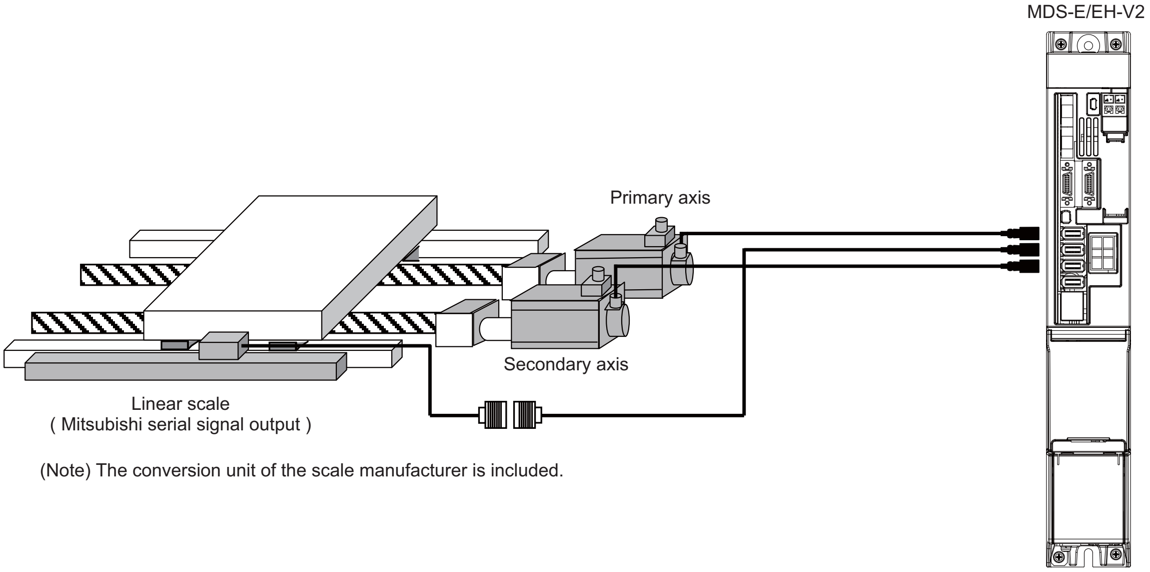
For the FB signal of the linear scale, the SIN wave signal is converted to Mitsubishi serial signal with the encoder conversion unit (MDS-EX-HR-11), and that signal is divided to each axis control inside 2-axis or 3-axis drive unit.



2) Mitsubishi serial signal output scale

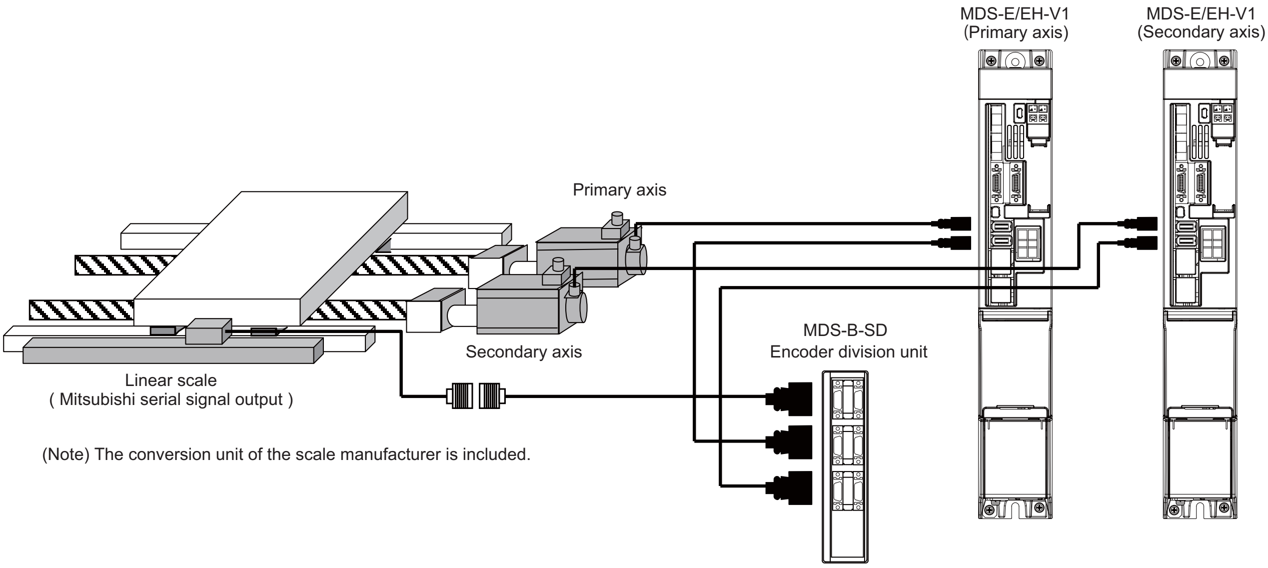
< When using MDS-E/EH-V2 >

The FB signal of the linear scale is divided to each axis control inside 2-axis drive unit. An external option unit is not required.



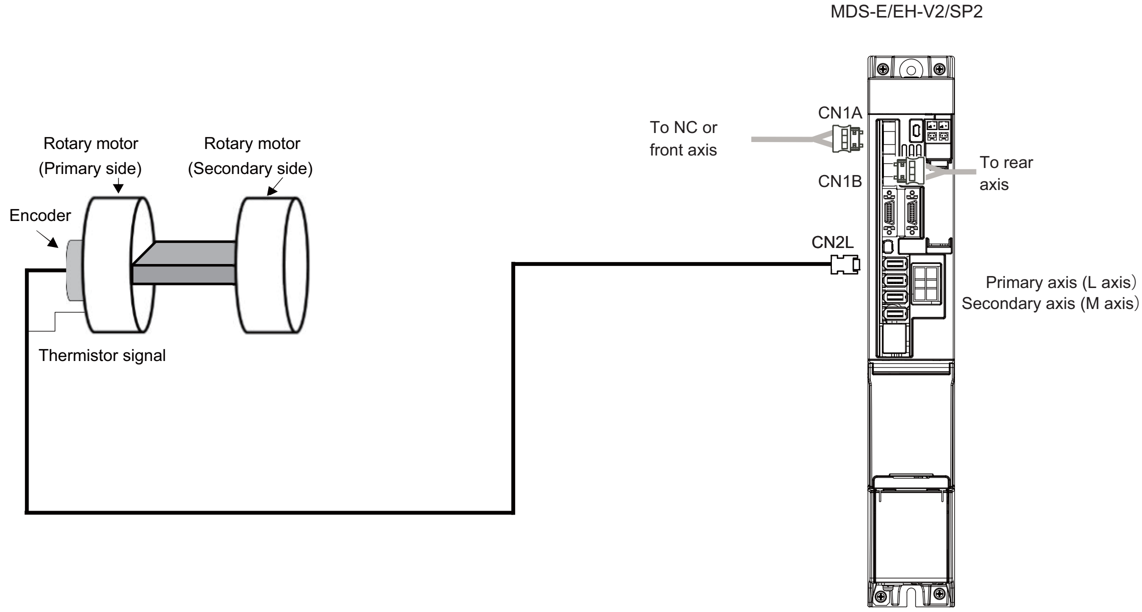
< When using two units of MDS-E/EH-V1 >

The FB signal of the linear scale is divided to each drive unit with the signal division unit (MDS-B-SD).

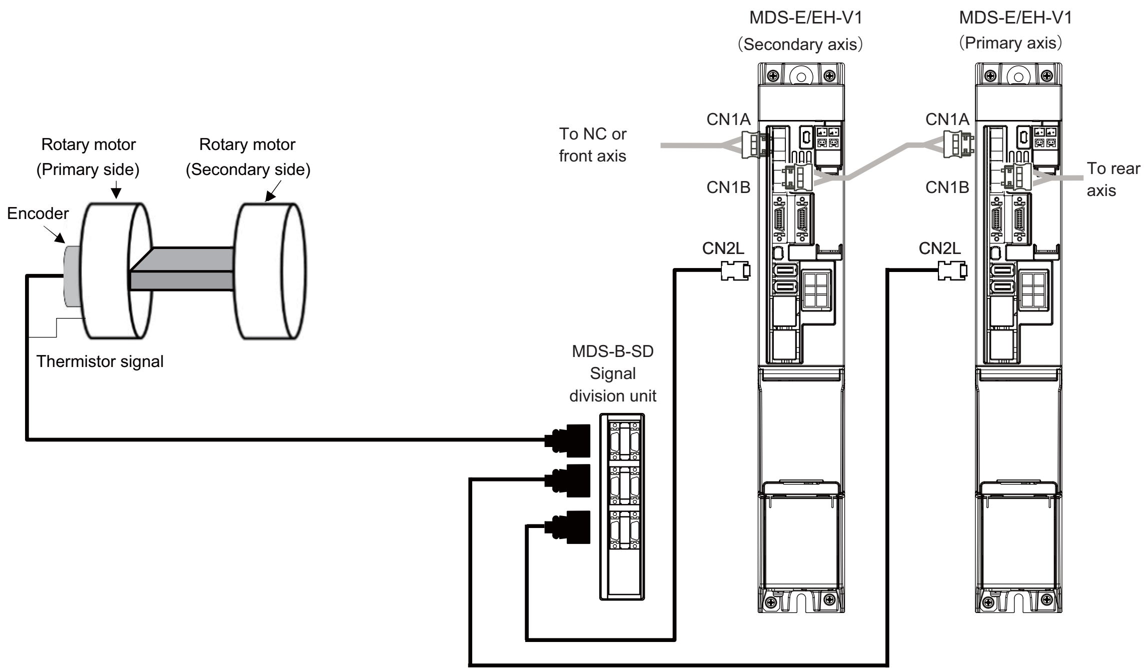


< Common encoder current command synchronous control system configuration >

< When using MDS-E/EH-V2/V3 >



< When using MDS-E/EH-V1 >



5.1.1 Dynamic Brake Unit (MDS-D-DBU)

The MDS-E-V1-320W and MDS-EH-V1-160W or larger units do not have dynamic brakes built in, so install an external dynamic brake unit.

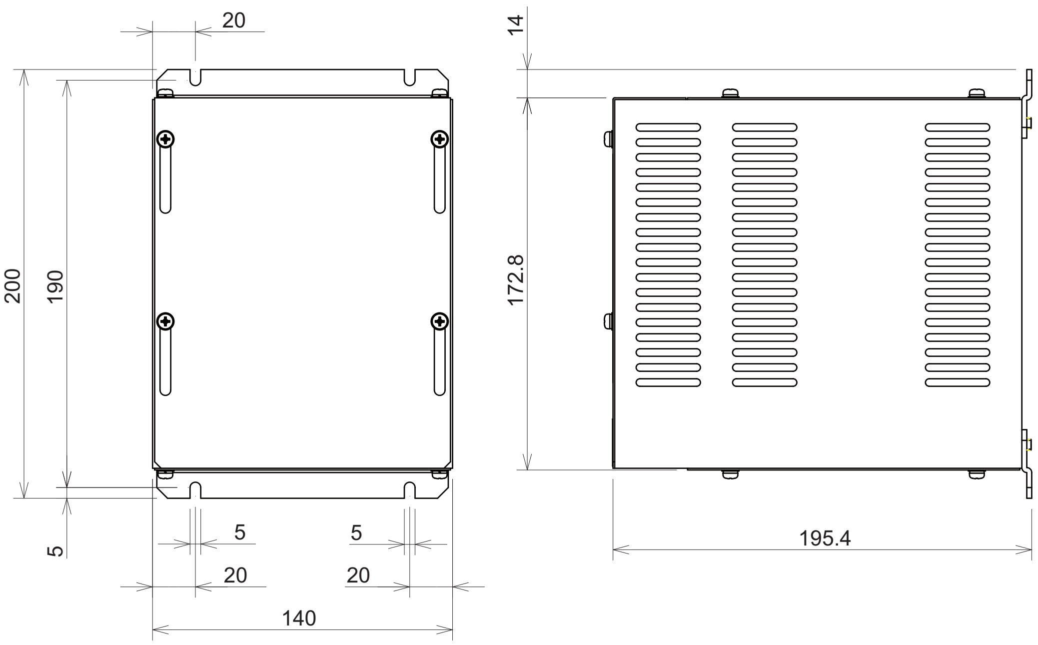
(1) Specifications

Type	Coil specifications	Wire size	Compatible drive unit	Mass (kg)
MDS-D-DBU	24VDC 160mA	$5.5mm^2$ or more (For IV wire)	MDS-E-V1-320W MDS-EH-V1-160W or larger	3kg

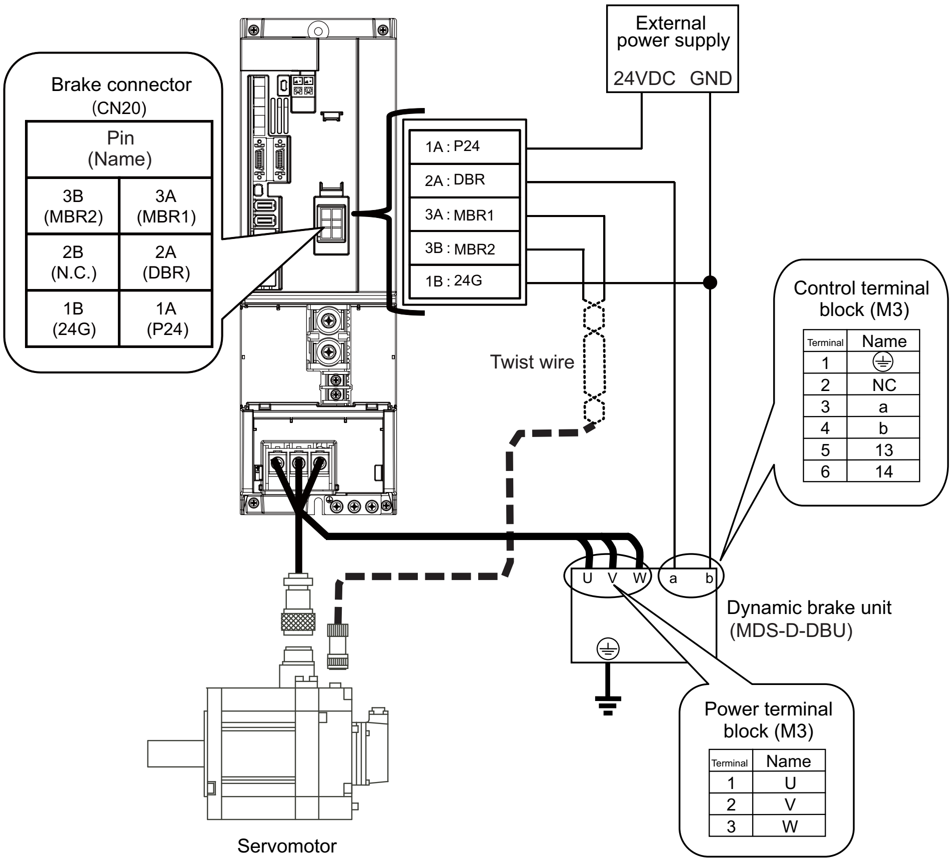
(2) Outline dimension drawings

MDS-D-DBU

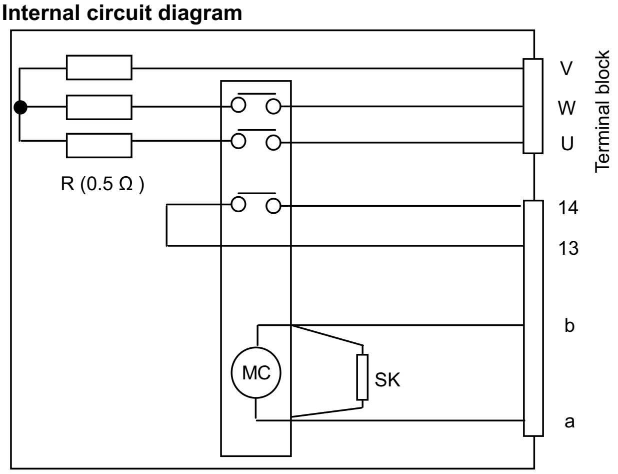
[Unit: mm]



(3) Connecting with the servo drive unit



Internal circuit diagram



⚠ CAUTION

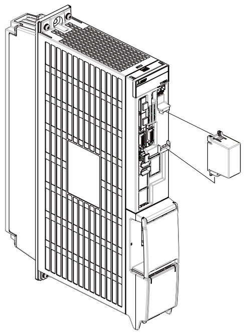
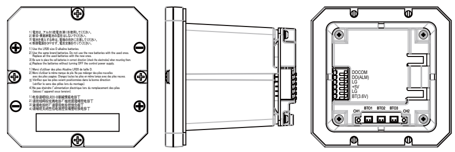
Correctly wire the dynamic brake unit to the servo drive unit.
Do not use for applications other than emergencies (normal braking, etc.). The internal resistor could heat up, and lead to fires or faults.

POINT

When you use a motor with a brake, please wire (between 1pin and 3pin) for the CN20 connector.

5.1.2 Battery Option (MDS-BAT6V1SET, MDSBTBOX-LR2060)

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

Type	MDS-BAT6V1SET	MDSBTBOX-LR2060
Installation type	Drive unit installation	Control panel installation
Hazard class	Not applicable	Not applicable
Number of connectable axes	Up to 3 axes	Up to 8 axes
Change method	Battery option change	Battery change
Appearance	(1) 	(2) 

⚠ CAUTION

1. When transporting lithium batteries with means such as by air transport, measures corresponding to the United Nations Dangerous Goods Regulations must be taken. (Refer to "Appendix 2 Restrictions for Lithium Batteries".)
2. The lithium battery must be transported according to the rules set forth by the International Civil Aviation Organization (ICAO), International Air Transportation Association (IATA), International Maritime Organization (IMO), and United States Department of Transportation (DOT), etc. The packaging methods,
   correct transportation methods, and special regulations are specified according to the quantity of lithium alloys. The battery unit exported from Mitsubishi is packaged in a container (UN approved part) satisfying the standards set forth in this UN Advisory.
3. To protect the absolute value, do not shut off the servo drive unit control power supply if the battery voltage becomes low (warning 9F).
4. The battery life (backup time) is greatly affected by the working ambient temperature. Generally, if the ambient temperature increases, the backup time and useful life will both decrease.

(1) Cell battery (MDS-BAT6V1SET)

(a) Specifications

Battery option type		Cell battery
		MDS-BAT6V1SET
Battery model name		2CR17335A
Nominal voltage		6V
Nominal capacity		1650mAh
Battery safety	Hazard class	Class9 Not applicable
	Battery shape	Set battery
	Number of batteries used	2
	Lithium alloy content	1.2g
	Mercury content	1ppm or less
Number of connectable axes (Note 1)		Up to 3 axes
Battery continuous backup time		Up to 2 axes: Approx. 10,000 hours 3 axes connected: Approx. 6,600 hours
Battery useful life (From date of unit manufacture)		5 years
Data save time in battery replacement		Approx. 20 hours at time of delivery, approx. 10 hours after 5 years
Back up time from battery warning to alarm occurrence (Note 2)		Up to 2 axes: Approx. 100 hours 3 axes connected: Approx. 60 hours
Mass		34g

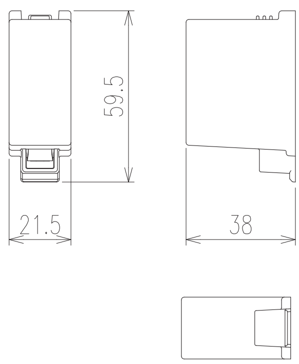
(Note 1) When using ball screw side encoder, both ball screw side encoder and motor side encoder need to be backed up by a battery, so the load becomes double.

(Note 2) This time is a guideline, so does not guarantee the back up time. Replace the battery with a new battery as soon as a battery warning occurs.

(Note 3) A battery load is generated in the axis for which the incremental control is set when a battery is connected.

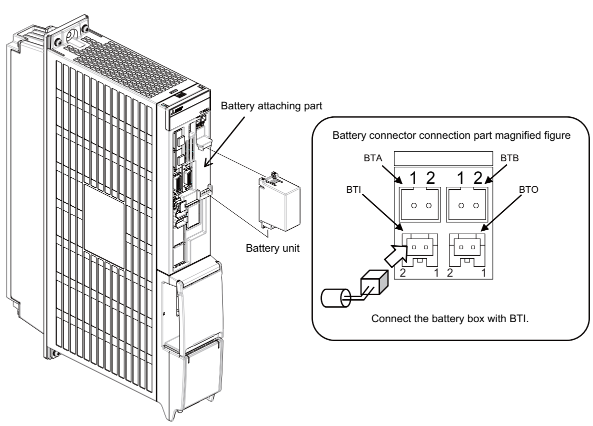
(b) Outline dimension drawings

[Unit: mm]



(c) Installing the cell battery

Connect the connector for the cell battery and install the battery case body to the upper front part of the servo drive unit.



(2) Battery box (MDSBTBOX-LR2060)

(a) Specifications

Battery option type	Battery box MDSBTBOX-LR2060
Battery model name (Note 1)	size-D alkaline batteries LR20 × 4 pieces
Nominal voltage (Note 2)	6.0V (Unit output: BTO1/2/3) 3.6V (Unit output: BT(3.6V))
Number of connectable axes (Note 3)	Up to 8 axes
Battery continuous backup time (Note 4)	Approx. 10000 hours (when 8 axes are connected, cumulative time in non-energized state)
Back up time from battery warning to alarm occurrence (Note 4)	Approx. 336 hours (when 8 axes are connected)

(Note 1) Install commercially-available alkaline dry batteries into MDSBTBOX-LR2060. The batteries should be procured by customers.
Make sure to use new batteries that have not passed the expiration date. We recommend you to replace the batteries in the one-year cycle.

(Note 2) 3.6V output is for old-type drive unit. It is not used for MDS-E/EH, EM/EMH, and EJ/EJH Series.

(Note 3) When using ball screw side encoder, both ball screw side encoder and motor side encoder need to be backed up by a battery, so the load becomes double.

(Note 4) This time is a guideline, so does not guarantee the back up time. Replace the battery with a new battery as soon as a battery warning (9F) occurs.

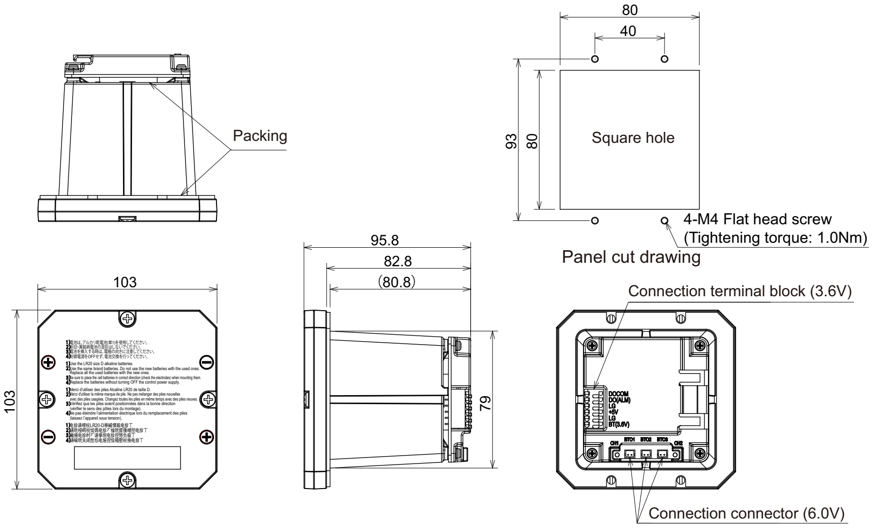
(Note 5) A battery load is generated in the axis for which the incremental control is set when a battery is connected.

(b) Explanation of connectors (BTO1/2/3)

		Name	Description
(1)	Power supply output for absolute position encoder backup	BTO	6V output for absolute position encoder backup
(2)		LG	Ground

(c) Outline dimension drawings

[Unit: mm]



POINT

As soon as the battery warning (9F) has occurred, replace the batteries with new ones.
Make sure to use new batteries that have not passed the expiration date. We recommend you to replace the batteries in the one-year cycle.

CAUTION

When installing the battery box on the panel, it may be damaged if the screw is tightened too much. Make sure the tightening torque of the screw.

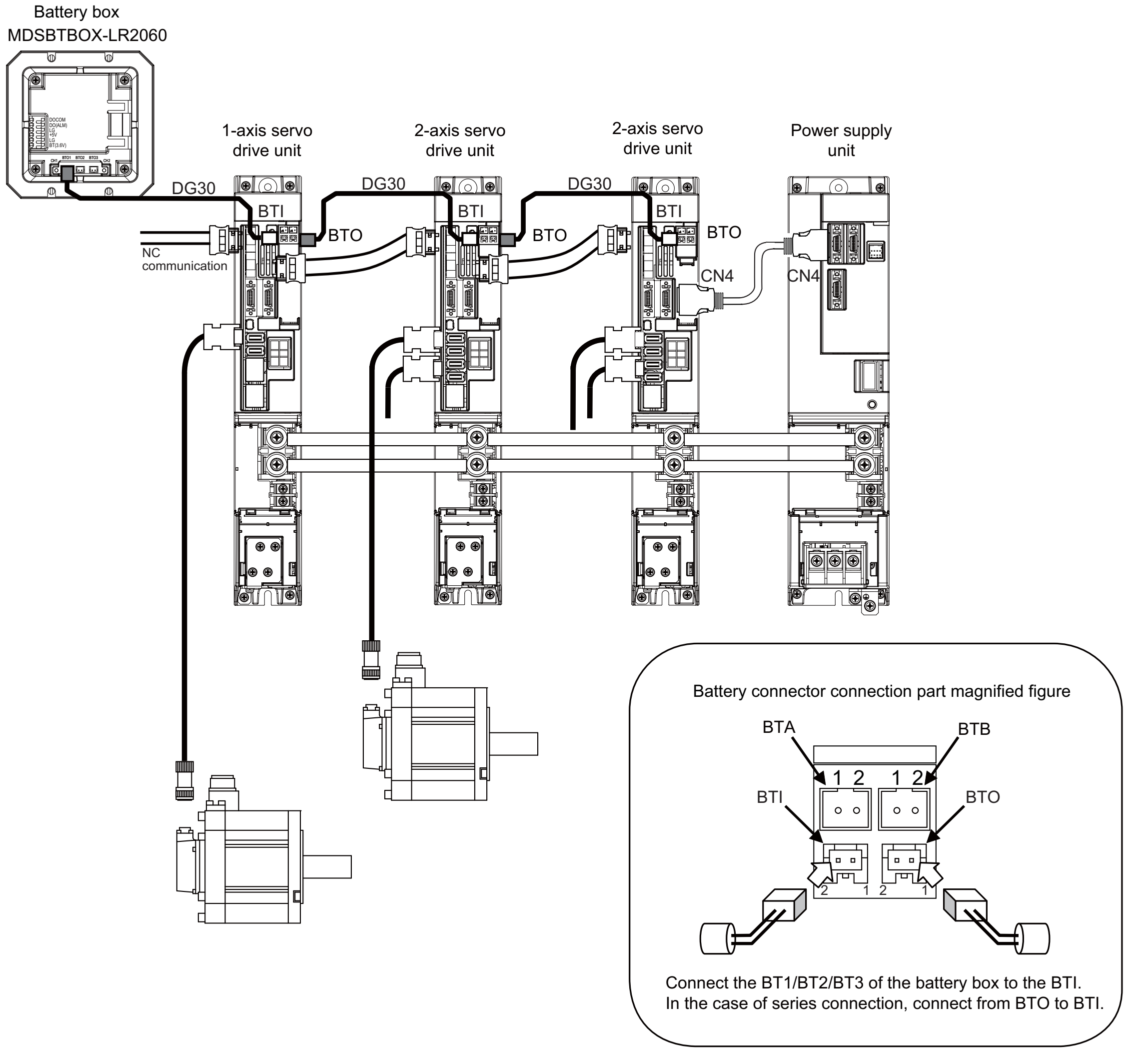
(d) When backing up for more than 8 axes

Add a MDSBTBOX-LR2060 so that the number of connectable axes for a battery unit is 8 axes or less.
For all of servo drive units supported by one MDSBTBOX-LR2060, start the control powers ON simultaneously.

CAUTION

1. The drive unit which is connected to the battery box and cell battery cannot be used together.
2. Replace the batteries with new ones without turning the control power of the drive unit OFF immediately after the battery voltage drop alarm (9F) has been detected.
3. Replace the batteries while applying the control power of all drive units which are connected to the battery box.

(e) System configuration



⚠ CAUTION

The total length of battery cable (from the battery unit to the last connected drive unit) must be 30m or less.

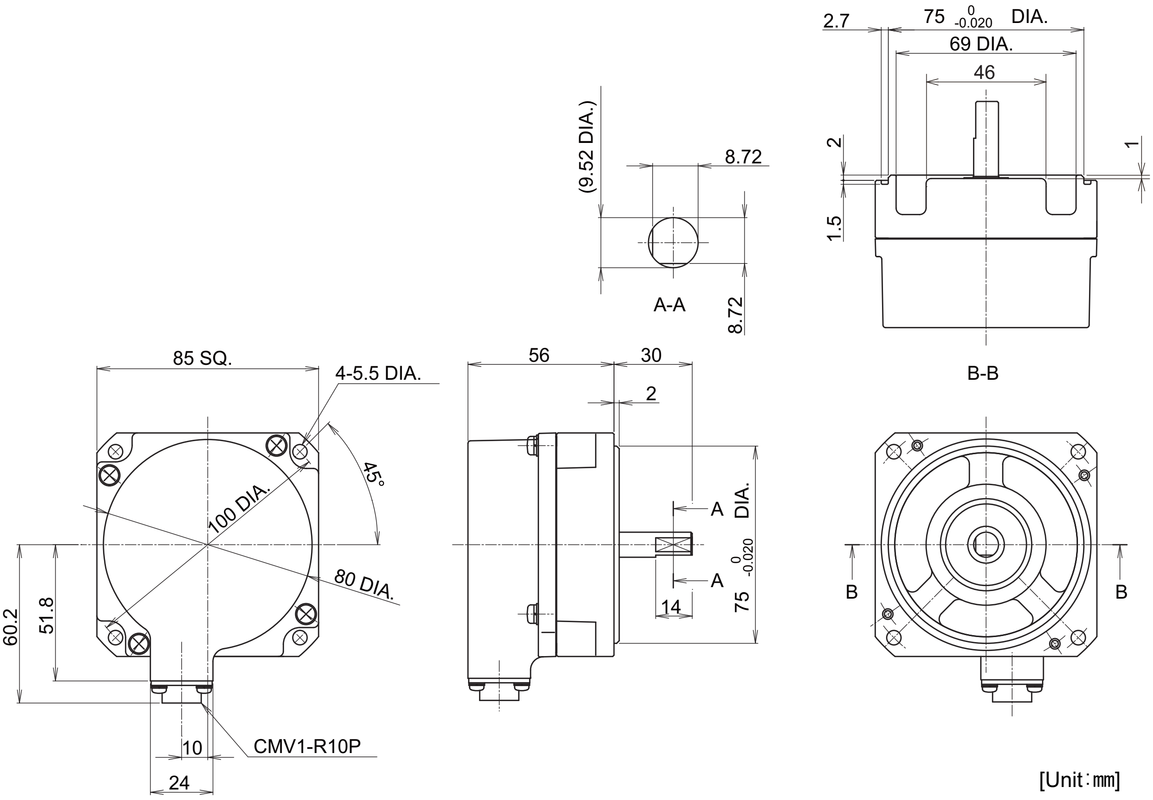
5.1.3 Ball Screw Side Encoder (OSA405ET2AS, OSA676ET2AS)

(1) Specifications

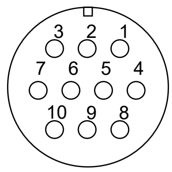
Encoder type		OSA405ET2AS	OSA676ET2AS
Electrical characteristics	Encoder resolution	4,194,304 pulse/rev	67,108,864 pulse/rev
	Detection method	Absolute position method (battery backup method)	
	Accuracy (*1)	±3 seconds	
	Tolerable rotation speed at power off (*2)	500r/min	
	Encoder output data	Serial data	
	Power consumption	0.3A	
Mechanical characteristics for rotation	Inertia	0.5×10^{-4}kgm^2 or less	
	Shaft friction torque	0.1Nm or less	
	Shaft angle acceleration	4×10^4rad/s^2 or less	
	Tolerable continuous rotation speed	4000r/min	
Mechanical configuration	Shaft amplitude (position 15mm from end)	0.02mm or less	
	Tolerable load (thrust direction/radial direction)	9.8N/19.6N	
	Mass	0.6kg	
	Degree of protection	IP67 (The shaft-through portion is excluded.)	
	Recommended coupling	Bellows coupling	
Working environment	Ambient temperature	0°C to +55°C	
	Storage temperature	-20°C to +85°C	
	Humidity	95%Ph	
	Vibration resistance	5 to 50Hz, total vibration width 1.5mm, each shaft for 30min	
	Impact resistance	490m/s^2 (50G)	

(*1) The values above are typical values after the calibration with our shipping test device and are not guaranteed.
(*2) If the tolerable rotation speed at power off is exceeded, the absolute position cannot be repaired.

(2) Outline dimension drawings
OSA405ET2AS / OSA676ET2AS



(3) Explanation of connectors



Connector pin layout

Pin	Function	Pin	Function
1	RQ	6	SD
2	RQ*	7	SD*
3	-	8	P5(+5V)
4	BAT	9	-
5	LG(GND)	10	SHD

5.1.4 Machine Side Encoder

(1) Relative position encoder

Depending on the output signal specifications, select a machine side relative position encoder with which the following (a), (b) or (c) is applied.

(a) Serial signal type (serial conversion unit made by each manufacture)

The following serial conversion unit converts the encoder output signal and transmits the signal to the drive unit in serial communication.

For details on the specifications of each conversion unit scale and for purchase, contact each corresponding manufacture directly.

Manufacturer	Encoder type	Interface unit type	Minimum detection resolution	Tolerable maximum speed
Magnescale Co., Ltd	SR67A SR75 SR85	Not required	0.1µm	200m/min
			0.05µm	
			0.01µm	
HEIDENHAIN CORPORATION	LS187, LS187C LS487, LS487C	EIB192M A4 20µm	0.0012µm	120m/min
		EIB392M A4 20µm		
	ERM280 1200	EIB192M C4 1200	0.0000183° (19,660,800p/rev)	20000r/min
		EIB392M C4 1200		
	ERM280 2048	EIB192M C6 2048	0.0000107° (33,554,432p/rev)	11718r/min
		EIB392M C6 2048		
GUBOA	MHS-04B Series	Not required	0.000343° (1,048,576p/rev)	Depending on the diameter of the gear (8000 to 40000r/min)

< Contact information about machine side encoder >

- Magnescale Co., Ltd.: http://www.mgscale.com/mgs/language/english/
- HEIDENHAIN CORPORATION: http://www.heidenhain.com/
- GUBOA Technology Co.: https://www.guboa.com/index/en/

⚠ CAUTION

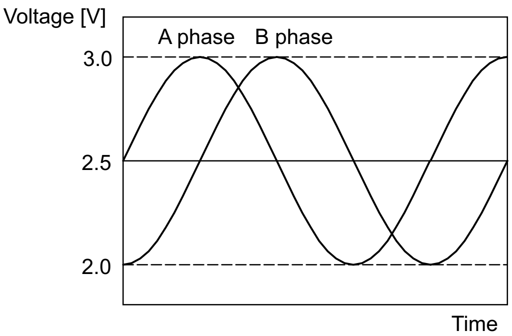
1. The above value does not guarantee the accuracy of the system.
2. The user shall prepare the above-mentioned detector after inquiring of each manufacturer about the specifications and confirm them.
3. When using an encoder not listed above, contact the manufacturer to make sure that the encoder is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

(b) SIN wave output (using MDS-EX-HR)

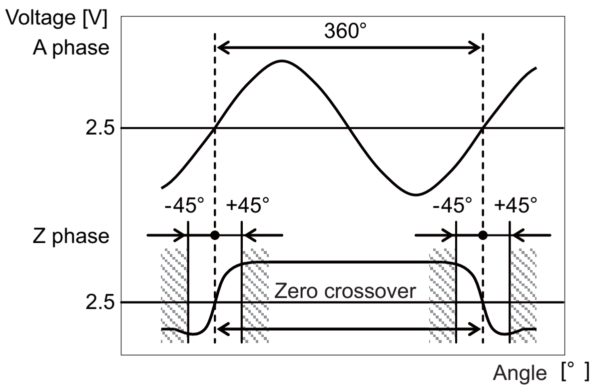
When using a relative position encoder that the signal is the SIN wave output, the encoder output signal is converted in the encoder conversion unit (MDS-EX-HR), and then the signal is transmitted to the drive unit in the serial communication. Select a relative position encoder with A/B phase SIN wave signal that satisfies the following conditions. For details on the specifications of MDS-EX-HR, refer to the section "MDS-EX-HR".

< Encoder output signal >

- 1Vp-p analog A-phase, B-phase, Z-phase differential output
- Output signal frequency 200kHz or less



A/B phase output signal waveform during forward run



Relationship between A phase and Z phase
(When the differential output waveform is measured)

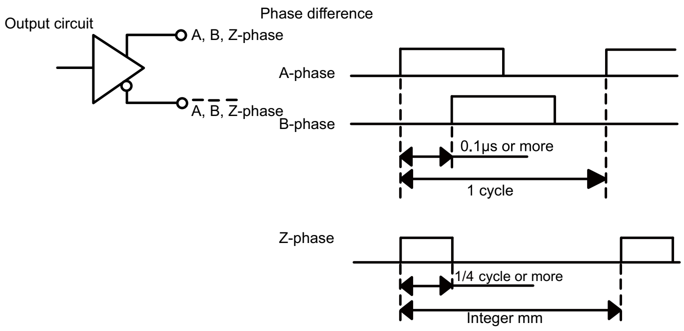
- Combination speed / rotation speed
  In use of linear scale:
  Maximum speed (m/min) = scale analog signal frequency (m) × 200,000 × 60
  In use of rotary encoder:
  Maximum rotation speed (r/min) = 200,000 / numbers of encoder scale (1/rev) × 60
  An actual Maximum speed/ rotary speed is limited by the mechanical specifications and electrical specifications, etc. of the connected scale, so contact the manufacture of the purchased scale.
- Division number 16384 divisions per 1 cycle of signal
  In use of linear scale:
  Minimum resolution (m) = scale analog signal frequency (m) / 16384
  In use of rotary encoder:
  Minimum resolution (pulse/rev) = numbers of encoder scale (1/rev) × 16384

⚠ CAUTION

The above value does not guarantee the accuracy of the system.

(c) Rectangular wave output

Select a relative position encoder with an A/B phase difference and Z-phase width at the maximum feedrate that satisfies the following conditions.
Use an A, B, Z-phase signal type with differential output (RS-422 standard product) for the output signal.



(Note 1) For a scale having multiple Z phases, select the neighboring Z phases whose distance is an integer multiple or 1/integer of the ball screw pitch.
(Note 2) The above value is minimum value that can be received normally in the servo drive unit side.
In an actual selection, ensure margin of 20% or more in consideration of degradation of electrical wave and speed overshoot.

< Example of scale specifications >

The example of using representative rectangular wave scale is shown below.
For specifications of each conversion unit and scale and for purchase, Contact each corresponding manufacture directly.

Manufacturer	Encoder type	Interface unit type	Minimum detection resolution	Tolerable maximum speed
Magnescale Co., Ltd	SR67A SR74 SR84	Not required	1.0μm	180m/min
			0.5μm	125m/min
			0.1μm	25m/min
			0.05μm	12m/min
HEIDENHAIN CORPORATION	LS187 LS487	IBV 101 (10 divisions)	0.5μm	120m/min
		IBV 102 (100divisions)	0.05μm	24m/min
		IBV 660B (400divisions)	0.0125μm	7.5m/min

< Contact information about machine side encoder >

- Magnescale Co., Ltd: http://www.mgscale.com/mgs/language/english/
- HEIDENHAIN CORPORATION: http://www.heidenhain.com/

(2) Absolute position encoder

The applicable absolute position encoders are as follows.

Manufacturer	Encoder type	Interface unit type	Minimum detection resolution	Tolerable maximum speed
Magnescale	SR67A SR77 SR87	Not required	0.1μm	200m/min
			0.05μm	
			0.01μm	
	RU77	Not required	0.0000429° (8,388,608p/rev)	2,000r/min
			0.0000107 (33,554,432p/rev)	2,000r/min
	RS87	Not required	0.0000429° (8,388,608p/rev)	4167r/min
HEIDENHAIN CORPORATION	LC195M LC495M	Not required	0.01μm	180m/min
			0.001μm	
	LC291M	Not required	0.01μm	180m/min
	LIC2197M	Not required	0.05μm/0.1μm	600m/min
	LIC2199M	Not required	0.05μm/0.1μm	600m/min
	MC15M	Not required	0.05μm	600m/min
	RCN2590M	Not required	0.0000013° (268,435,456p/rev)	1500r/min
	RCN5390M	Not required	0.0000054° (67,108,864p/rev)	1500r/min
	RCN5590M	Not required	0.0000013° (268,435,456p/rev)	1500r/min
	RCN8390M	Not required	0.0000007° (536,870,912p/rev)	500r/min
	ROC425M	Not required	0.0000107° (33,554,432p/rev)	15000r/min
	ROC2390M	Not required	0.0000054° (67,108,864p/rev)	3000r/min
	ECA4000 Series	Not required	0.0000027° (134,217,728p/rev)	2550 to 7000r/min
Mitutoyo Corporation	AT343	Not required	0.05μm	120m/min
	AT543	Not required	0.05μm	150m/min
	AT545	Not required	0.00488 (20/4096)μm	150m/min
	AT1143	Not required	0.05μm	180m/min
	ST748	Not required	0.1μm	300m/min
NIDEC MACHINE TOOL CORPORATION	MPRZ Series	ADB-K70M	0.000043° (8,388,608p/rev)	10,000r/min
FAGOR Automation	SAM Series	Not required	0.05μm	120m/min
	SVAM Series	Not required	0.05μm	120m/min
	GAM Series	Not required	0.05μm	120m/min
	G2AM Series	Not required	0.05μm	180m/min
	LAM Series	Not required	0.1μm	120m/min
	G3BM Series	Not required	0.01μm	180m/min
	HAM Series	Not required	0.0000429° (8,388,608p/rev)	6000r/min
			0.0000027° (134,217,728p/rev)	6000r/min
	H2AM Series	Not required	0.0000054° (67,108,864p/rev)	1500r/min

Manufacturer	Encoder type	Interface unit type	Minimum detection resolution	Tolerable maximum speed
Renishaw plc.	RL40N Series	Not required	0.05μm	6,000m/min
			0.001μm	
	RA Series	Not required	0.0000429° (8,388,608p/rev)	36000r/min
			0.0000027° (134,217,728p/rev)	36000r/min
	FORTiS Series	Not required	0.001μm	240m/min

< Contact information about machine side encoder >

- Magnescale Co., Ltd.: http://www.mgscale.com/mgs/language/english/
- HEIDENHAIN CORPORATION: http://www.heidenhain.com/
- Mitutoyo Corporation: http://www.mitutoyo.co.jp/eng/
- NIDEC MACHINE TOOL CORPORATION: http://www.nidec.com/en/nidec-machinetool/
- FAGOR Automation: http://www.fagorautomation.com/
- Renishaw plc.: http://www.renishaw.com/en/renishaw-enhancing-efficiency-in-manufacturing-and-healthcare--1030

⚠ CAUTION

Confirm the specifications of each encoder manufacturer before using machine side encoders made by other manufacturers.

5.2 Spindle Options

According to the spindle control to be adopted, select the spindle side encoder based on the following table.

(1) No-variable speed control
(When spindle and motor are directly coupled or coupled with a 1:1 gear ratio)

Spindle control item	Control specifications	Without spindle side encoder	With spindle side encoder
Spindle control	Normal cutting control	●	This normally is not used for no-variable speed control.
	Constant surface speed control (lathe)	●	
	Thread cutting (lathe)	●	
Orientation control	1-point orientation control	●	
	Multi-point orientation control	●	
	Orientation indexing	●	
Synchronous tap control	Standard synchronous tap	●	
	Synchronous tap after zero point return	●	
Spindle synchronous control	Without phase alignment function	●	
	With phase alignment function	●	
C-axis control	C-axis control	● (Note 2)	●

(Note 1) ●: Control possible
x : Control not possible
(Note 2) When spindle and motor are coupled with a 1:1 gear ratio, use of a spindle side encoder is recommended to assure the precision.

(2) Variable speed control
(When using V-belt, or when spindle and motor are connected with a gear ratio other than 1:1)

Spindle control item	Control specifications	Without spindle side encoder	With spindle side encoder		
			TS5690/ERM280/ GEL2449M/MHS-04B Series	OSE-1024	Proximity switch
Spindle control	Normal cutting control	●	●	●	●
	Constant surface speed control (lathe)	● (Note 2)	●	●	● (Note 2)
	Thread cutting (lathe)	x	●	●	x
Orientation control	1-point orientation control	x	●	●	● (Note 4)
	Multi-point orientation control	x	●	●	x
	Orientation indexing	x	●	●	x
Synchronous tap control	Standard synchronous tap	● (Note 3)	●	●	● (Note 3)
	Synchronous tap after zero point return	x	●	●	x
Spindle synchronous control	Without phase alignment function	● (Note 2)	●	●	● (Note 2)
	With phase alignment function	x	●	●	x
C-axis control	C-axis control	x	●	x	x

(Note 1) ● :Control possible
x :Control not possible
(Note 2) Control not possible when connected with the V-belt.
(Note 3) Control not possible when connected with other than the gears.
(Note 4) Orientation is carried out after the spindle is stopped when a proximity switch is used.
As for 2-axis spindle drive unit, setting is available only for one of the axes.

5.2.1 Spindle Side ABZ Pulse Output Encoder (OSE-1024 Series)

When a spindle and motor are connected with a V-belt, or connected with a gear ratio other than 1:1, use this spindle side encoder to detect the position and speed of the spindle. Also use this encoder when orientation control and synchronous tap control, etc are executed under the above conditions.

(1) Specifications

Encoder type		OSE-1024-3-15-68	OSE-1024-3-15-68-8
Mechanical characteristics for rotation	Inertia	0.1x10^{-4}kgm^2 or less	0.1x10^{-4}kgm^2 or less
	Shaft friction torque	0.98Nm or less	0.98Nm or less
	Shaft angle acceleration	10^{4}rad/s^2 or less	10^{4}rad/s^2 or less
	Tolerable continuous rotation speed	6000 r/min	8000 r/min
Mechanical configuration	Bearing maximum non-lubrication time	20000h/6000r/min	20000h/8000r/min
	Shaft run-out (position 15mm from end)	0.02mm or less	0.02mm or less
	Tolerable load (thrust direction/radial direction)	10kg/20kg Half of value during operation	10kg/20kg Half of value during operation
	Mass	1.5kg	1.5kg
	Degree of protection	IP54	
	Squareness of flange to shaft	0.05mm or less	
	Flange matching eccentricity	0.05mm or less	
Working environment	Ambient temperature range	-5°C to +55°C	
	Storage temperature range	-20°C to +85°C	
	Humidity	95%Ph	
	Vibration resistance	5 to 50Hz, total vibration width 1.5mm, each shaft for 30min.	
	Impact resistance	294.20m/s^2 (30G)	

(2) Detection signals

Signal name	Number of detection pulses
A, B phase	1024p/rev
Z phase	1p/rev

Connector pin layout

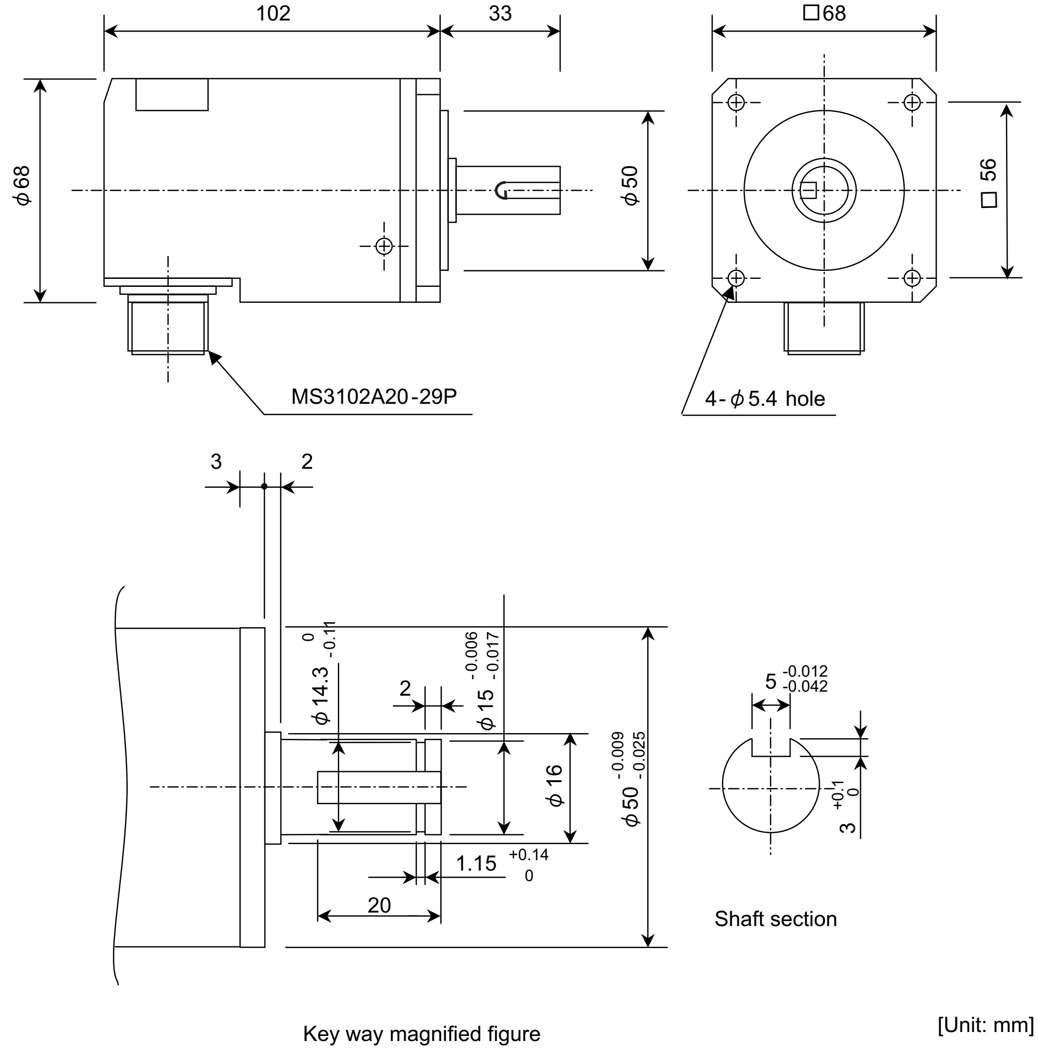
Pin	Function	Pin	Function
A	A+ signal	K	0V
B	Z+ signal	L	-
C	B+ signal	M	-
D	-	N	A- signal
E	Case grounding	P	Z- signal
F	-	R	B- signal
G	-	S	-
H	+5V	T	-
J	-		

⚠ CAUTION

Cautions for connecting the spindle end with an OSE-1024 encoder

1. Confirm that the gear ratio (pulley ratio) of the spindle end to the encoder is 1:1.
2. Use a timing belt when connecting by a belt.

(3) Outline dimension drawings



Spindle side encoder (OSE-1024-3-15-68, OSE-1024-3-15-68-8)

5.2.2 Spindle Side PLG Serial Output Encoder (TS5690, MU1606 Series)

This encoder is used when a more accurate synchronous tapping control or C-axis control than OSE encoder is performed to the spindle which is not directly-connected to the spindle motor.

(1) Type configuration

< Sensor type >

TS5690N (1) (2) (3)

(1)

Symbol	The number of compatible detection gear teeth
64	64
90	90
12	128
19	192
25	256

(2)

Symbol	Length of the cable
1	400mm
2	800mm
3	1200mm
4	1600mm
5	2000mm

(3)

Symbol	Lead-out direction	Conncector specifications
2	Vertical direction	Standard
7	Shaft direction	Standard
8	Shaft direction	Waterproof
9	Vertical direction	Waterproof

< Detection gear type >

MU1606N (1) (2)

(1)

Symbol	The number of detection gear teeth
6	64
9	90
7	128
2	192
8	256

(2) Each specification number

(2) Specifications

Sensor	**Series type**		**TS5690N64xx**									
	xx (The end of the type name)	**Standard connector**	12	22	32	42	52	17	27	37	47	57
		Waterproof connector	19	29	39	49	59	18	28	38	48	58
	Length of lead [mm]		400±10	800±20	1200±20	1600±30	2000±30	400±10	800±20	1200±20	1600±30	2000±30
	Lead-out direction of lead		Vertical direction					Axis direction				
Detection gear	**Type**		**MU1606N601**									
	The number of teeth		64									
	Outer diameter [mm]		Φ52.8									
	Inner diameter [mm]		Φ40H5									
	Thickness [mm]		12									
Notched fitting section	**Outer diameter [mm]**		Φ59.4									
	Outer diameter tolerance [mm]		-0.070 to -0.030									
The number of output pulse	**A/B phase**		64									
	Z phase		1									
Detection resolution [p/rev]			2 million									
Absolute accuracy at stop			150"									
Tolerable speed [r/min]			40,000									
Signal output			Mitsubishi high-speed serial									

Sensor	**Series type**		**TS5690N90xx**									
	xx (The end of the type name)	**Standard connector**	12	22	32	42	52	17	27	37	47	57
		Waterproof connector	19	29	39	49	59	18	28	38	48	58
	Length of lead [mm]		400±10	800±20	1200±20	1600±30	2000±30	400±10	800±20	1200±20	1600±30	2000±30
	Lead-out direction of lead		Vertical direction					Axis direction				
Detection gear	**Type**		**MU1606N906**									
	The number of teeth		90									
	Outer diameter [mm]		Φ73.6									
	Inner diameter [mm]		Φ60H5									
	Thickness [mm]		12									
Notched fitting section	**Outer diameter [mm]**		Φ79.2									
	Outer diameter tolerance [mm]		-0.040 to 0									
The number of output pulse	**A/B phase**		90									
	Z phase		1									
Detection resolution [p/rev]			2.88 million									
Absolute accuracy at stop			105"									
Tolerable speed [r/min]			30,000									
Signal output			Mitsubishi high-speed serial									

Sensor	**Series type**		**TS5690N12xx**									
	xx (The end of the type name)	**Standard connector**	12	22	32	42	52	17	27	37	47	57
		Waterproof connector	19	29	39	49	59	18	28	38	48	58
	Length of lead [mm]		400±10	800±20	1200±20	1600±30	2000±30	400±10	800±20	1200±20	1600±30	2000±30
	Lead-out direction of lead		Vertical direction					Axis direction				
Detection gear	**Type**		**MU1606N709**									
	The number of teeth		128									
	Outer diameter [mm]		Φ104.0									
	Inner diameter [mm]		Φ80H5									
	Thickness [mm]		12									
Notched fitting section	**Outer diameter [mm]**		Φ108.8									
	Outer diameter tolerance [mm]		-0.015 to +0.025									
The number of output pulse	**A/B phase**		128									
	Z phase		1									
Detection resolution [p/rev]			4 million									
Absolute accuracy at stop			100"									
Tolerable speed [r/min]			20,000									
Signal output			Mitsubishi high-speed serial									

Sensor	Series type		TS5690N19xx									
	xx (The end of the type name)	Standard connector	12	22	32	42	52	17	27	37	47	57
		Waterproof connector	19	29	39	49	59	18	28	38	48	58
	Length of lead [mm]		400±10	800±20	1200±20	1600±30	2000±30	400±10	800±20	1200±20	1600±30	2000±30
	Lead-out direction of lead		Vertical direction					Axis direction				
Detection gear	Type		MU1606N203									
	The number of teeth		192									
	Outer diameter [mm]		Φ155.2									
	Inner diameter [mm]		Φ125H5									
	Thickness [mm]		12									
Notched fitting section	Outer diameter [mm]		Φ159.4									
	Outer diameter tolerance [mm]		-0.035 to +0.005									
The number of output pulse	A/B phase		192									
	Z phase		1									
Detection resolution [p/rev]			6 million									
Absolute accuracy at stop			97.5"									
Tolerable speed [r/min]			15,000									
Signal output			Mitsubishi high-speed serial									

Sensor	Series type		TS5690N25xx									
	xx (The end of the type name)	Standard connector	12	22	32	42	52	17	27	37	47	57
		Waterproof connector	19	29	39	49	59	18	28	38	48	58
	Length of lead [mm]		400±10	800±20	1200±20	1600±30	2000±30	400±10	800±20	1200±20	1600±30	2000±30
	Lead-out direction of lead		Vertical direction					Axis direction				
Detection gear	Type		MU1606N802									
	The number of teeth		256									
	Outer diameter [mm]		Φ206.4									
	Inner diameter [mm]		Φ160									
	Thickness [mm]		15.8									
Notched fitting section	Outer diameter [mm]		Φ210.2									
	Outer diameter tolerance [mm]		0.0 to +0.040									
The number of output pulse	A/B phase		256									
	Z phase		1									
Detection resolution [p/rev]			8 million									
Absolute accuracy at stop			95"									
Tolerable speed [r/min]			10,000									
Signal output			Mitsubishi high-speed serial									

⚠ CAUTION

1.Selected encoders must be able to tolerate the maximum rotation speed of the spindle.

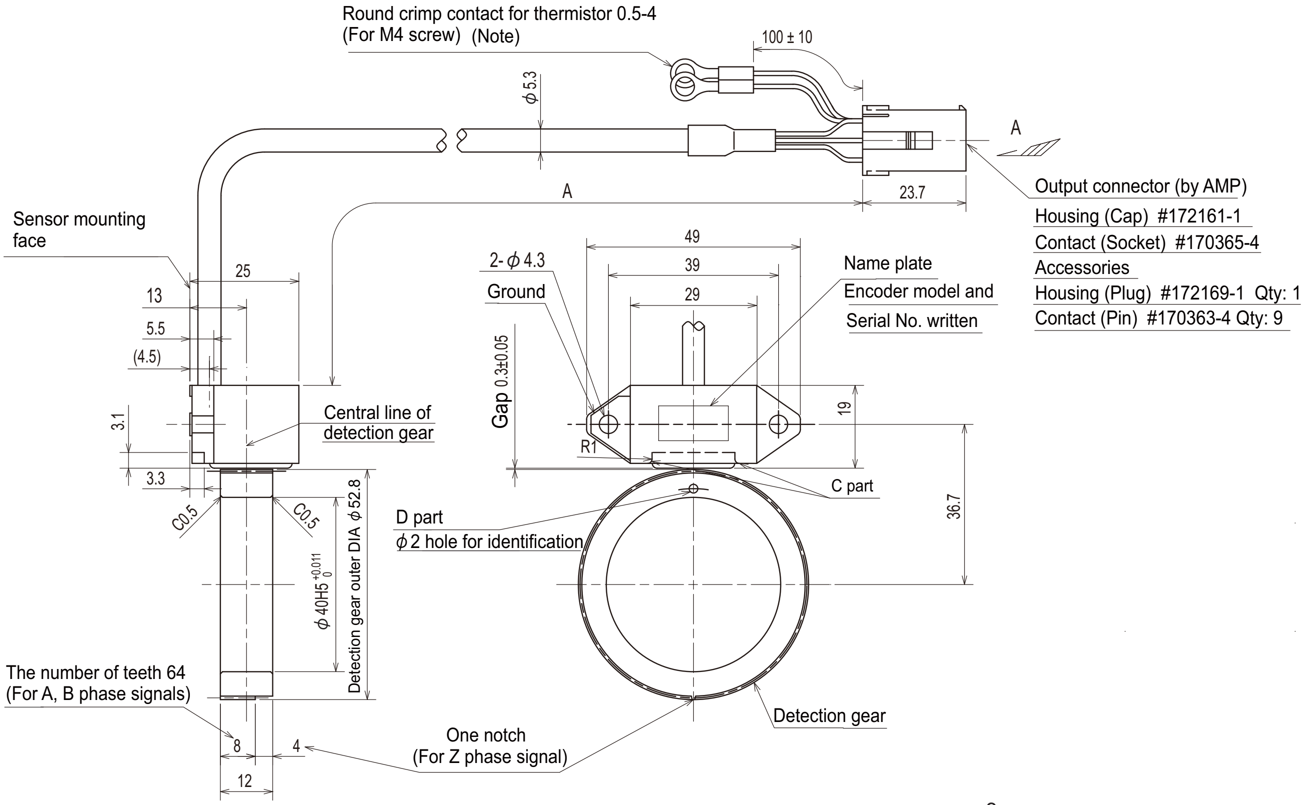
2.Please contact your Mitsubishi Electric dealer for the special products not listed above.

(3) Outline dimension drawings

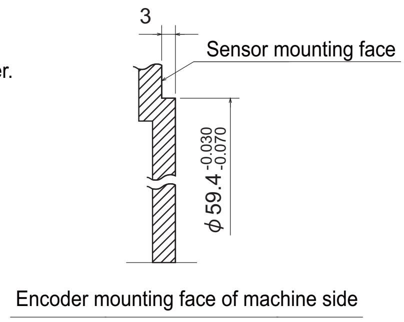
> ⚠ **CAUTION**
>
> Always apply the notched fitting section machining with the specified dimensions to the sensor installation surface.

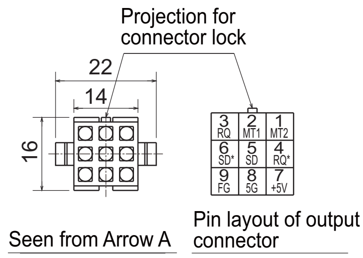
< TS5690N64x2 + MU1606N601 >

[Unit: mm]



(Note) The thermistor contact is not used when the encoder is used as a spindle side encoder.
Insulate the terminal.

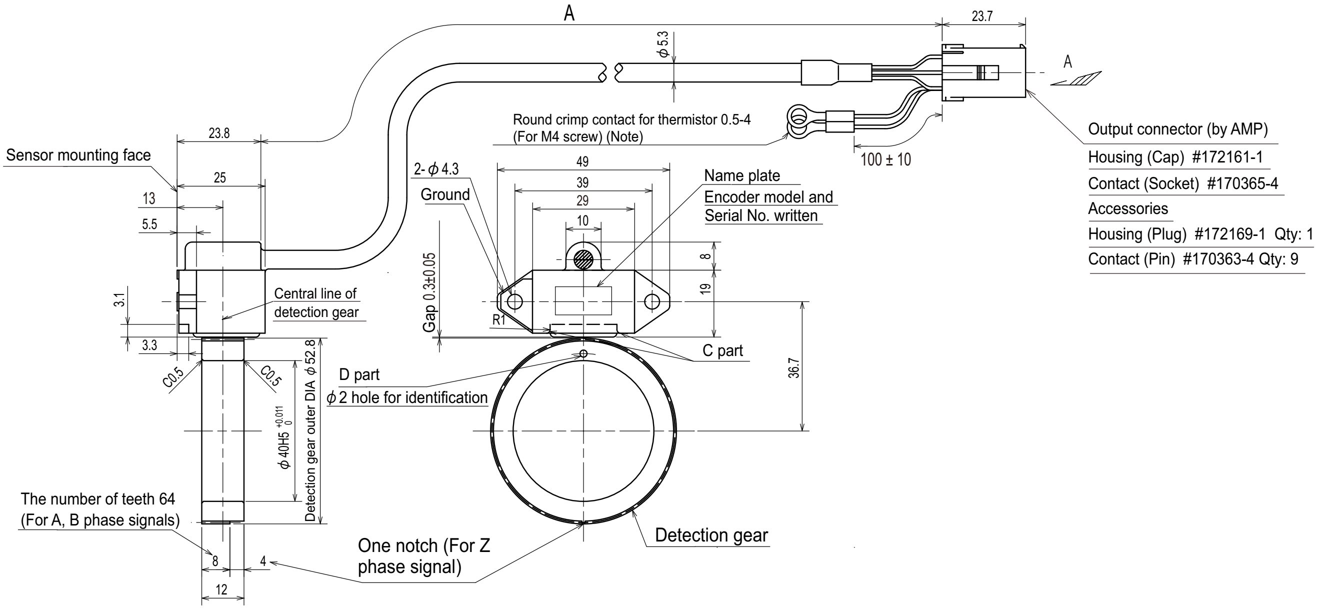




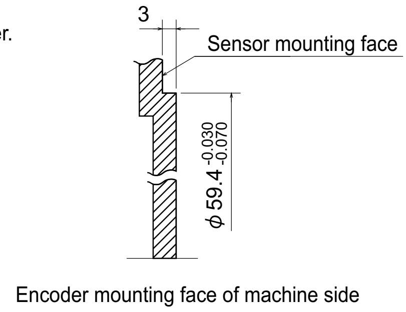
Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N6412	400±10	Vertical direction	MU1606N601
TS5690N6422	800±20		
TS5690N6432	1200±20		
TS5690N6442	1600±30		
TS5690N6452	2000±30		

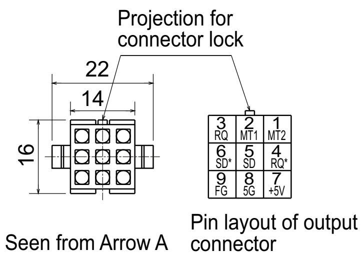
< TS5690N64x7 + MU1606N601 >

[Unit: mm]



(Note) The thermistor contact is not used when the encoder is used as a spindle side encoder.
Insulate the terminal.

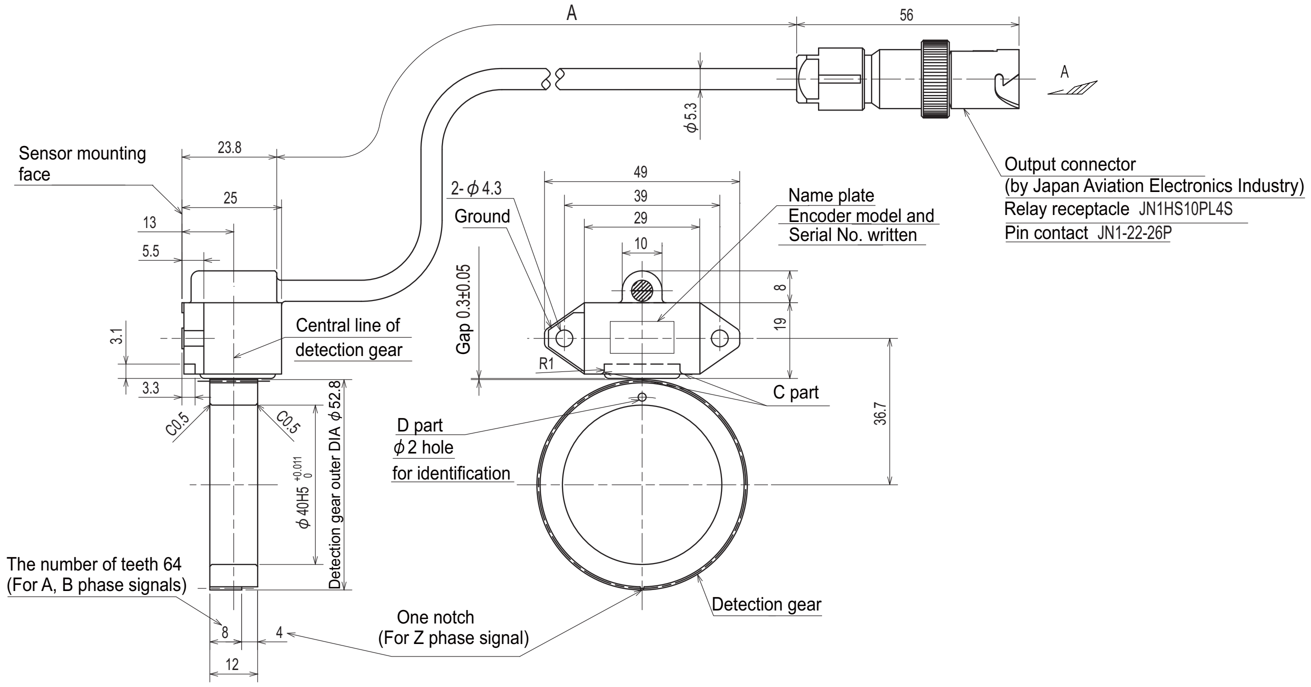


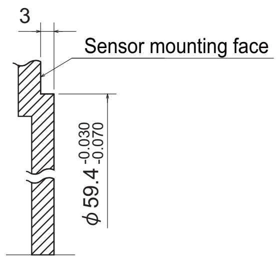


Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N6417	400±10	Axis direction	MU1606N601
TS5690N6427	800±20		
TS5690N6437	1200±20		
TS5690N6447	1600±30		
TS5690N6457	2000±30		

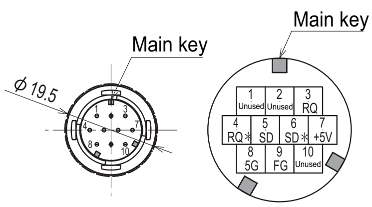
< TS5690N64x8 + MU1606N601 >

[Unit: mm]





Encoder mounting face of machine side



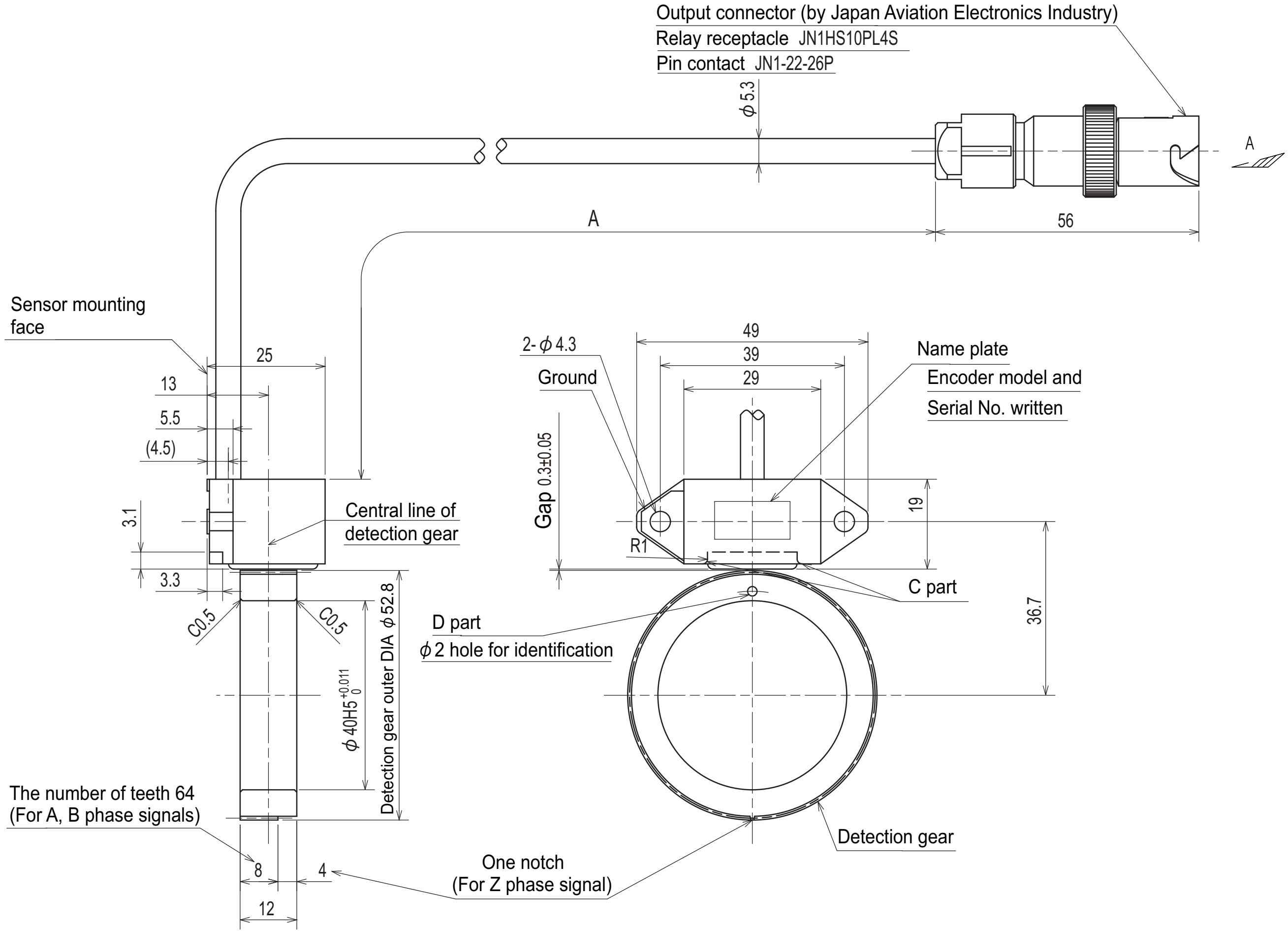
Seen from Arrow A

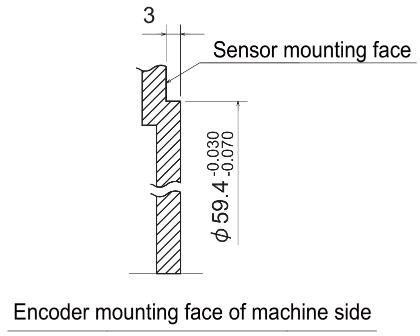
Pin layout of output connector

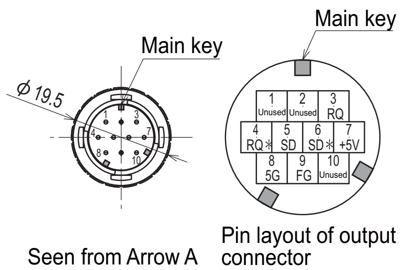
Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N6418	400±10	Axis direction	MU1606N601
TS5690N6428	800±20		
TS5690N6438	1200±20		
TS5690N6448	1600±30		
TS5690N6458	2000±30		

< TS5690N64x9 + MU1606N601 >

[Unit: mm]



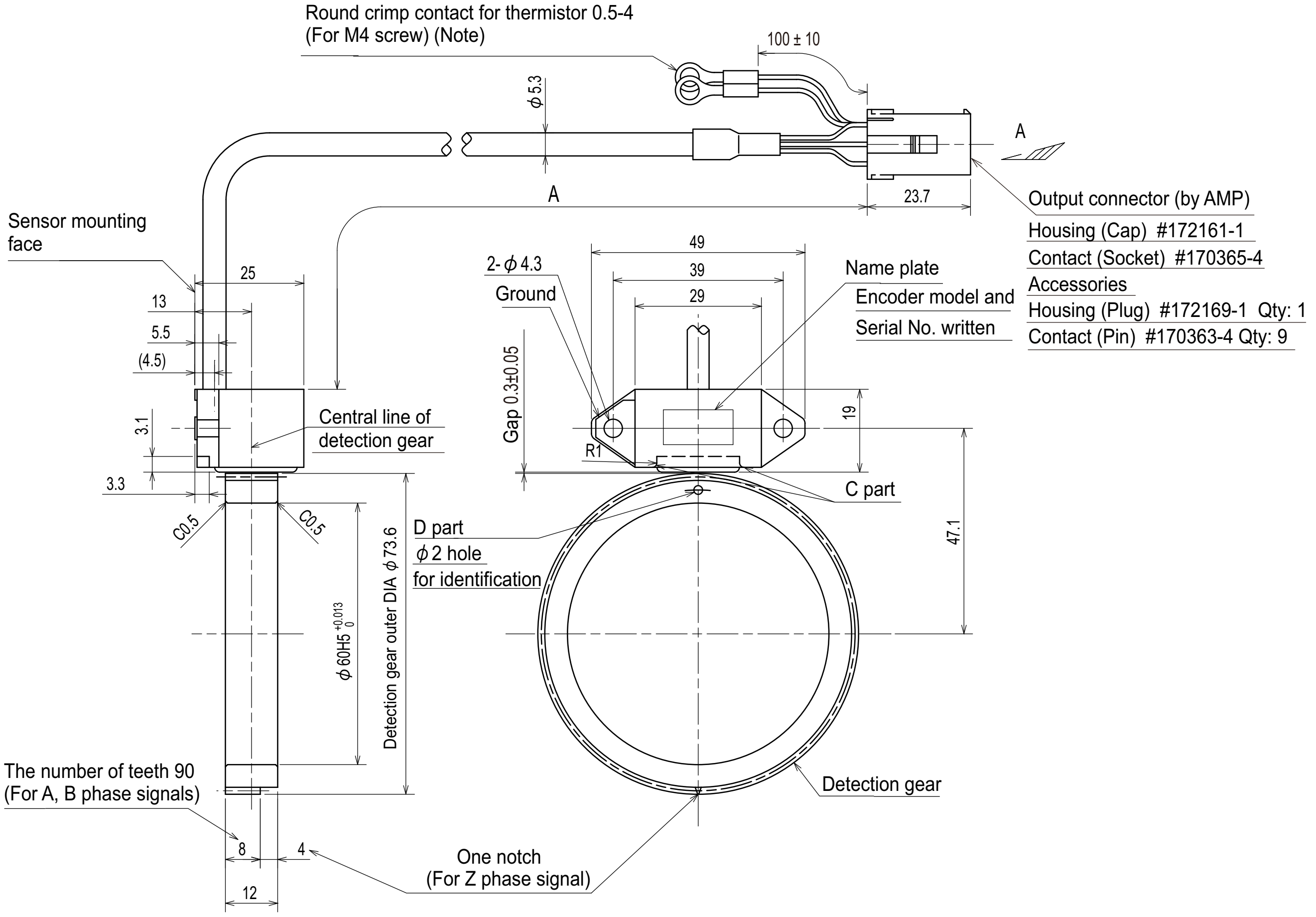




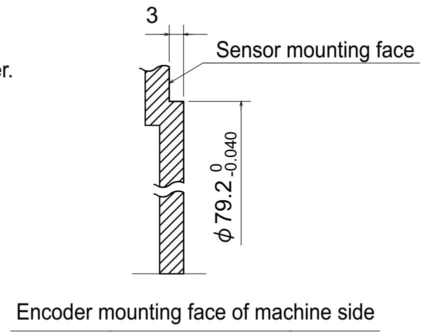
Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N6419	400±10	Vertical direction	MU1606N601
TS5690N6429	800±20		
TS5690N6439	1200±20		
TS5690N6449	1600±30		
TS5690N6459	2000±30		

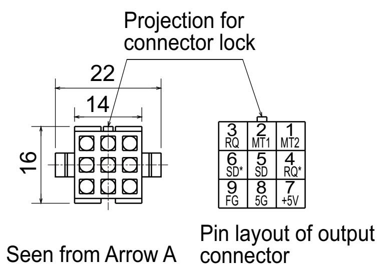
< TS5690N90x2 + MU1606N906 >

[Unit: mm]



(Note) The thermistor contact is not used when the encoder is used as a spindle side encoder.
Insulate the terminal.

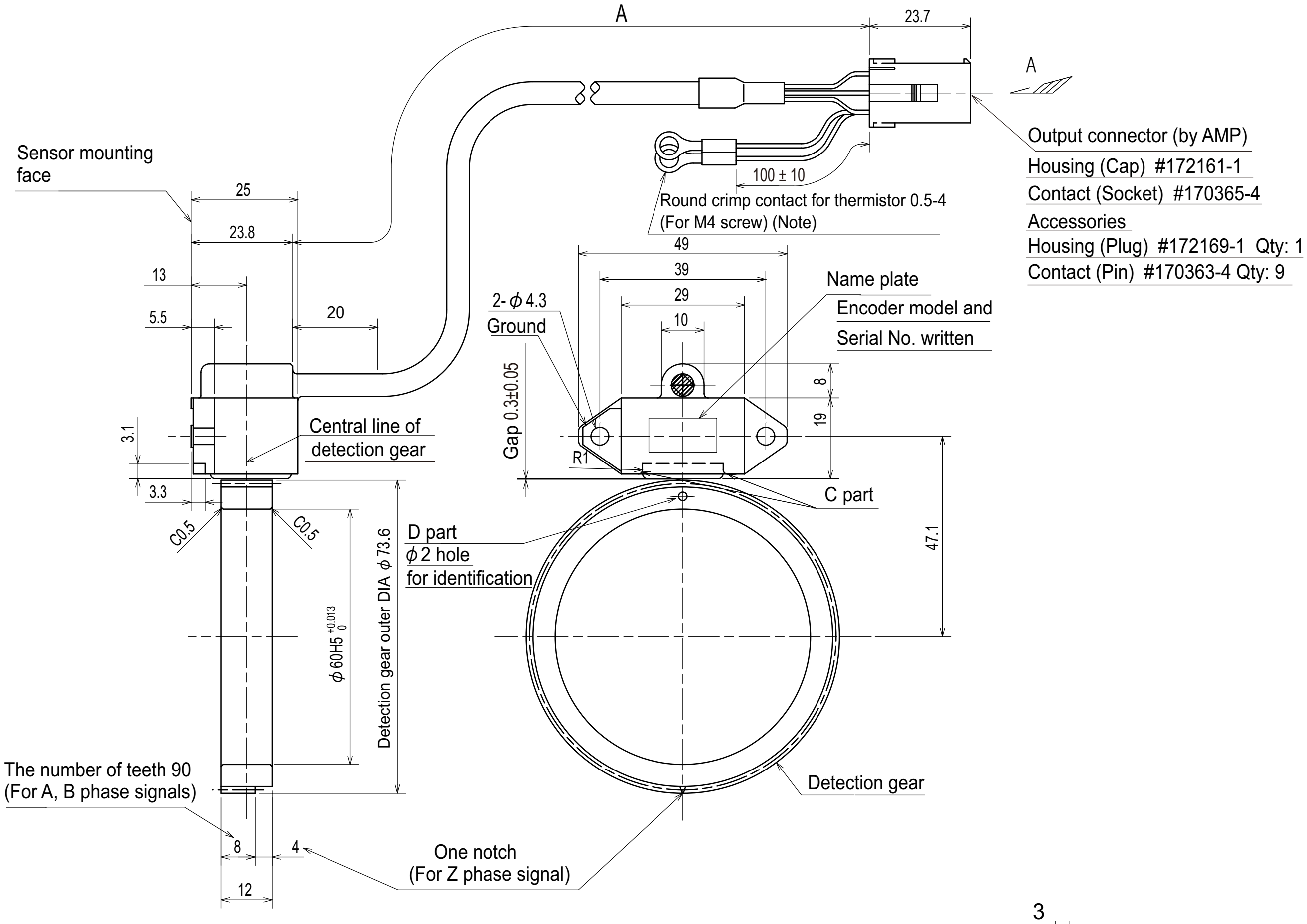




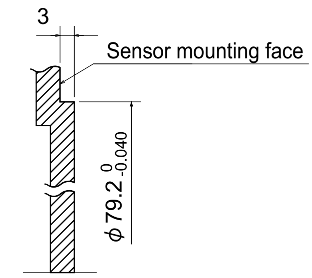
Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N9012	400±10	Vertical direction	MU1606N906
TS5690N9022	800±20		
TS5690N9032	1200±20		
TS5690N9042	1600±30		
TS5690N9052	2000±30		

< TS5690N90x7 + MU1606N906 >

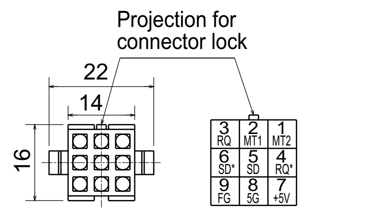
[Unit: mm]



(Note) The thermistor contact is not used when the encoder is used as a spindle side encoder.
Insulate the terminal.



Encoder mounting face of machine side



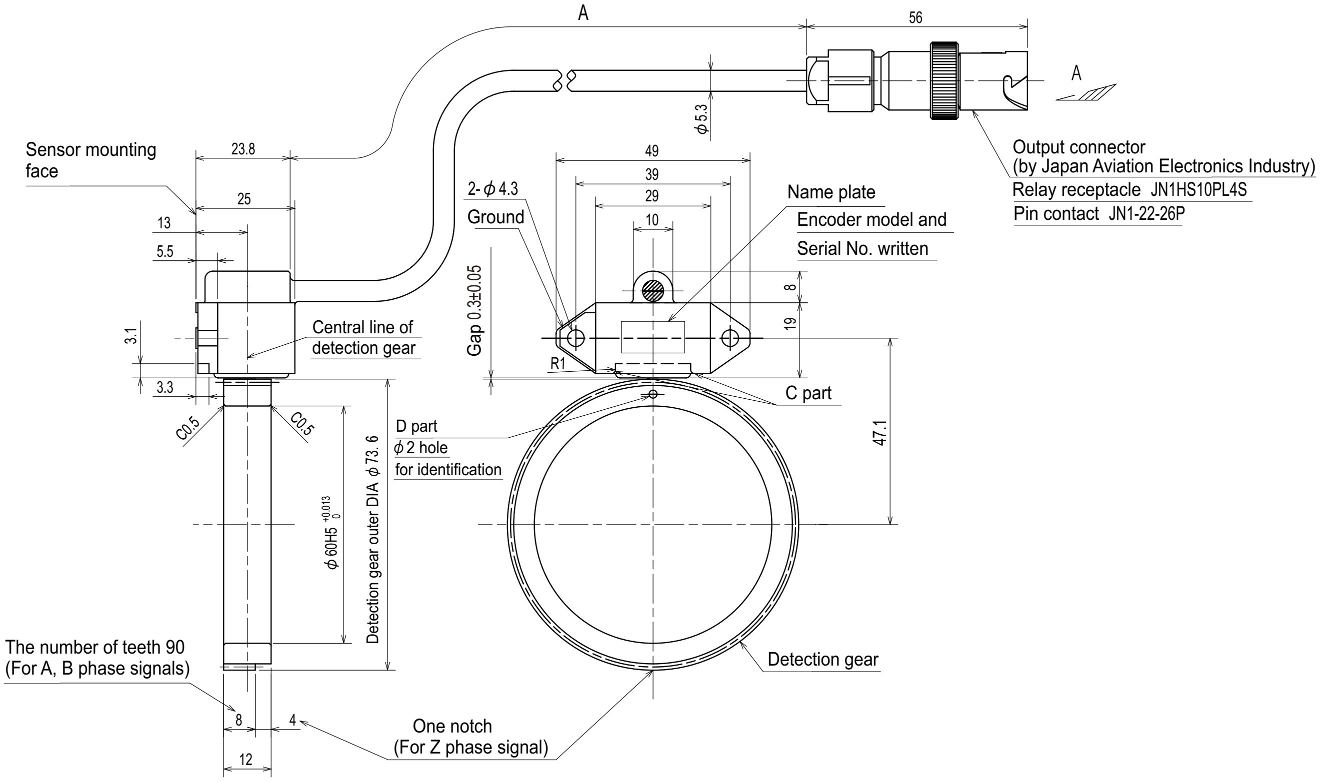
Seen from Arrow A

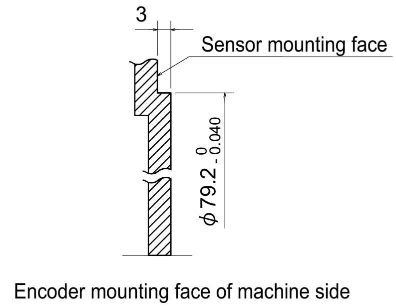
Pin layout of output connector

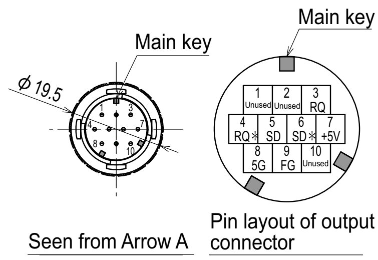
Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N9017	400±10	Axis direction	MU1606N906
TS5690N9027	800±20		
TS5690N9037	1200±20		
TS5690N9047	1600±30		
TS5690N9057	2000±30		

< TS5690N90x8 + MU1606N906 >

[Unit: mm]



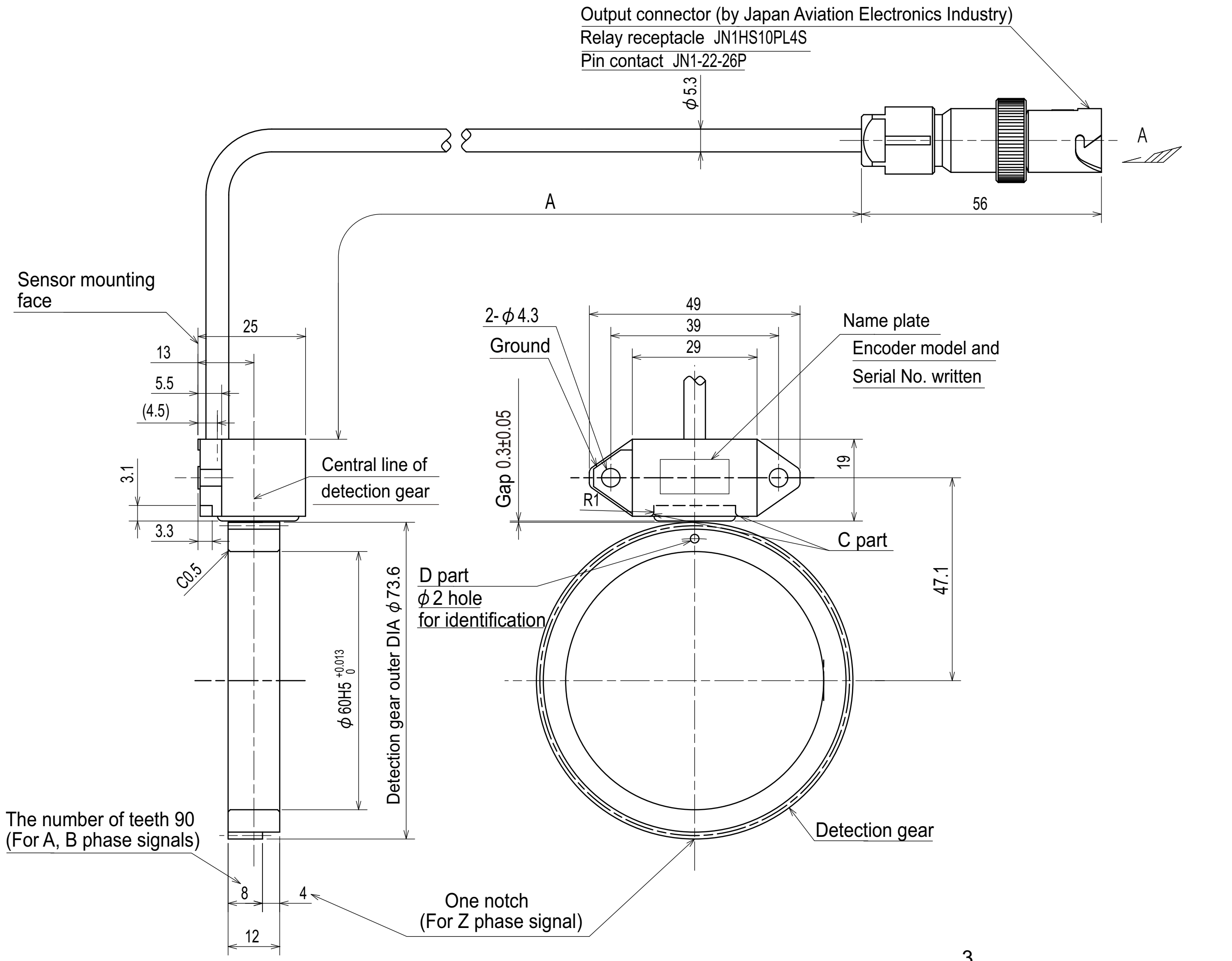


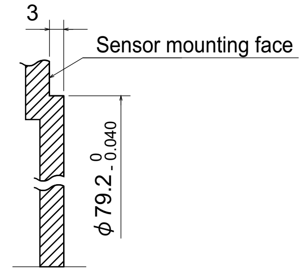


Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N9018	400±10	Axis direction	MU1606N906
TS5690N9028	800±20		
TS5690N9038	1200±20		
TS5690N9048	1600±30		
TS5690N9058	2000±30		

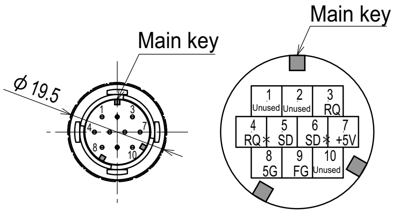
< TS5690N90x9 + MU1606N906 >

[Unit: mm]





Encoder mounting face of machine side



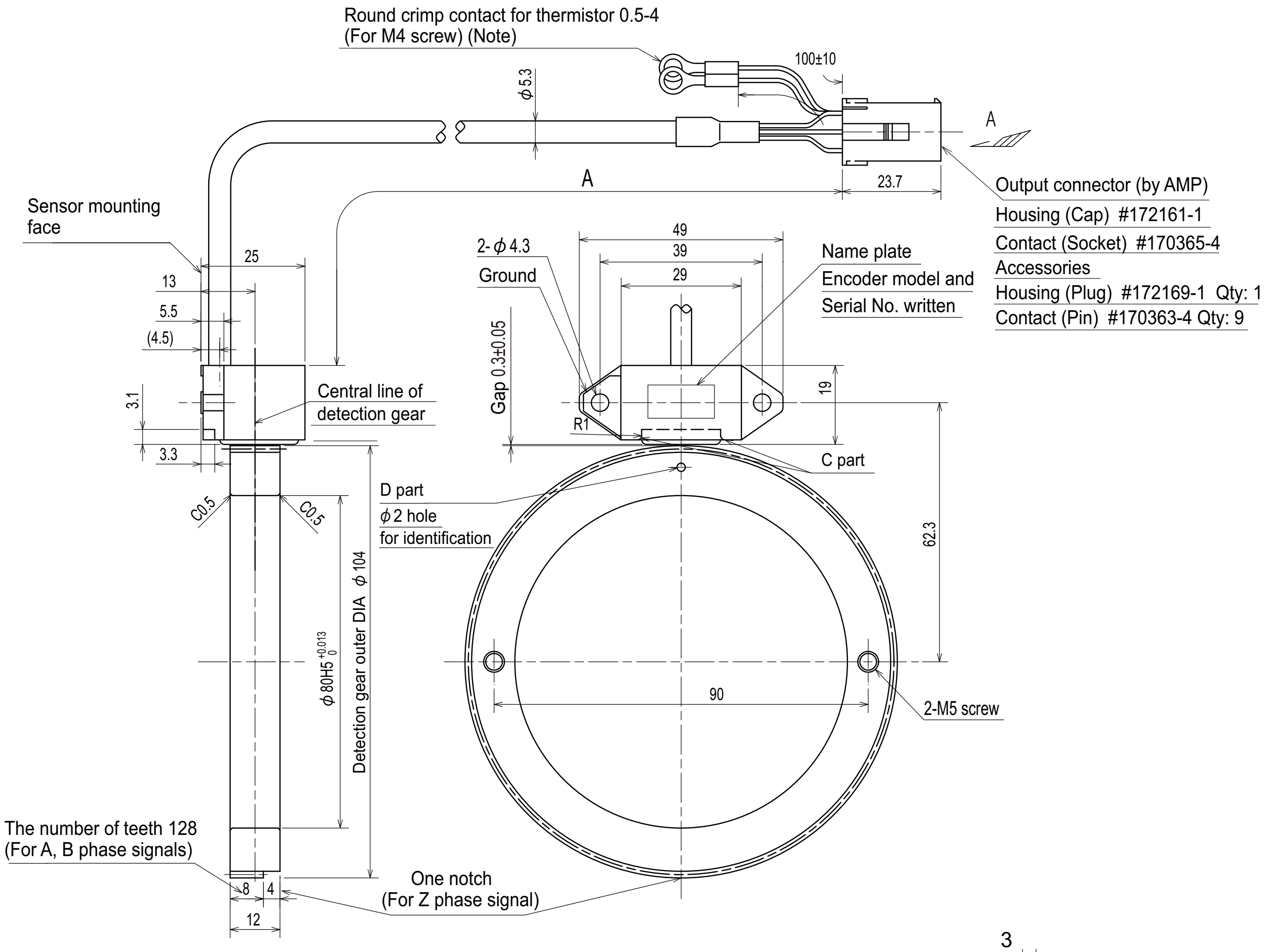
Seen from Arrow A

Pin layout of output connector

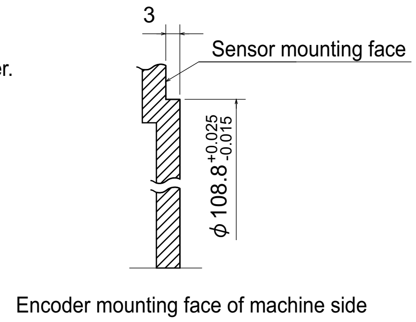
Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N9019	400±10	Vertical direction	MU1606N906
TS5690N9029	800±20		
TS5690N9039	1200±20		
TS5690N9049	1600±30		
TS5690N9059	2000±30		

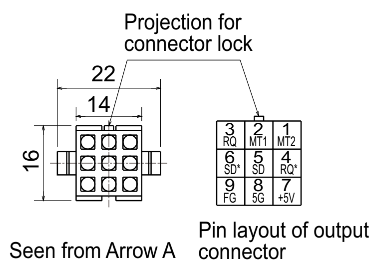
< TS5690N12x2 + MU1606N709 >

[Unit: mm]



(Note) The thermistor contact is not used when the encoder is used as a spindle side encoder.
Insulate the terminal.

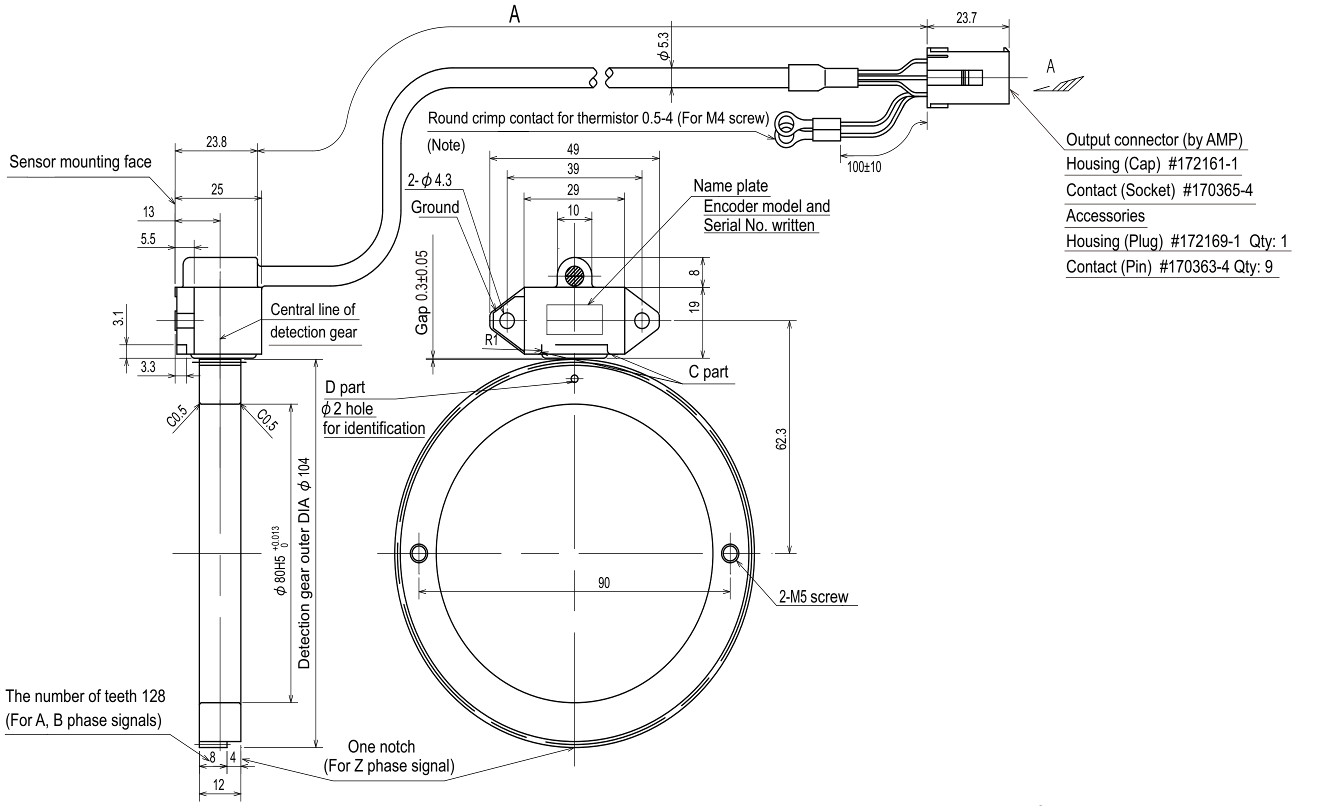




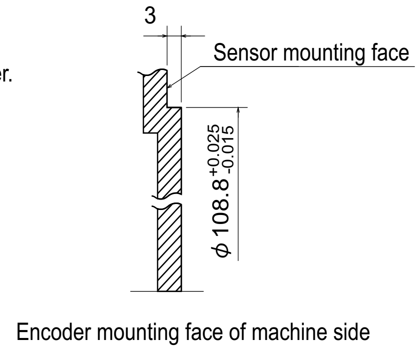
Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N1212	400±10	Vertical direction	MU1606N709
TS5690N1222	800±20		
TS5690N1232	1200±20		
TS5690N1242	1600±30		
TS5690N1252	2000±30		

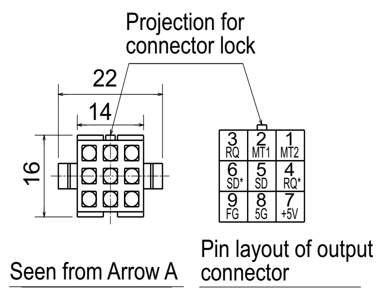
< TS5690N12x7 + MU1606N709 >

[Unit: mm]



(Note) The thermistor contact is not used when the encoder is used as a spindle side encoder.
Insulate the terminal.

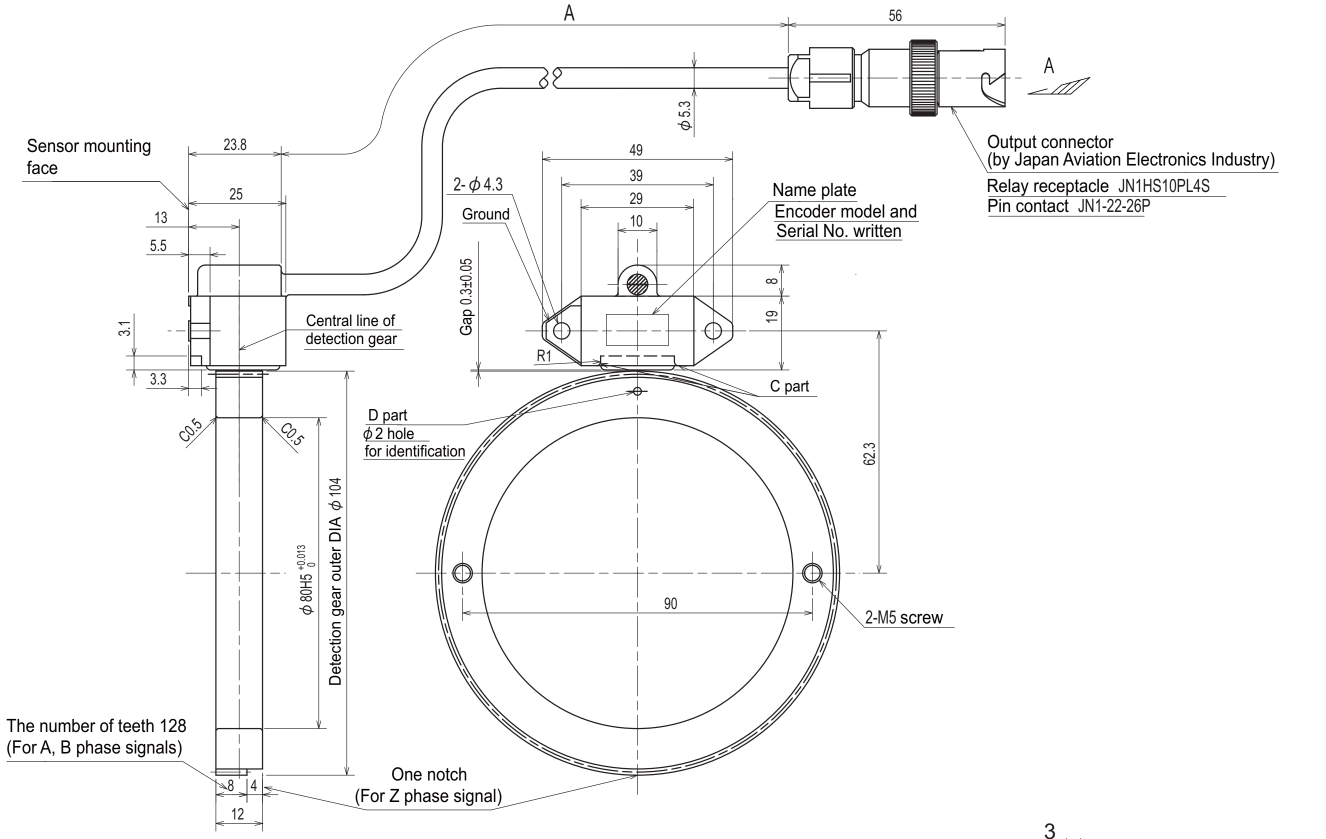


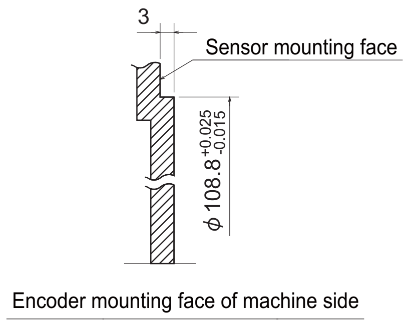


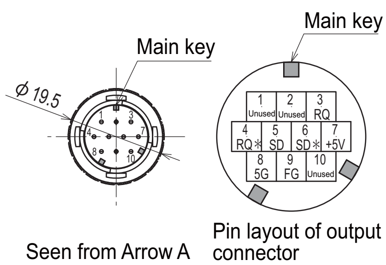
Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N1217	400±10	Axis direction	MU1606N709
TS5690N1227	800±20		
TS5690N1237	1200±20		
TS5690N1247	1600±30		
TS5690N1257	2000±30		

< TS5690N12x8 + MU1606N709 >

[Unit: mm]



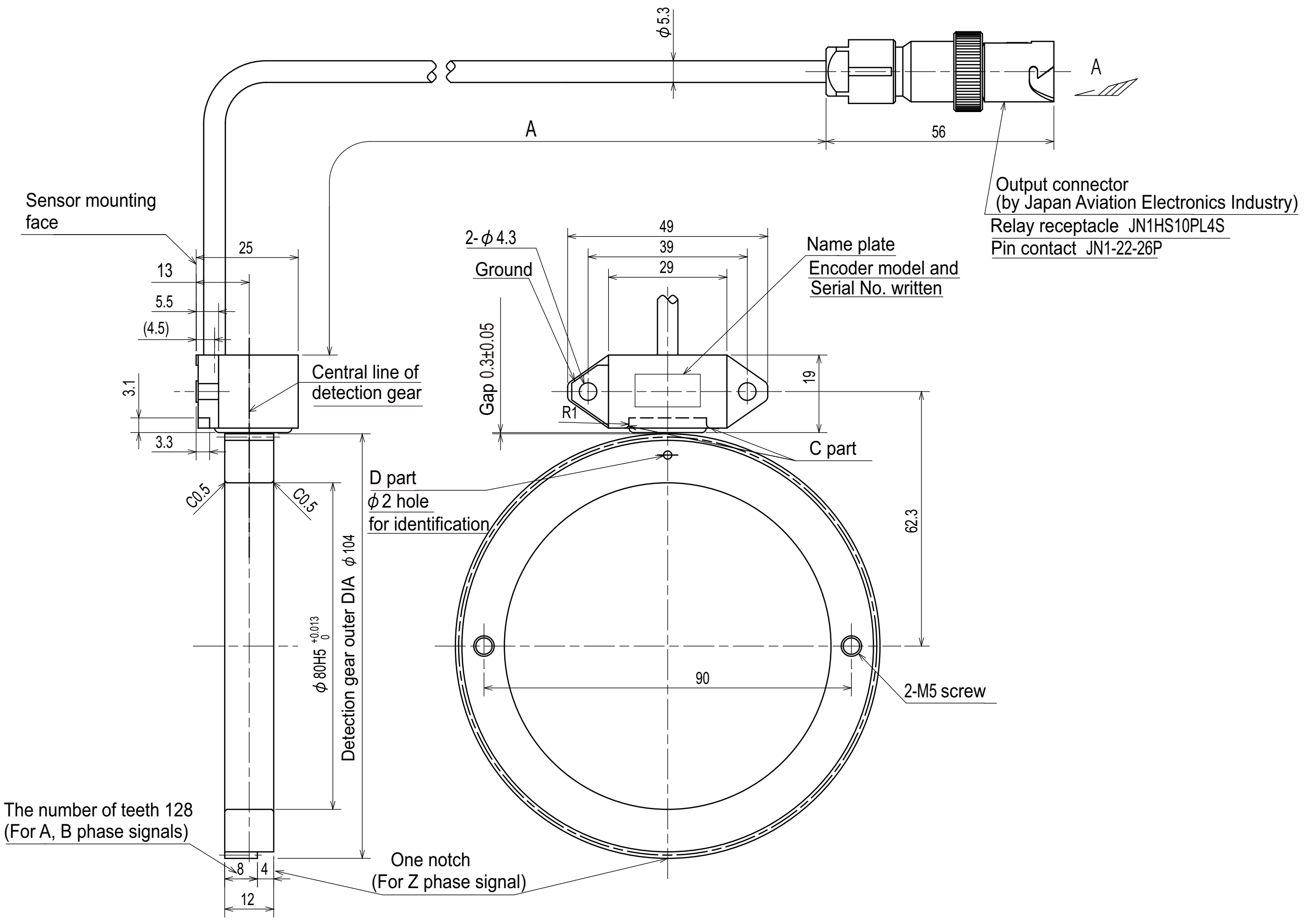


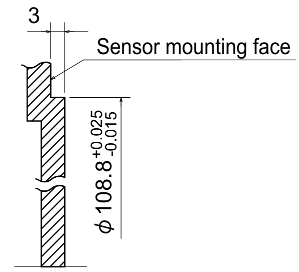


Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N1218	400±10	Axis direction	MU1606N709
TS5690N1228	800±20		
TS5690N1238	1200±20		
TS5690N1248	1600±30		
TS5690N1258	2000±30		

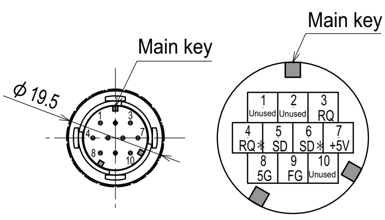
< TS5690N12x9 + MU1606N709 >

[Unit: mm]





Encoder mounting face of machine side



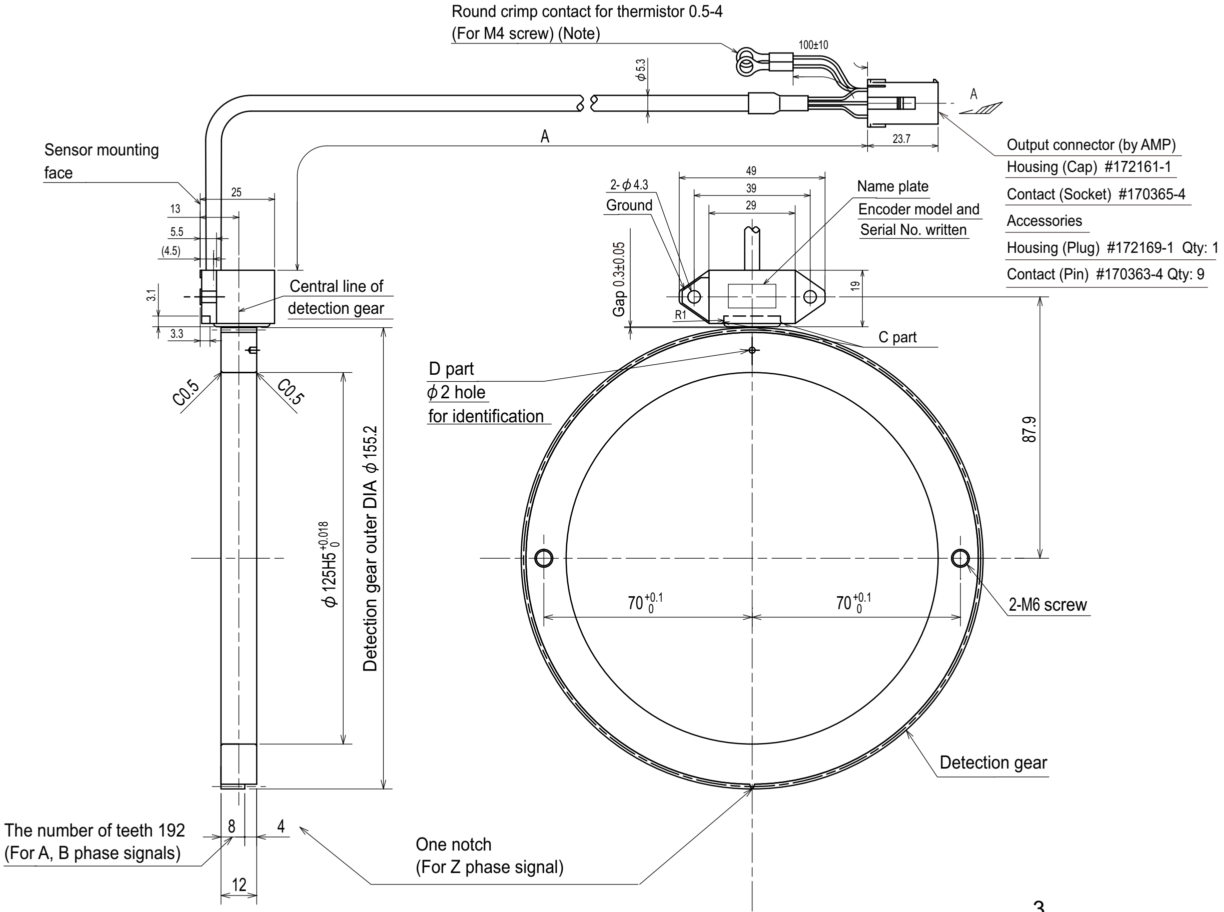
Seen from Arrow A

Pin layout of output connector

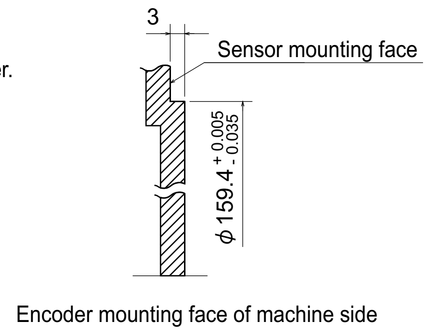
Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N1219	400±10	Vertical direction	MU1606N709
TS5690N1229	800±20		
TS5690N1239	1200±20		
TS5690N1249	1600±30		
TS5690N1259	2000±30		

< TS5690N19x2 + MU1606N203 >

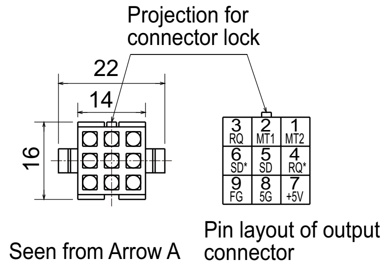
[Unit: mm]



(Note) The thermistor contact is not used when the encoder is used as a spindle side encoder.
Insulate the terminal.

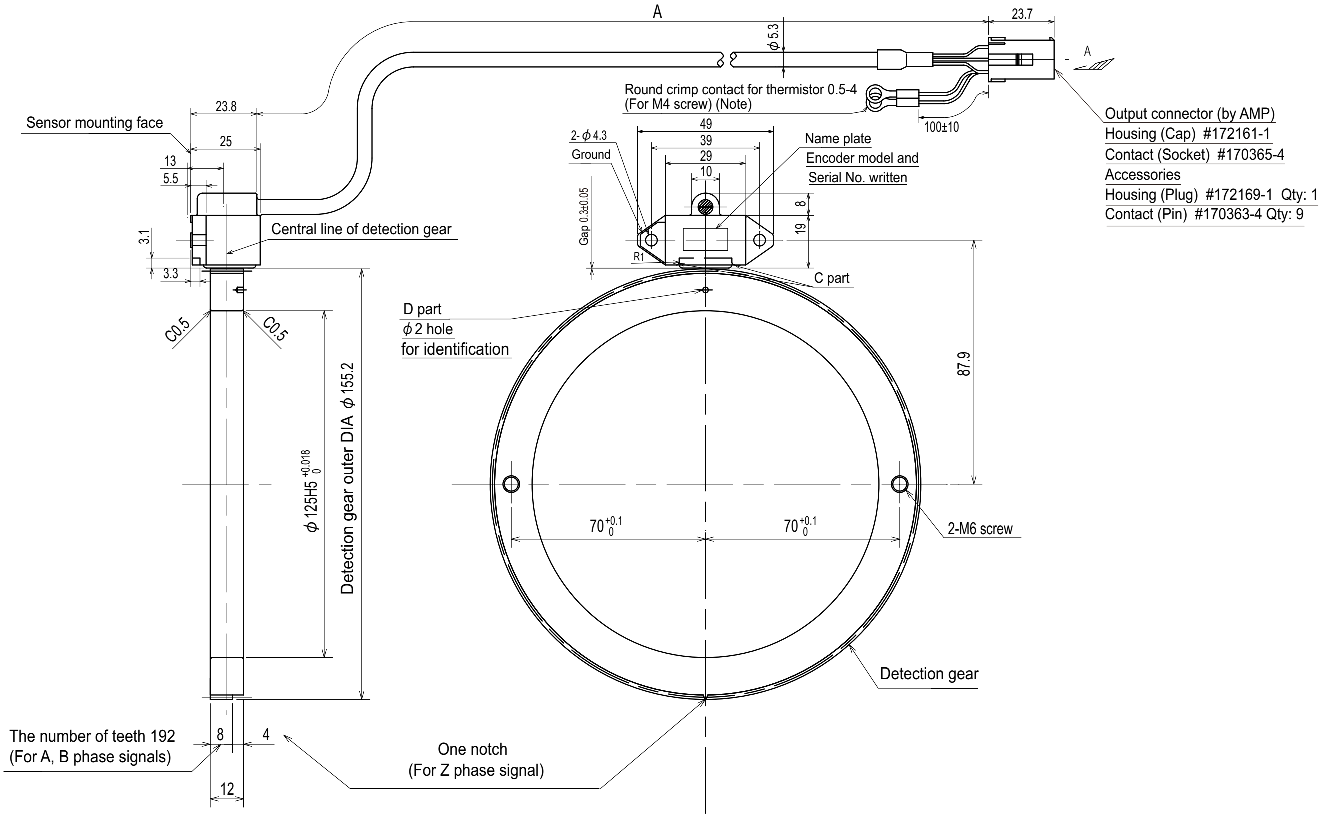


Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N1912	400±10	Vertical direction	MU1606N203
TS5690N1922	800±20		
TS5690N1932	1200±20		
TS5690N1942	1600±30		
TS5690N1952	2000±30		

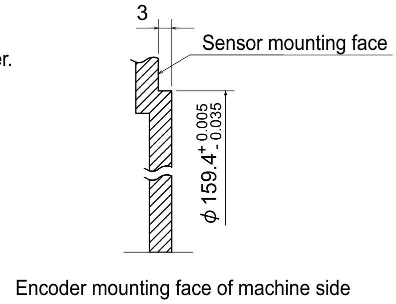


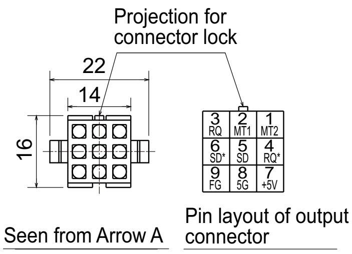
< TS5690N19x7 + MU1606N203 >

[Unit: mm]



(Note) The thermistor contact is not used when the encoder is used as a spindle side encoder.
Insulate the terminal.

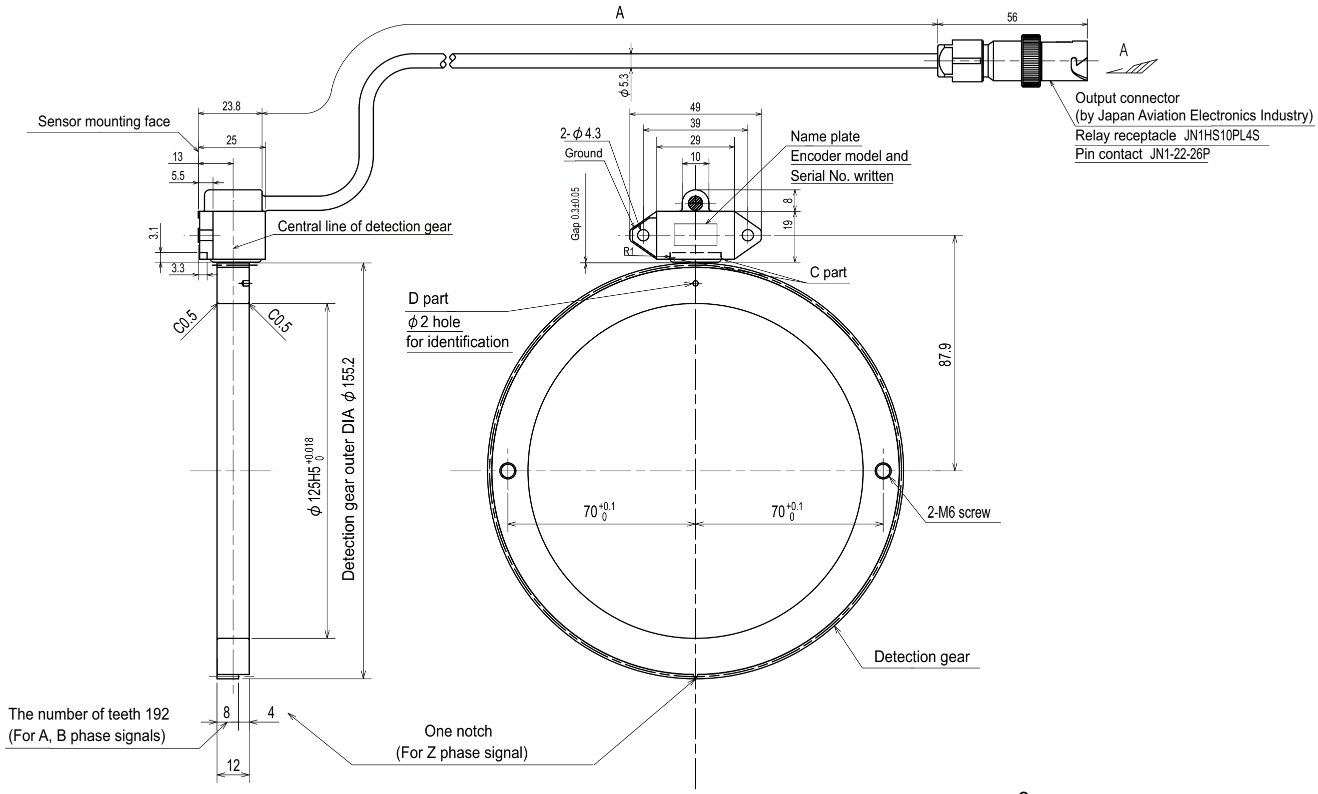


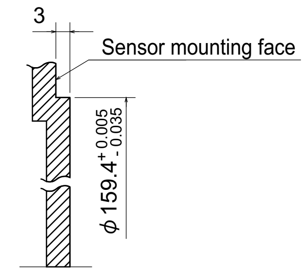


Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N1917	400±10	Axis direction	MU1606N203
TS5690N1927	800±20		
TS5690N1937	1200±20		
TS5690N1947	1600±30		
TS5690N1957	2000±30		

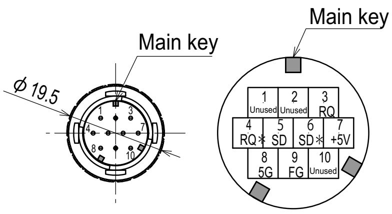
< TS5690N19x8 + MU1606N203 >

[Unit: mm]





Encoder mounting face of machine side



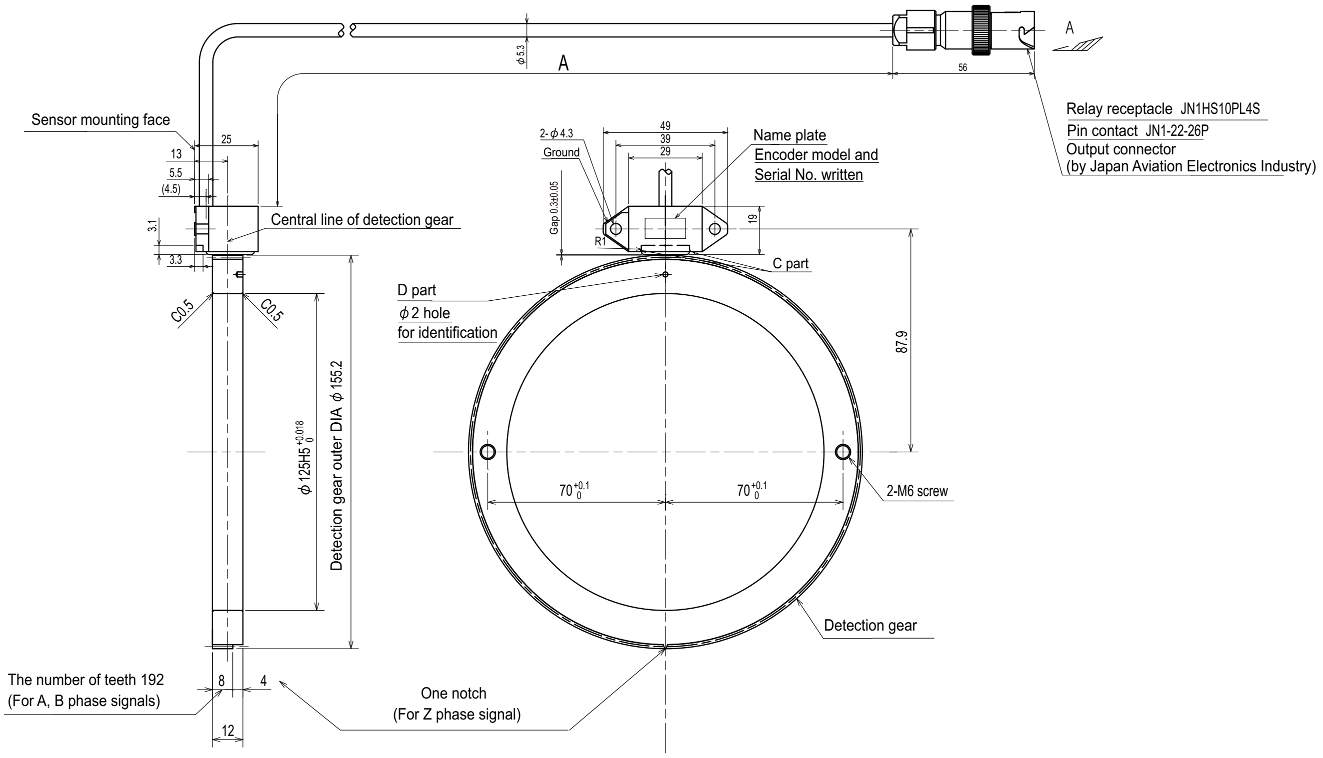
Seen from Arrow A

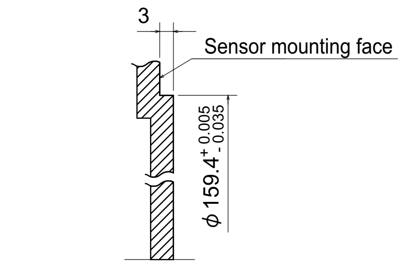
Pin layout of output connector

Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N1918	400±10	Axis direction	MU1606N203
TS5690N1928	800±20		
TS5690N1938	1200±20		
TS5690N1948	1600±30		
TS5690N1958	2000±30		

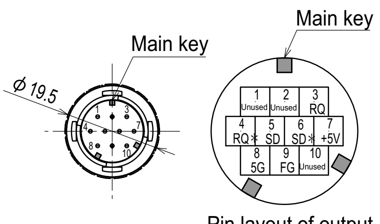
< TS5690N19x9 + MU1606N203 >

[Unit: mm]





Encoder mounting face of machine side



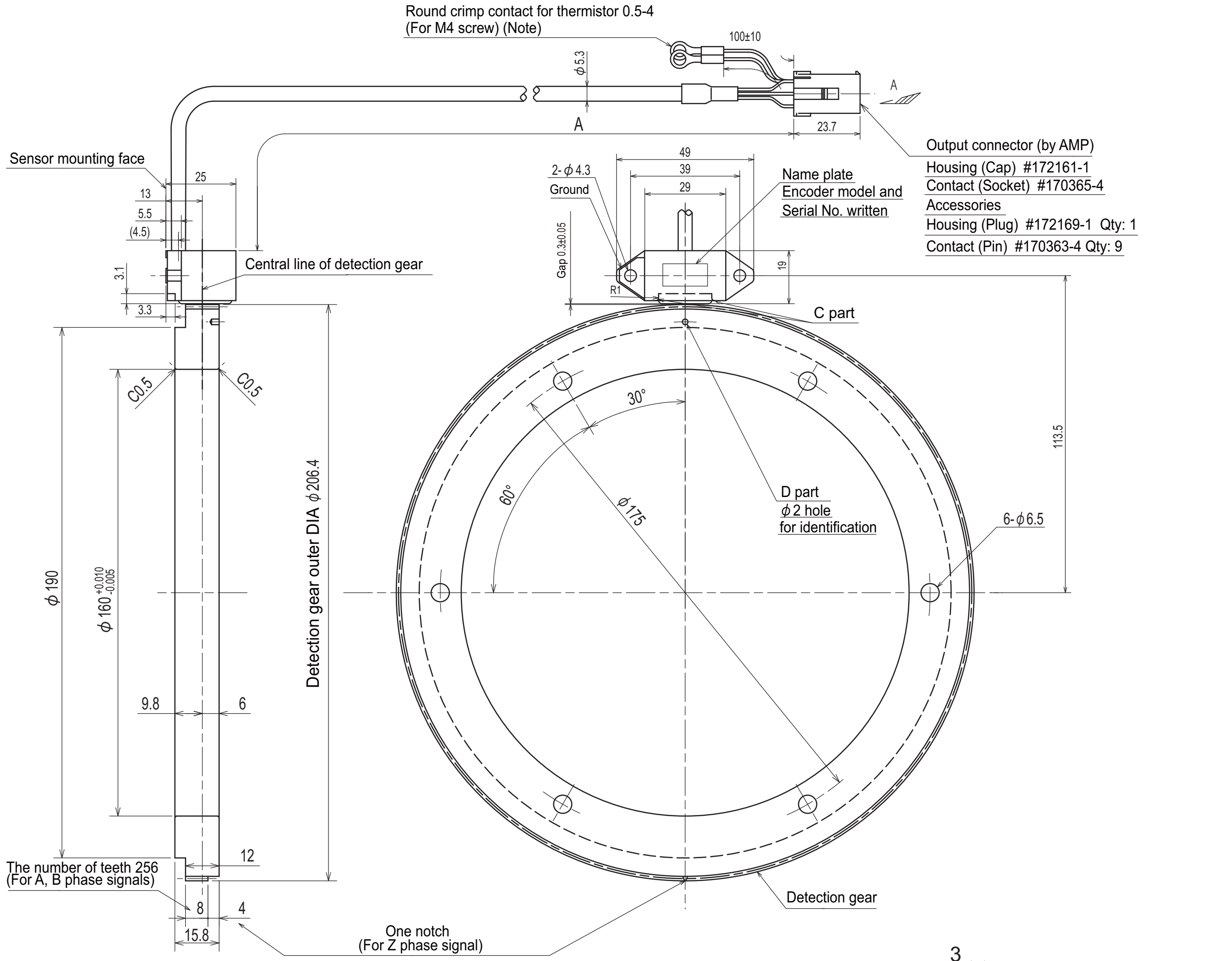
Seen from Arrow A

Pin layout of output connector

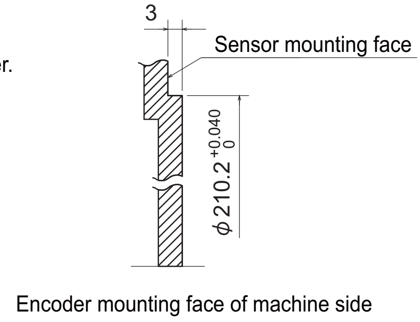
Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N1919	400±10	Vertical direction	MU1606N203
TS5690N1929	800±20		
TS5690N1939	1200±20		
TS5690N1949	1600±30		
TS5690N1959	2000±30		

< TS5690N25x2 + MU1606N802 >

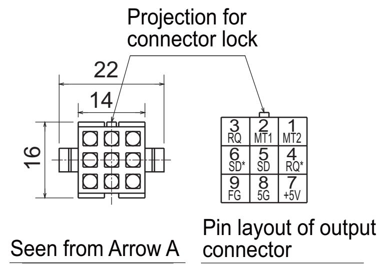
[Unit: mm]



(Note) The thermistor contact is not used when the encoder is used as a spindle side encoder.
Insulate the terminal.

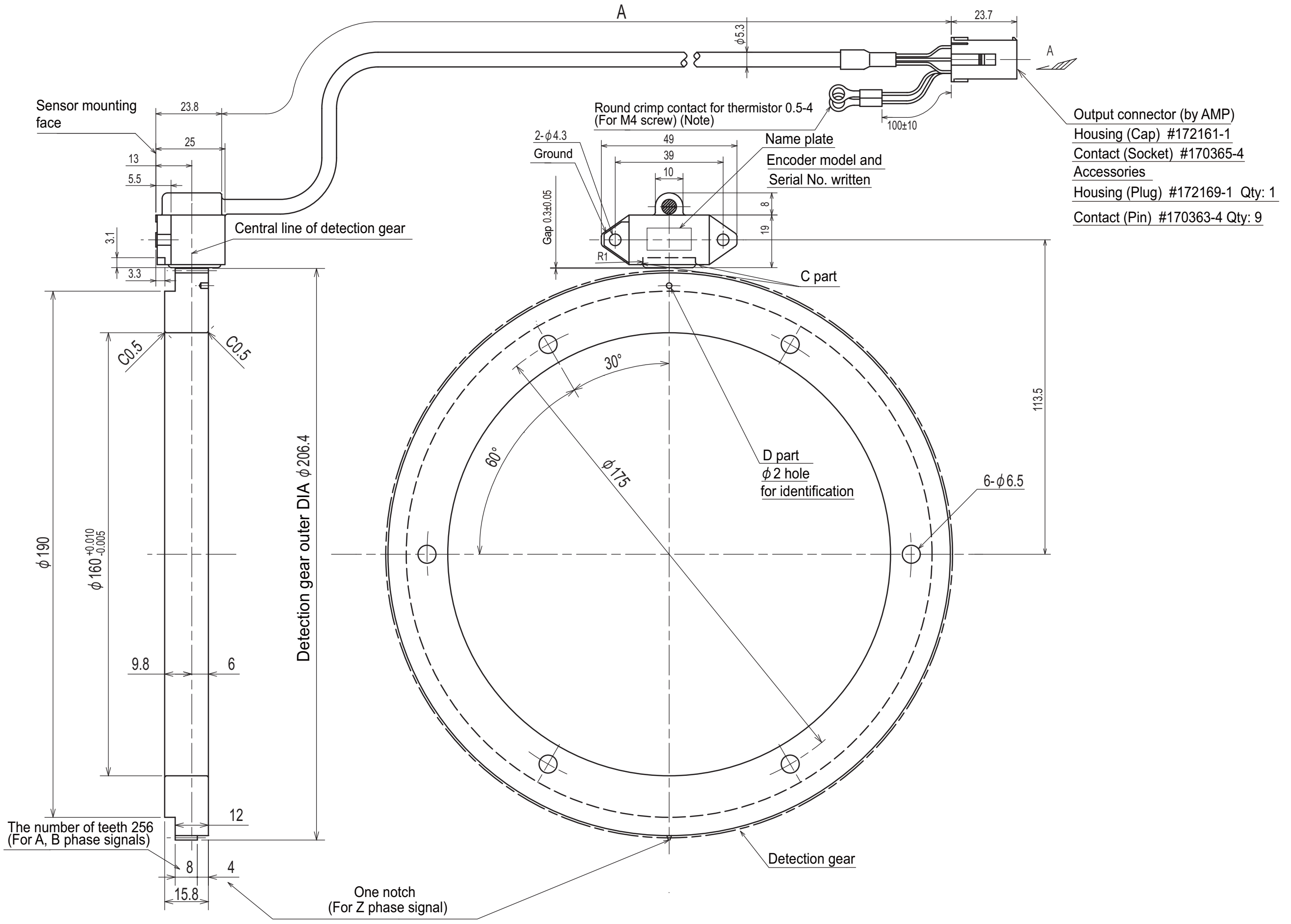


Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N2512	400±10	Vertical direction	MU1606N802
TS5690N2522	800±20		
TS5690N2532	1200±20		
TS5690N2542	1600±30		
TS5690N2552	2000±30		

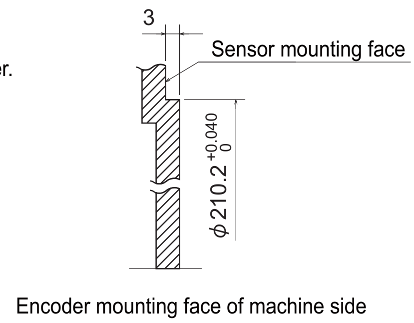


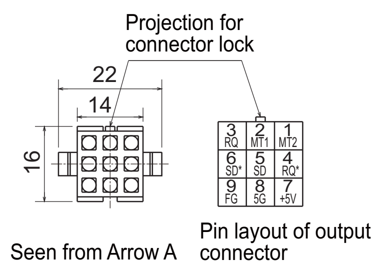
< TS5690N25x7 + MU1606N802 >

[Unit: mm]



(Note) The thermistor contact is not used when the encoder is used as a spindle side encoder.
Insulate the terminal.

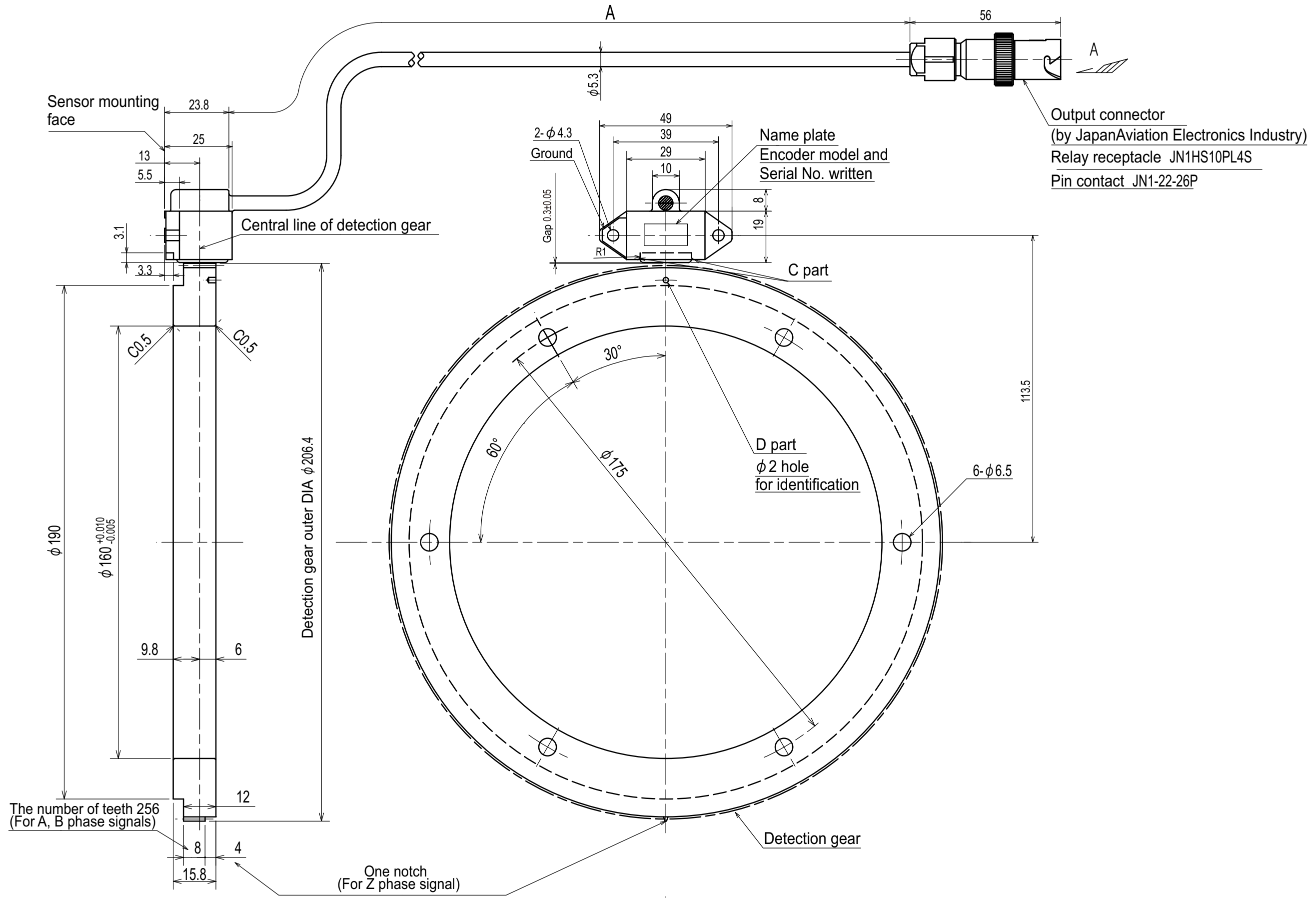


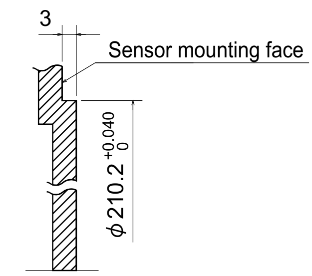


Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N2517	400±10	Axis direction	MU1606N802
TS5690N2527	800±20		
TS5690N2537	1200±20		
TS5690N2547	1600±30		
TS5690N2557	2000±30		

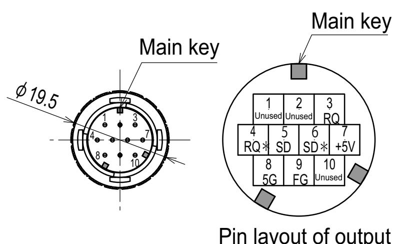
< TS5690N25x8 + MU1606N802 >

[Unit: mm]





Encoder mounting face of machine side



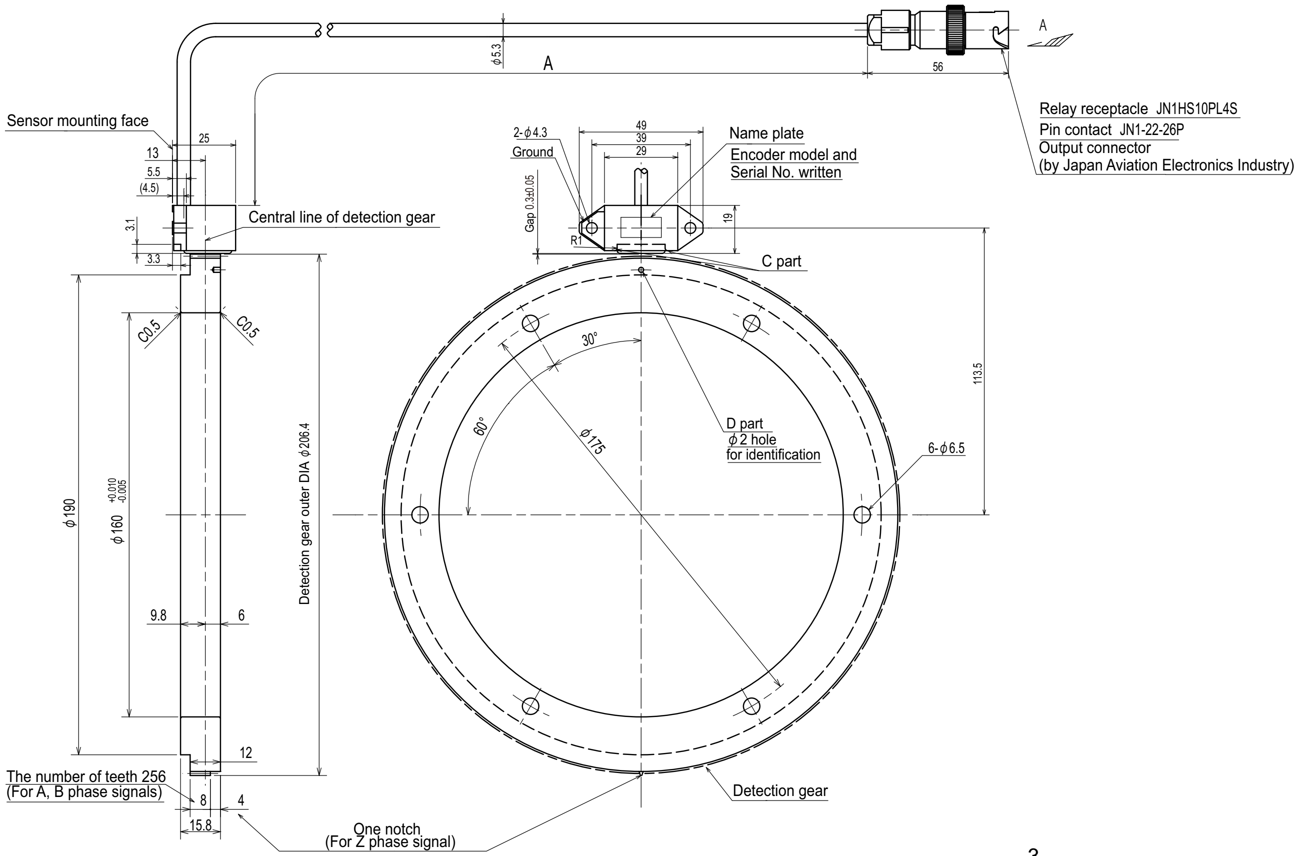
Seen from Arrow A

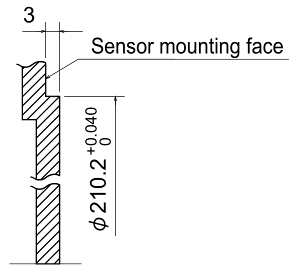
Pin layout of output connector

Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N2518	400±10	Axis direction	MU1606N802
TS5690N2528	800±20		
TS5690N2538	1200±20		
TS5690N2548	1600±30		
TS5690N2558	2000±30		

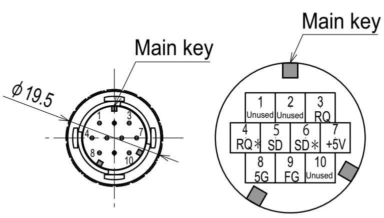
< TS5690N25x9 + MU1606N802 >

[Unit: mm]





Encoder mounting face of machine side



Seen from Arrow A　　Pin layout of output connector

Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N2519	400±10	Vertical direction	MU1606N802
TS5690N2529	800±20		
TS5690N2539	1200±20		
TS5690N2549	1600±30		
TS5690N2559	2000±30		

5.2.3 Spindle Side Accuracy Serial Output Encoder (Other Manufacturer's Product)

C-axis control encoder is used in order to perform an accurate C-axis control.

Manufacturer	Encoder type	Interface unit type	Minimum detection resolution	Tolerable maximum speed
HEIDENHAIN CORPORATION	ERM280 1200	EIB192M C4 1200	0.0000183° (19,660,800 p/rev)	20000 r/min
		EIB392M C4 1200		
	ERM280 2048	EIB192M C6 2048	0.0000107° (33,554,432 p/rev)	11718 r/min
		EIB392M C6 2048		
LENORD+BAUER	GEL2449M	Not required	0.000687° (524,288 p/rev)	Depending on the diameter of the gear
GUBOA	MHS-04B Series	Not required	0.000343° (1,048,576 p/rev)	Depending on the diameter of the gear (8000 to 40000 rpm)

<Contact information about machine side encoder>
- HEIDENHAIN CORPORATION: http://www.heidenhain.com/
- Lenord, Bauer & Co. GmbH: http://www.lenord.com/welcome-to-lenord-bauer/
- GUBOA Technology Co.: https://www.guboa.com/index/en/

⚠ CAUTION

Confirm specifications of each encoder manufacturer before using the machine side encoder.

5.3 Encoder Interface Unit

5.3.1 Serial Output Interface Unit for ABZ Analog Encoder MDS-EX-HR

This unit superimposes the scale analog output raw waves, and generates high resolution position data. Increasing the encoder resolution is effective for the servo high-gain.

(1) Specifications

Type	MDS-EX-HR-11
Consumption current	150mA
Analog signal input specifications	A -phase, B -phase, Z-phase (Amplitude 1Vp-p / Min.: 0.8Vp-p Max.: 1.2Vp-p)
Compatible frequency	Analog raw waveform max.200kHz
Scale resolution	Analog raw waveform / 16384 division
Output communication style	High-speed serial communication
Working ambient temperature	0 to 55°C
Working ambient humidity	90%RH or less (with no dew condensation)
Atmosphere	No toxic gases
Tolerable vibration	98.0 m/s^2 (10G)
Tolerable impact	294.0 m/s^2 (30G)
Tolerable power voltage	5VDC±5%
Maximum heating value	2W
Cable length	Drive side: Max. 30m / Encoder side: Max. 15m
Mass	0.2kg
Degree of protection	IP67

(Note) For the encoder side cable, wire the power line redundantly so that the voltage supplied to the encoder will not drop below the minimum tolerance.

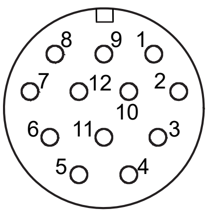
(2) Explanation of connectors

Connector name	Application
SCALE	For connection with scale
DRIVE	For connection with servo drive unit

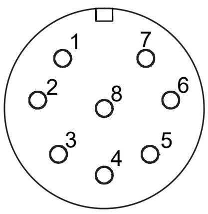
SCALE		DRIVE	
Pin No.	Function	Pin No.	Function
1	A+ signal	1	RQ+ signal
2	A- signal	2	RQ- signal
3	B+ signal	3	SD+ signal
4	B- signal	4	SD- signal
5	Z+ signal	5	P5
6	Z- signal	6	P5
7	-	7	GND
8	-	8	GND
9	-		
10	-		
11	P5		
12	GND		

< Connector pin layout >

Connector	Type
SCALE	RM15WTRZ-12S(71) (Hirose Electric)
DRIVE	RM15WTRZ- 8P(71) (Hirose Electric)

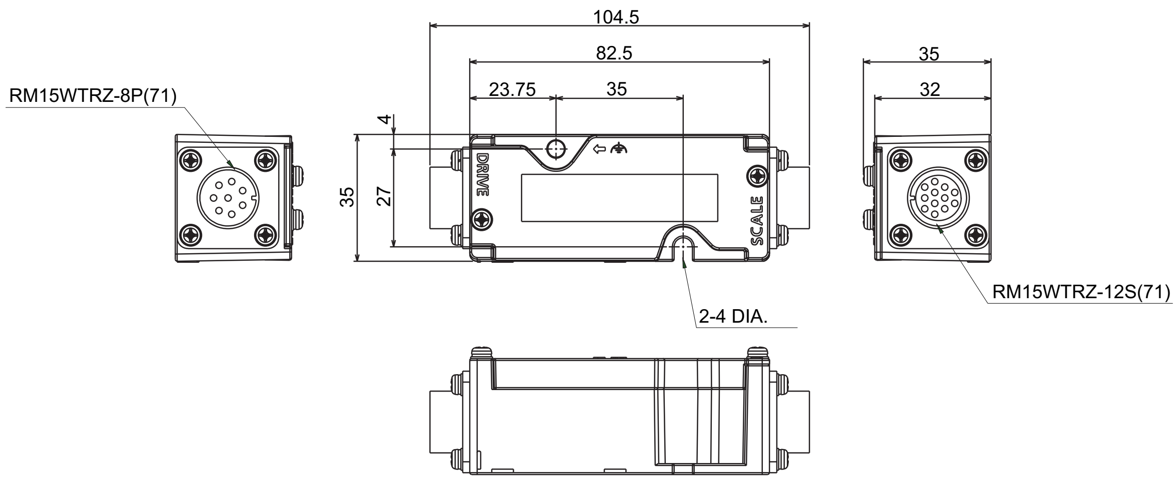


SCALE



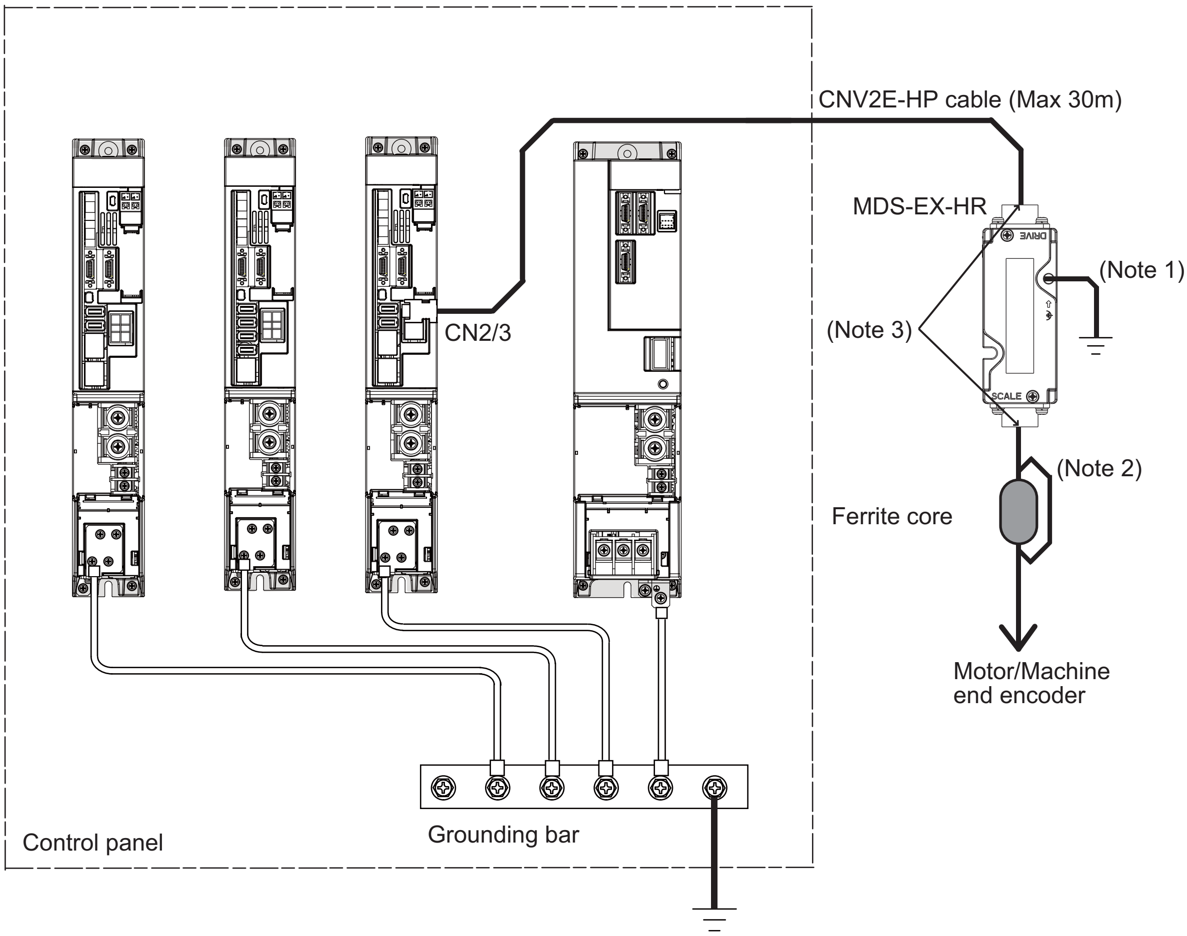
DRIVE

(3) Outline dimension drawings



[Unit:mm]

(4) Example of wiring



(Note 1) Ground the MDS-EX-HR unit.

(Note 2) Place a ferrite core as close as possible to the MDS-EX-HR unit.
The effect of noise suppression is obtained as much as the number of times the cable is wound around the ferrite core according to the cable diameter.

(Note 3) Use shielded cables and join the shield to the connector shell.

5.3.2 Serial Signal Division Unit MDS-B-SD

This unit has a function to divide the position and speed signals fed back from the high-speed serial encoder and high-speed serial linear scale. This unit is used to carry out synchronized control of the motor with two MDS-E/EH-V1 drive units.

(1) Specifications

Type	MDS-B-SD
Compatible servo drive unit	MDS-E/EH-V1- □
Input/output communication style	High-speed serial communication I/F, RS485 or equivalent
Working ambient temperature	0 to 55°C
Working ambient humidity	90%RH or less (with no dew condensation)
Atmosphere	No toxic gases
Tolerable vibration	98.0 m/s^2 (10G)
Tolerable impact	294.0 m/s^2 (30G)
Tolerable power voltage	5VDC±10%
Maximum heating value	4W
Mass	0.5kg or less
Degree of protection	IP20

POINT

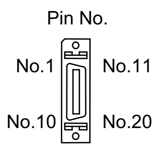
Always provide one MDS-B-SD unit for one speed command synchronous control operation.
The CN2 system's CN2A and the CN3 system's CN3A cannot be connected to different servo drive units.

(2) Explanation of connectors

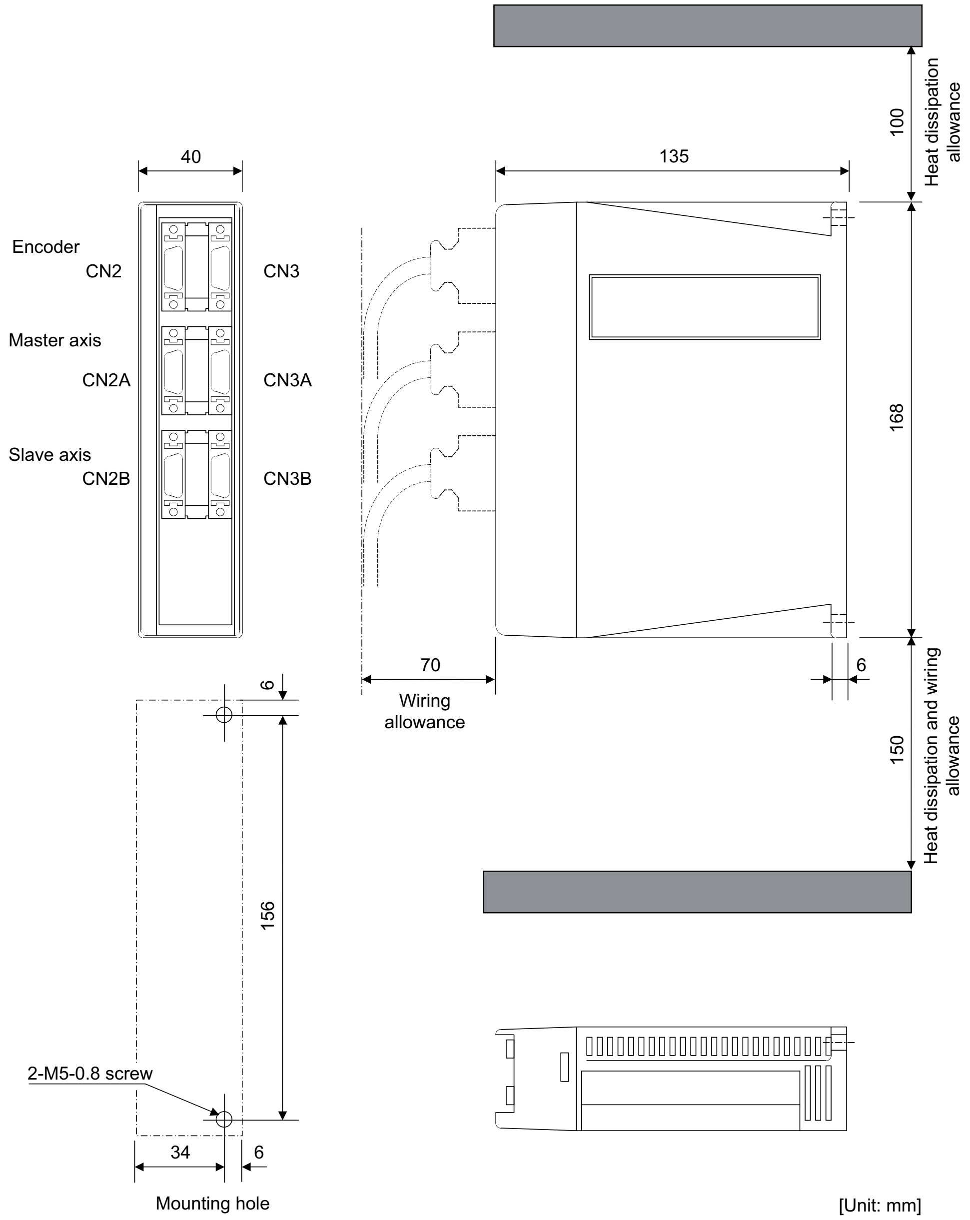
Encoder connector : CN2			
Pin No.	Name	Pin No.	Name
1	LG	11	LG
2		12	
3		13	
4		14	
5		15	
6	SD	16	SD*
7	RQ	17	RQ*
8		18	
9	BAT	19	
10	P5 (+5V)	20	P5 (+5V)

< Connector pin layout >

Encoder connector : CN2



(3) Outline dimension drawings



5.3.3 Pulse Output Interface Unit for ABZ Analog Encoder IBV Series (Other Manufacturer's Product)

(1) Appearance

IBV100 series

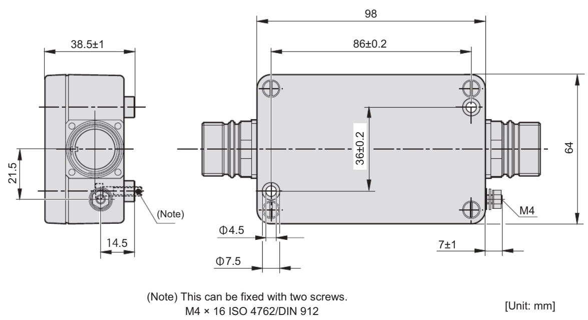
IBV600 series

(2) Specifications

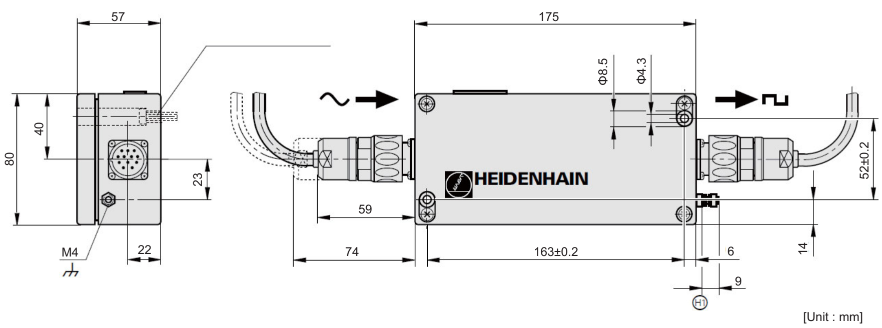
Type	IBV 101	IBV 102	IBV 660B
Manufacturer HEIDENHAIN	HEIDENHAIN CORPORATION		
Input signal	A-phase, B-phase: SIN wave 1Vpp, Z-phase		
Maximum input frequency	400kHz		
Output signal	Rectangular wave pulse signal		
Interpolation division number	Maximum 10 divisions	Maximum 100 divisions	Maximum 400 divisions
Compatible encoder	LS187, LS487	LS187, LS487	LS187, LS487
Minimum detection resolution	0.5μm	0.05μm	0.0125μm
Working temperature	0°C to 70°C		
Degree of protection	IP65		
Mass	300g		

(3) Outline dimension drawings

IBV100 series



IBV600 series



> ⚠ **CAUTION**
>
> These are other manufacturer's products. When purchasing these products, refer to the manufacturer's information materials for the product specifications.

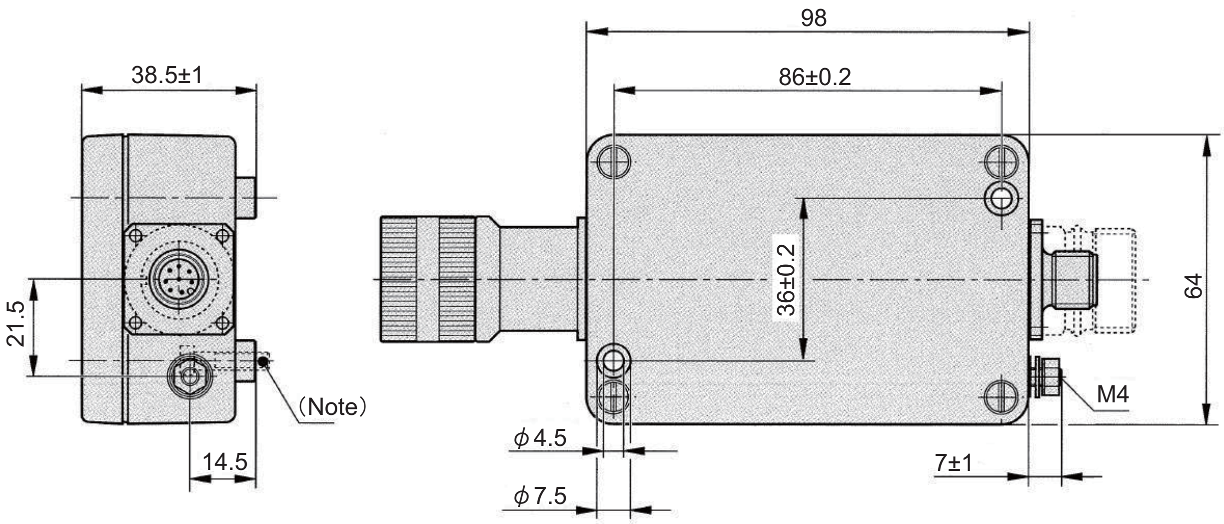
5.3.4 Serial Output Interface Unit for ABZ Analog Encoder EIB192M (Other Manufacturer's Product)

(1) Appearance

(2) Specifications

Type	EIB192M A4 20μm	EIB192M C4 1200	EIB192M C4 2048
Manufacturer	HEIDENHAIN CORPORATION		
Input signal	A-phase, B-phase: SIN wave 1Vpp, Z-phase		
Maximum input frequency	400kHz		
Output signal	Mitsubishi high-speed serial signal (Mitsu02-4)		
Interpolation division number	Maximum 16384 divisions		
Compatible encoder	LS187, LS487	ERM280 1200	ERM280 2048
Minimum detection resolution	0.0012μm	0.0000183° (19,660,800p/rev)	0.0000107° (33,554,432p/rev)
Working temperature	0°C to 70°C		
Degree of protection	IP65		
Mass	300g		

(3) Outline dimension drawings



(Note) Two fixing screws (M4×16 DIN 912/ISO 4762) [Unit : mm]

⚠ CAUTION

These are other manufacturer's products. When purchasing these products, refer to the manufacturer's information materials for the product specifications.

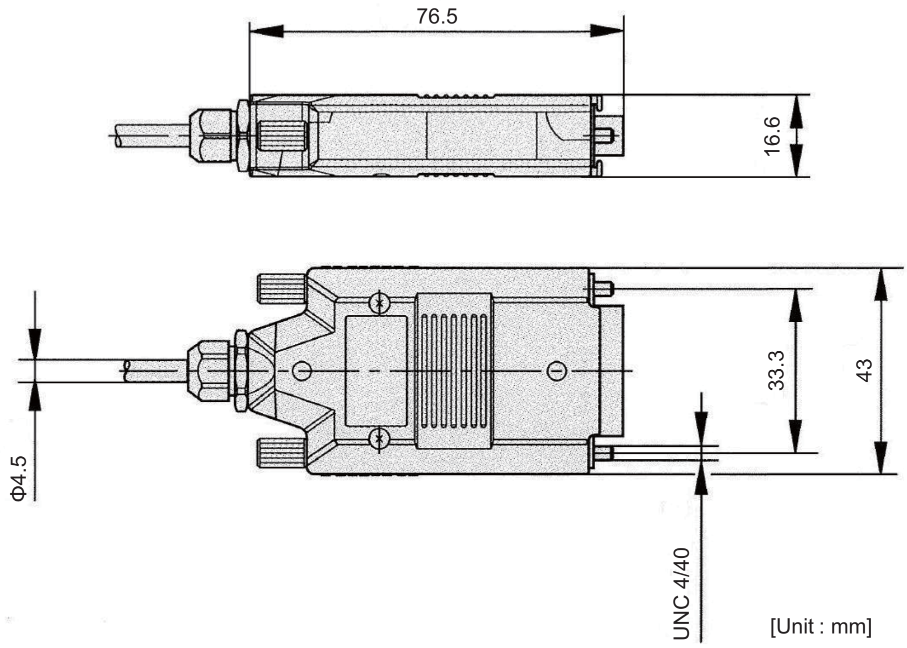
5.3.5 Serial Output Interface Unit for ABZ Analog Encoder EIB392M (Other Manufacturer's Product)

(1) Appearance

(2) Specifications

Type	EIB392M A4 20µm	EIB392M C4 1200	EIB392M C4 2048
Manufacturer	HEIDENHAIN CORPORATION		
Input signal	A-phase, B-phase: SIN wave 1Vpp, Z-phase		
Maximum input frequency	400kHz		
Output signal	Mitsubishi high-speed serial signal (Mitsu02-4)		
Interpolation division number	Maximum 16384 divisions		
Compatible encoder	LS187, LS487	ERM280 1200	ERM280 2048
Minimum detection resolution	0.0012µm	0.0000183° (19,660,800p/rev)	0.0000107° (33,554,432p/rev)
Working temperature	0°C to 70°C		
Degree of protection	IP40		
Mass	140g		

(3) Outline dimension drawings



[Unit : mm]

> ⚠ **CAUTION**
>
> These are other manufacturer's products. When purchasing these products, refer to the manufacturer's information materials for the product specifications.

5.3.6 Serial Output Interface Unit for ABZ Analog Encoder ADB-K70M (Other Manufacturer's Product)

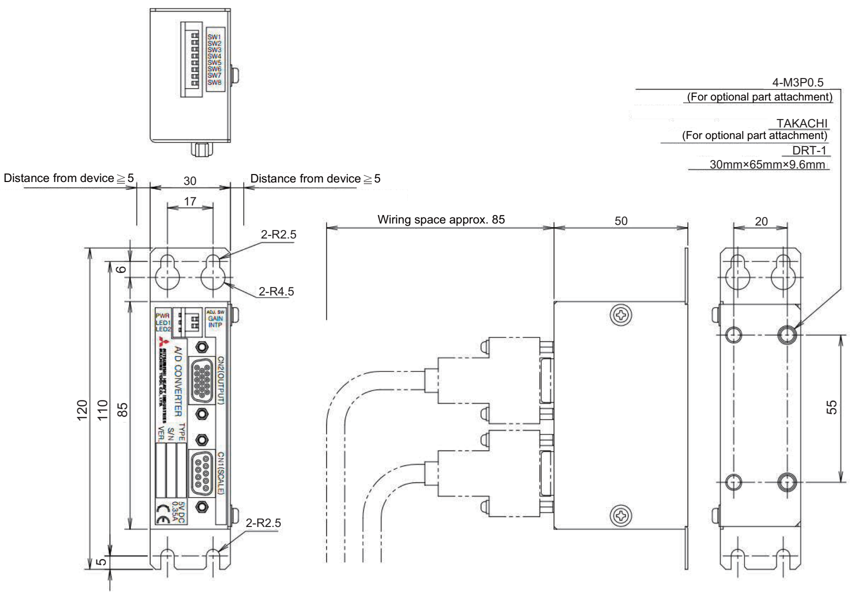
(1) Appearance

(2) Specifications

Type	ADB-K70M
Manufacturer	NIDEC MACHINE TOOL CORPORATION
Maximum response speed	10,000r/min
Output signal	Mitsubishi high-speed serial signal
Compatible encoder	MPRZ Series
Minimum detection resolution	0.000043° (8,388,608p/rev)
Working temperature	0°C to 55°C
Degree of protection	IP20
Mass	0.15kg

(3) Outline dimension drawings

[Unit : mm]



⚠ **CAUTION**

These are other manufacturer's products. When purchasing these products, refer to the manufacturer's information materials for the product specifications.

5.4 Drive Unit Option

5.4.1 DC Connection Bar

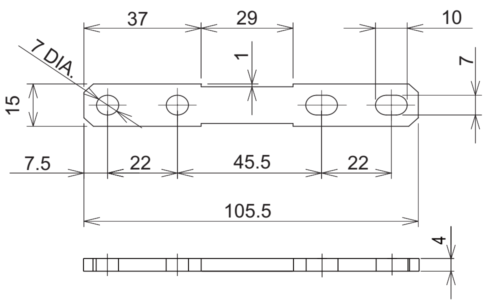
When connecting a large capacity drive unit with L+L- terminal of power supply unit, DC connection bar is required. In use of the following large capacity drive units, use a dedicated DC connection bar. The DC connection bar to be used depends on the connected power supply, so make a selection according to the following table.

Series	Large capacity drive unit	Power supply unit	Required connection bar
MDS-E	MDS-E-SP-400 MDS-E-SP-640	MDS-E-CV-300 MDS-E-CV-370 MDS-E-CV-450	E-BAR-B0606
	MDS-E-SP-400 MDS-E-SP-640	MDS-E-CV-550	E-BAR-A0606 (Two-parts set)
MDS-EH	MDS-EH-SP-200 MDS-EH-SP-320 MDS-EH-SP-480 MDS-EH-SP-600	MDS-EH-CV-550 MDS-EH-CV-750	E-BAR-A0606 (Two-parts set)
	MDS-EH-V1-200 MDS-EH-SP-200 MDS-EH-SP-320	MDS-EH-CV-300 MDS-EH-CV-370 MDS-EH-CV-450	DH-BAR-B0606
	MDS-EH-V1-200	MDS-EH-CV-185	DH-BAR-C0606

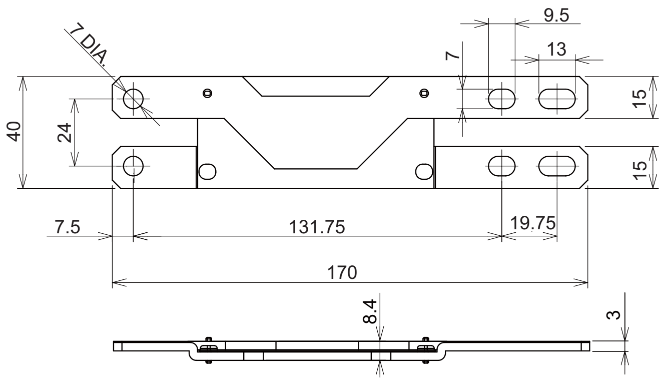
(1) Outline dimension drawings

[Unit:mm]

E-BAR-A0606

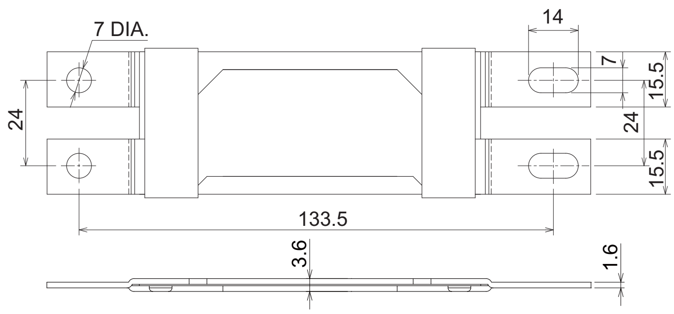


E-BAR-B0606

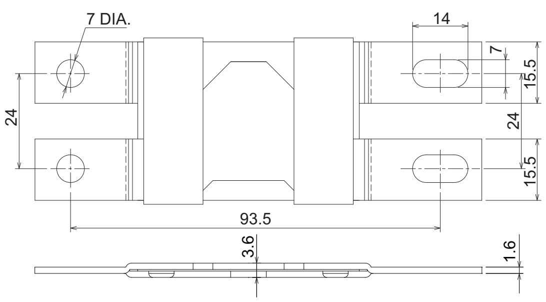


(Note) E-BAR-A0606 is a set of two DC connection bars.

DH-BAR-B0606



DH-BAR-C0606



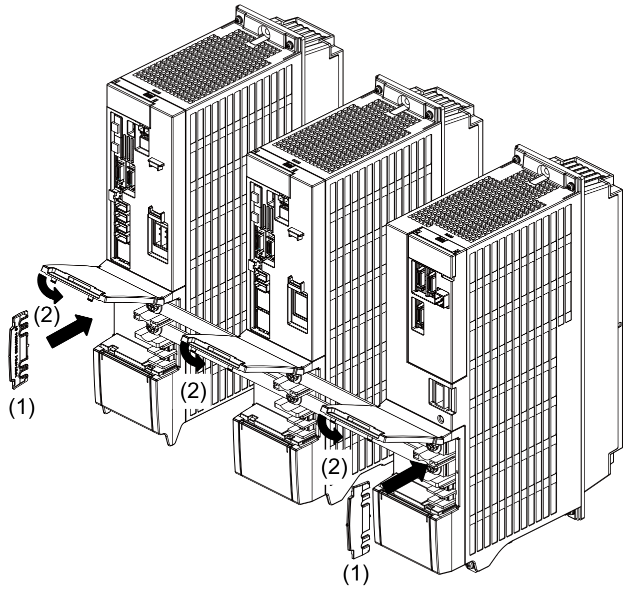
POINT

Always install a large capacity drive unit in the left side of power supply unit, and connect with DC connection bar.

5.4.2 Side Protection Cover

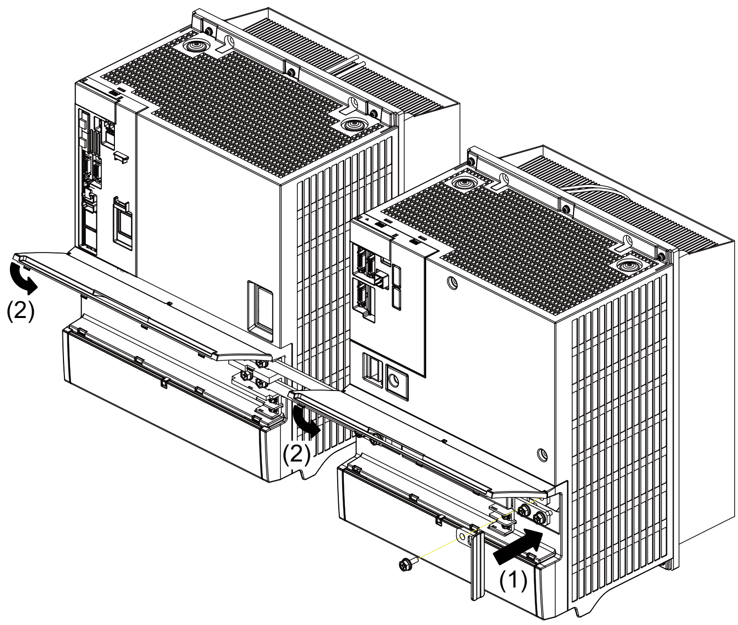
Install the side protection cover outside the both ends of the connected units.

(Installation method 1)



(1): Install the side protection cover
(type: E-COVER-1).
(2): Close the front cover.

(Installation method 2): Installation of large capacity unit (MDS-E-SP-400/640, MDS-EH-SP-200/320/480/600, MDS-EH-V1-200, MDS-E-CV-550, MDS-EH-CV-550/750)



(1): Install the side protection cover
(type: E-COVER-2).
(2): Close the front cover.

5.4.3 Power Backup Unit (MDS-D/DH-PFU)

MDS-D/DH-PFU unit is a system to protect the machine and the drive units safely by decelerating and stopping the motor at power failure. There are two unit types of 200V specification and 400V specification in accordance with the NC servo and spindle system.

(1) Type configuration

MDS- $\boxed{(1)}$ **-PFU**

(1)

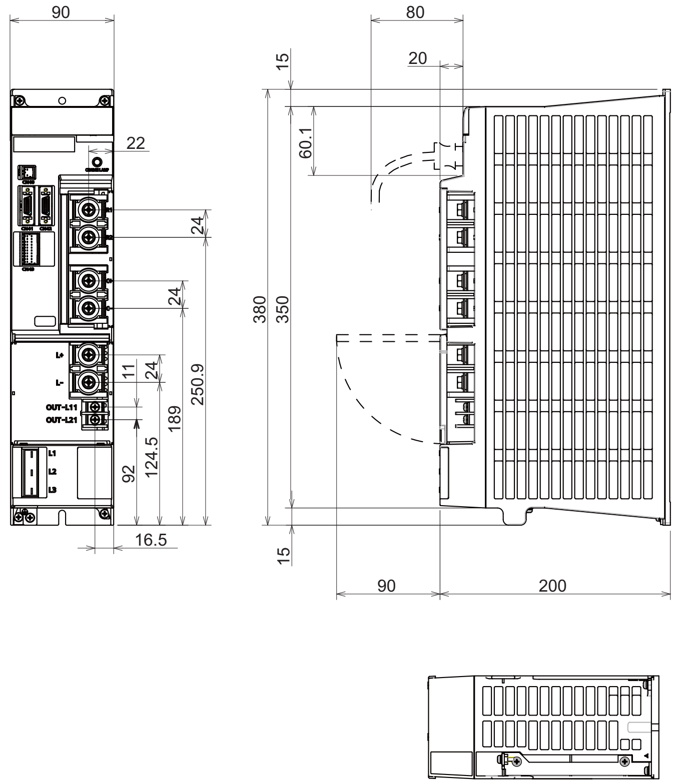
Symbol	Voltage class
D	200V
DH	400V

(2) Specifications

Model Name		MDS-D-PFU	MDS-DH-PFU
AC Input	Rated voltage [V]	200 to 230AC (50/60Hz) Tolerable fluctuation : between +10% and -15%	380 to 480AC (50/60Hz) (Exclusively for earthed-star supply system) Tolerable fluctuation : between +10% and -10%
	Frequency [Hz]	50/60 Tolerable fluctuation : between +3% and -3%	
	Rated current [A]	4	2
DC Input and output	Rated voltage [V]	270 to 311DC	513 to 648DC
	Rated current [A]	Regenerating Input: MAX 300A Powering Output: MAX 200A	Regenerating Input: MAX 200A Powering Output: MAX 160A
AC output for control power supply backup	Voltage [V]	Single phase 200 to 230VAC (50Hz or 60Hz) 50Hz at backup	Single phase 380 to 480VAC (50Hz or 60Hz) 50Hz at backup
	Current [A]	MAX 4	MAX 2
	Maximum number of connectable drive units	6 (excluding power supply units)	
	Changeover time	100ms or less after instantaneous interruption of AC input	
	Minimum backup time	75ms or longer (When 200VAC is input and the maximum number of connectable drive units is connected)	75ms or longer (When 380VAC is input and the maximum number of connectable drive units is connected)
Degree of protection		IP20 (Except for Terminal block and Connector)	
Environment	Ambient temperature	Operation: 0 to 55°C (with no freezing) Storage / Transportation: -15°C to 70°C (with no freezing)	
	Ambient humidity	Operation / Storage / Transportation: 90%RH or less (with no dew condensation)	
	Atmosphere	Indoors (no direct sunlight) With no corrosive gas, inflammable gas, oil mist, dust or conductive fine particles	
	Altitude	Operation/Storage: 1000 meters or less above sea level, Transportation: 13000 meters or less above sea level	
	Vibration	Operation / Storage: 4.9m/s^2 (0.5G) or less	
Cooling method		Natural air cooling	
Mass [kg]		4	

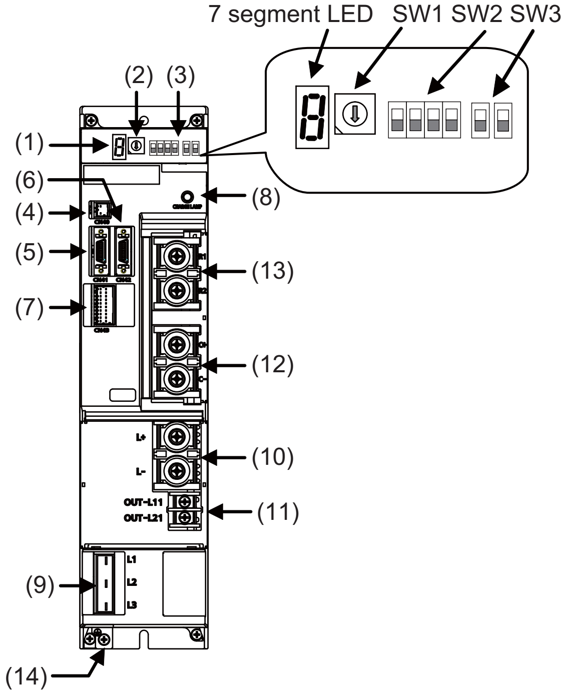
(3) Outline dimension drawings
< MDS-D-PFU / MDS-DH-PFU >

[Unit : mm]



(4) Explanation of each part

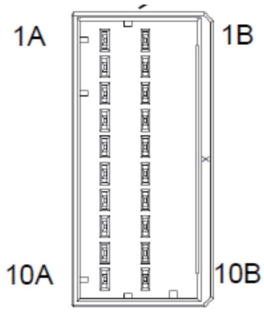
< MDS-D-PFU / MDS-DH-PFU >



		Name		Application	Screw size	Compatible wire
(1)	Control circuit	LED	---	Unit status indication 7 segment LED	---	---
(2)		SW1	---	Function setting rotary switch	---	---
(3)		SW2,SW3	---	Function setting DIP switch	---	---
(4)		CN40	---	(Not used)	---	---
(5)		CN41	---	For connecting MDS-E/EH-CV	---	---
(6)		CN42	---	Maintenance	---	---
(7)		CN43	---	DIO	---	---
(8)		Charge LED	---	Voltage status indication between TE4 terminals	---	---
(9)	Main circuit	TE1	L1 L2 L3	Control power input terminal (Three-phase AC input)	---	AWG#14 (2mm^2)
(10)		TE2	L+ L-	Power backup unit voltage input/output terminal Connected to the L+ and L- terminals of the power supply unit	M6×18 Tightening torque 4.0Nm	AWG#4 (22 mm^2) or above
(11)		TE3	OUT-L11 OUT-L21	Power backup unit voltage output terminal (AC output) Connected to the L11 and L21 terminals of the power supply unit and drive unit	M4×10 Tightening torque 1.2Nm	AWG#14 (2mm^2)
(12)		TE4	C+ C-	Capacitor unit connection terminal	M6×18 Tightening torque 4.0Nm	AWG#10 (5.5mm^2)
(13)		TE5	R1 R2	Regenerative resistor connection terminal	M6×18 Tightening torque 4.0Nm	AWG#10 (5.5 mm^2)
(14)		PE		Grounding terminal	M4×12 Tightening torque 1.2Nm	AWG#14 (2mm^2)

(5) Explanation of connectors

< CN43 connector >



No.	Signal name	Function	Description
1B	24VOUT	Internal 24V output	Internal 24V output. This enables connection to the 24V input power supply for DO. (Note that the DO output current should be 100mA or less.)
2B	DO_COM	DO common terminal	Common terminal for DO output circuit
5B	DO2	Tool escape request	ON:Normal, OFF: Tool escape request
10B	THM1	Thermal error detection	Shorted: Normal, Open: Error detection
1A	24GOUT	Internal 24V output GND	
2A	DO_COM2	DO common terminal 2	
3A	DO_COM2	DO common terminal 2	
10A	THM2(24GOUT)	Thermal error detection	GND for internal 24V input

5.4.4 Regenerative Resistors for Power Backup Unit (R-UNIT-6,7)

Check the availability of connection of the power backup unit and the regenerative resistor for the power backup unit.
The regenerative resistor generates heats, so wire and install the unit while taking care to safety.

(1) Specifications

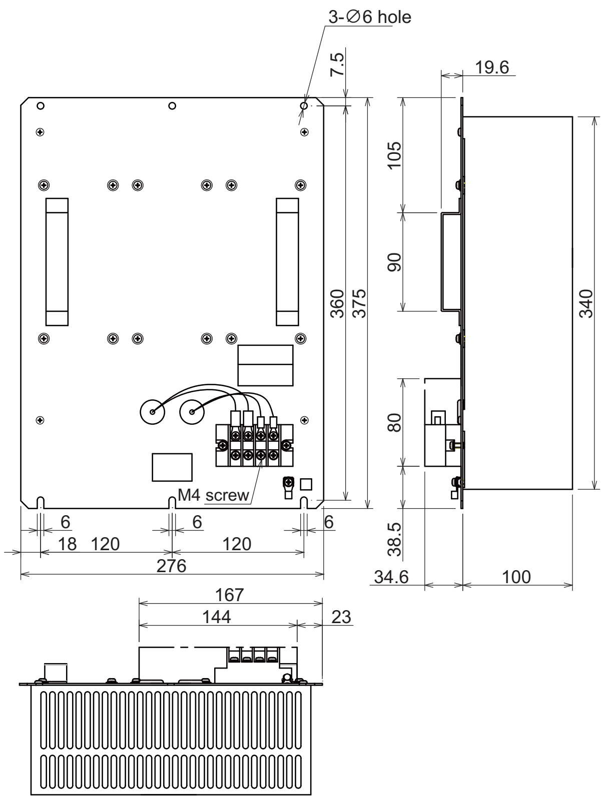
Model Name		R-UNIT-7	R-UNIT-6
Compatible power backup unit name		MDS-D-PFU	MDS-DH-PFU
Resistance value [Ω]		1.4	5
Instantaneous regeneration capacity [kW]		114	128
Allowable regeneration workload [kJ]		180	180
Environment	Ambient temperature	Operation: 0 to 55°C (with no freezing) Storage / Transportation: -15°C to 70°C (with no freezing)	
	Ambient humidity	Operation / Storage / Transportation: 90%RH or less (with no dew condensation)	
	Atmosphere	Indoors (no direct sunlight) With no corrosive gas, inflammable gas, oil mist, dust or conductive fine particles	
	Altitude	Operation/Storage: 1000 meters or less above sea level, Transportation: 13000 meters or less above sea level	
	Vibration	Operation / Storage: 4.9m/s^2 (0.5G) or less	
Cooling method		Natural air cooling	
Mass [kg]		10	

⚠ CAUTION

1. Only the designated combination can be used for the power backup unit and the regenerative resistor for the power backup unit.
   There is a risk of fire, so always use the designated combination.
2. Select the function selection rotary switch (SW1) of the power backup unit according to the regenerative resistor for the power backup unit to be used.

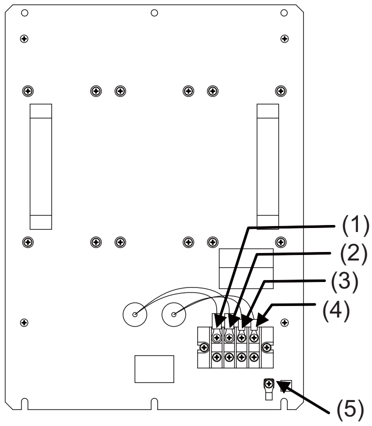
(2) Outline dimension drawings
< R-UNIT-6 / R-UNIT-7 >

[Unit : mm]



(3) Explanation of each part

< R-UNIT-6 / R-UNIT-7 >



Name		Function	Compatible wire	Terminal specification
(1)	R1	PFU connection terminal	AWG10 (5.5 mm^2)	M4 screw Compatible crimp terminal: Round: Up to 5.5-4
(2)	R2			
(3)	AL1	Thermal connection output terminal	AWG#18 to AWG#24 (0.75mm^2 to 0.2mm^2)	M4 screw Compatible crimp terminal: Round: Up to 1.25-4
(4)	AL2			
(5)	E	Grounding terminal	AWG10 (5.5 mm^2)	M4 screw Compatible crimp terminal: Round: Up to 5.5-4

5.4.5 Capacitor Unit for Power Backup Unit (MDS-D/DH-CU)

Check the availability of connection of the power backup unit and the capacitor unit. The powering energy at retraction/ tool escape is supplied to the capacitor unit.

(1) Specifications

Model Name		MDS-D-CU	MDS-DH-CU
Compatible power backup unit name		MDS-D-PFU	MDS-DH-PFU
Capacity [μF]		28000	7000
DC Input and output	Rated voltage [V]	DC270 to 311	DC513 to 648
Environment	Ambient temperature	Operation: 0 to 55°C (with no freezing) Storage / Transportation: -15°C to 70°C (with no freezing)	
	Ambient humidity	Operation / Storage / Transportation: 90%RH or less (with no dew condensation)	
	Atmosphere	Indoors (no direct sunlight) With no corrosive gas, inflammable gas, oil mist, dust or conductive fine particles	
	Altitude	Operation/Storage: 1000 meters or less above sea level, Transportation: 13000 meters or less above sea level	
	Vibration	Operation / Storage: 4.9m/s^2 (0.5G) or less	
Cooling method		Natural air cooling	
Mass [kg]		11	

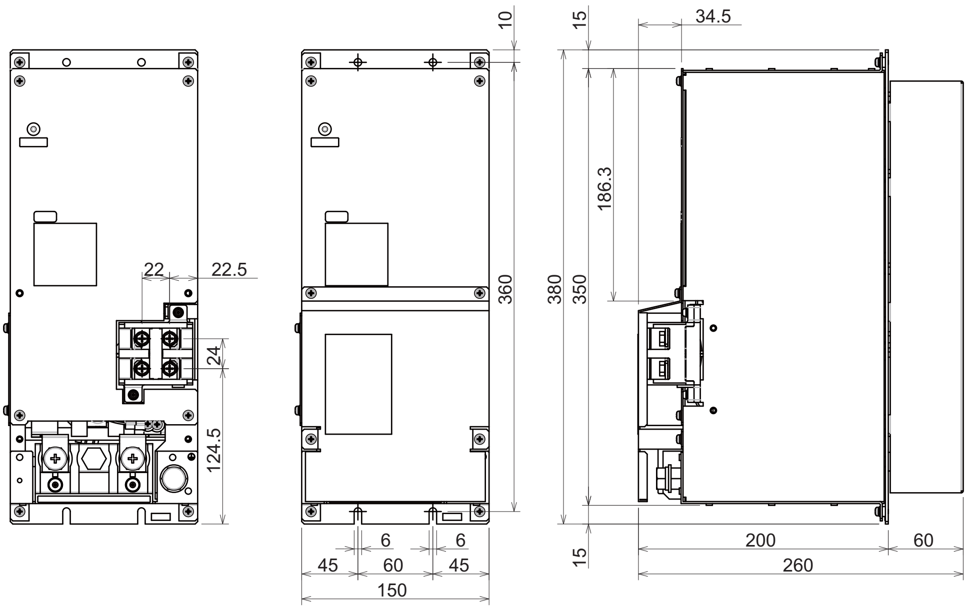
⚠ **CAUTION**

1. Only the designated combination can be used for the power backup unit and the capacitor unit.
   There is a risk of fire, so always use the designated combination.
2. Do not reverse the polarity when connecting.
3. When using the retraction/tool escape function, the supported software version for the power backup unit is A1 or later.
4. Select the function setting dip switch (SW2) of the power backup unit according to the capacitor unit to be used.

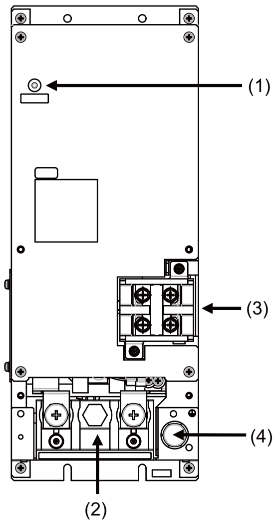
(2) Outline dimension drawings

< MDS-D-CU/MDS-DH-CU >

[Unit : mm]



(3) Explanation of each part
< MDS-D-CU/MDS-DH-CU >

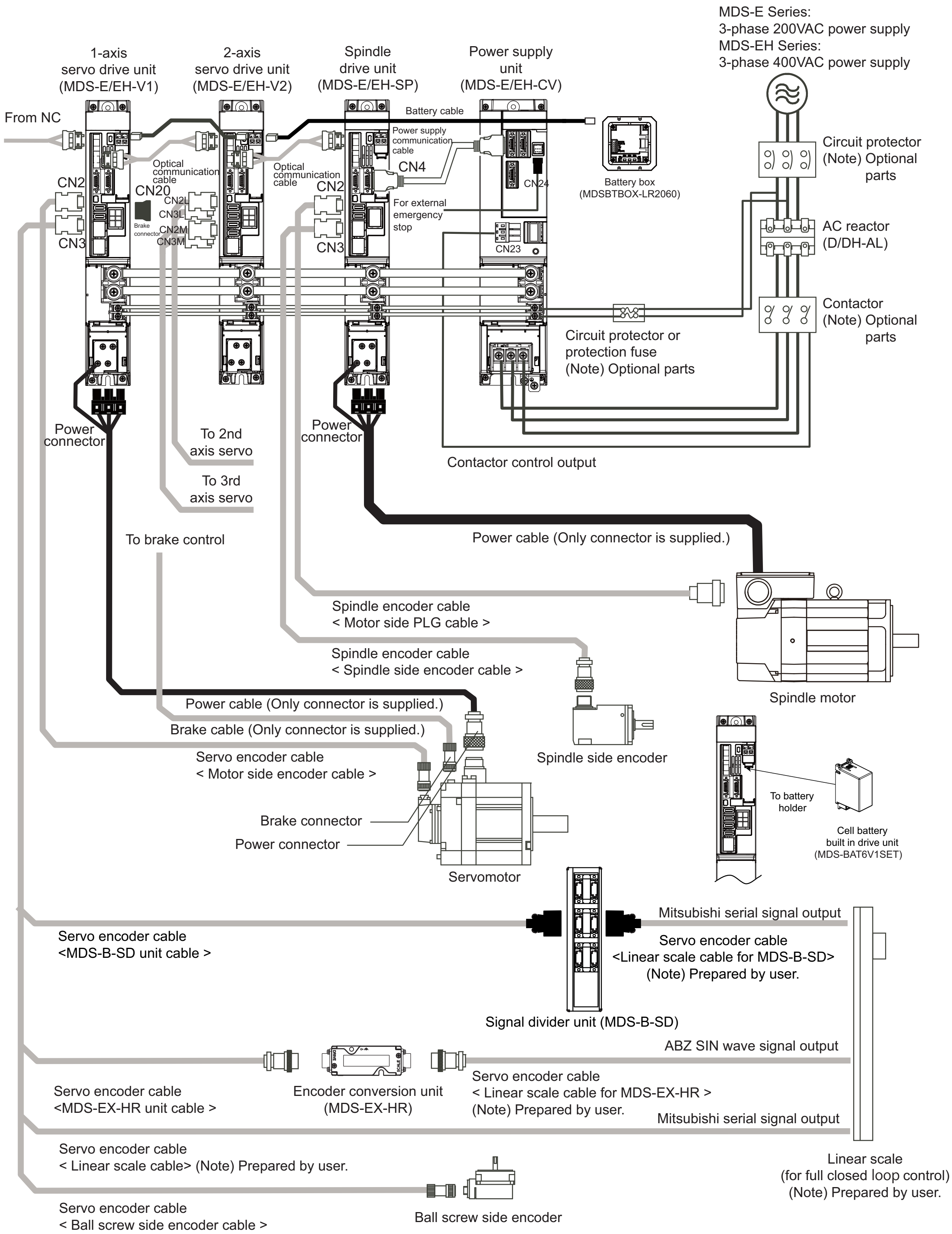


	Name		Function	Compatible wire	Terminal specification
(1)	Charge LED	---	Voltage status indication between TE1 terminals	---	---
(2)	TE1	C+ C-	PFU connection terminal	AWG#4 (22 mm^2)	M10 screw Compatible crimp terminal: Round: Up to 8-10
(3)	TE2	C+ C-	Capacitor unit connection terminal (for extension)	AWG#4 (22 mm^2)	M6 screw Compatible crimp terminal: Round: Up to 8-6
(4)	PE		Grounding terminal	AWG#10 (5.5 mm^2)	M10 screw Compatible crimp terminal: Round: Up to 8-10

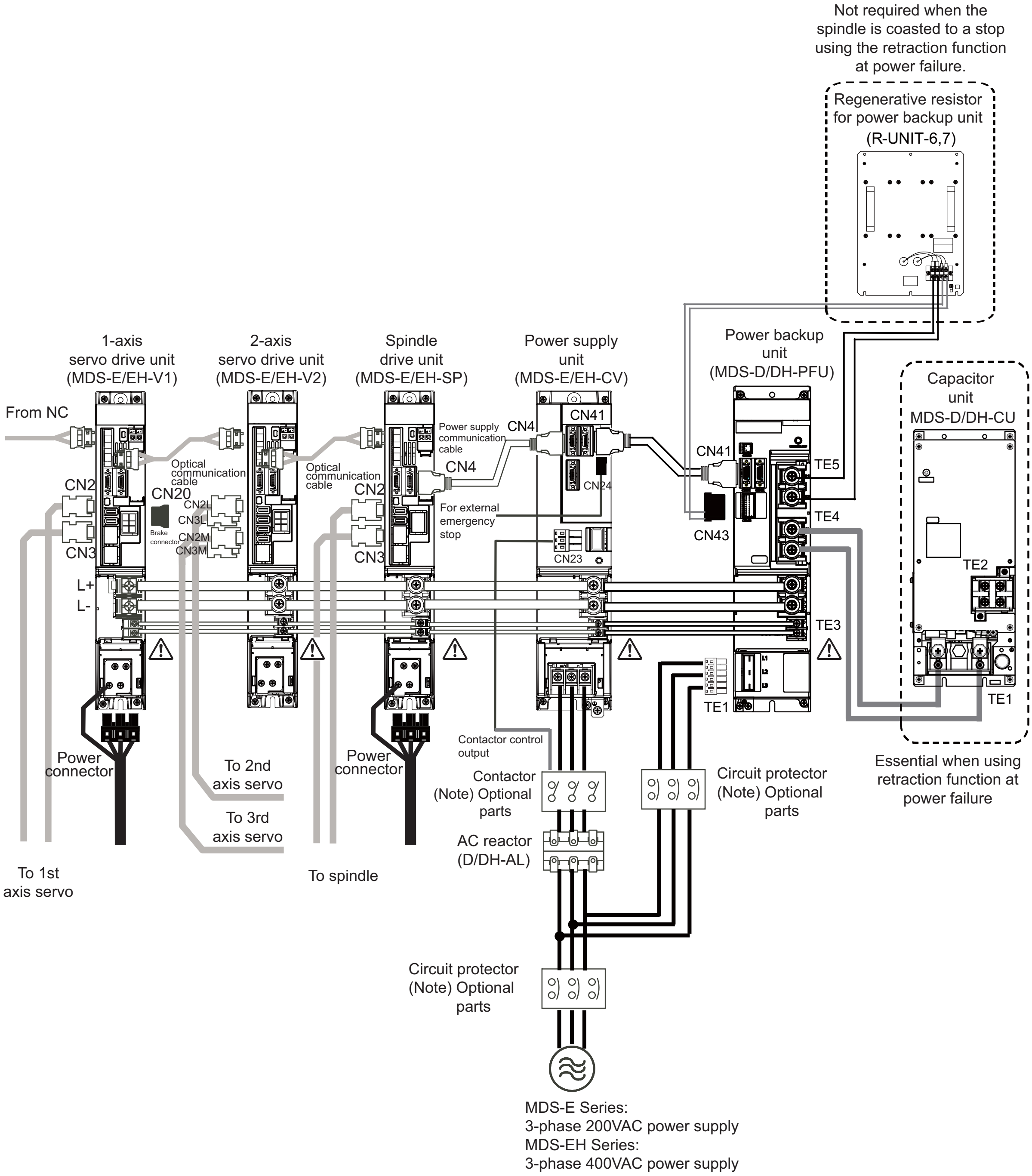
5.5 Cables and Connectors

5.5.1 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.



< When MDS-D/DH-PFU is connected >



⚠ CAUTION

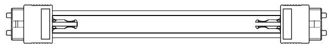
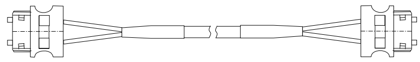
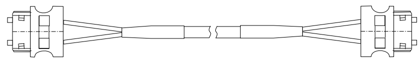
Connect the PFU's TE3 (OUT-L11, OUT-L21) to L11 and L21 of each unit.

Do not connect them to a commercial AC power supply. The unit will be damaged if connecting the PFU's TE3 to a commercial AC power supply.

When retrofitting the PFU, disconnect commercial AC power from L11, L21.

5.5.2 List of Cables and Connectors

< Optical communication cable >

Item		Model	Contents	
For CN1A/ CN1B	Optical communication cable For wiring between drive units (inside panel)	J396 L □ M □ : Length 0.3, 0.5, 1, 2, 3, 5m	Drive unit side connector (Honda Tsushin Kogyo) Connector: LGP-Z0007PK 	Drive unit side connector (Honda Tsushin Kogyo) Connector: LGP-Z0007PK
	Optical communication cable For wiring between drive units (outside panel) For NC - drive unit	J395 L □ M □ : Length 3, 5, 7, 10m	Drive unit side connector (Honda Tsushin Kogyo) Connector: LGP-Z0007PK 	Drive unit side connector (Honda Tsushin Kogyo) Connector: LGP-Z0007PK
	Optical communication cable For wiring between drive units (outside panel)	G380 L □ M □ : Length 5, 10, 12, 15, 20, 25, 30m	Drive unit side connector (Tyco Electronics) Connector: 1123445-1 	Drive unit side connector (Tyco Electronics) Connector: 1123445-1

(Note) For details on the optical communication cable, refer to the section "Optical Communication Cable Specification".

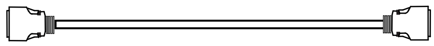
< Battery cable and connector >

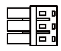
Item		Model	Contents	
For drive unit	Battery cable (For drive unit - battery box, For drive unit - drive unit)	DG30- □ M □ : Length 0.3, 0.5, 1.0, 2.0, 3.0, 5.0, 7.0, 10.0m	Battery input side connector (J.S.T) Connector: PAP-02V-O Contact: SPHD-001G-P0.5 (Note 1) 	Battery output side connector (J.S.T) Connector: PHR-2-BL Contact: SPH-002GW-P0.5S (Note 2)

(Note 1) Hand crimping tools: YC-611R
(Note 2) Hand crimping tools: YRM-240

< Power supply communication cable and connector >

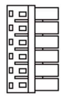
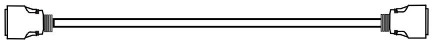
<table>
<tr><th colspan="2">Item</th><th>Model</th><th colspan="2">Contents</th></tr>
<tr><td>For CN4/9</td><td>Power supply communication cable</td><td>SH21
Length:
0.35, 0.5, 1, 2, 3m</td><td colspan="2">Drive unit side connector (3M)
Connector: 10120-6000EL
Shell kit : 10320-3210-000

Power supply unit side connector (3M)
Connector: 10120-6000EL
Shell kit : 10320-3210-000
</td></tr>
<tr><td rowspan="2">For CN4/9</td><td rowspan="2">Power supply communication cable connector set</td><td rowspan="2">FCUA-CS000</td><td>Drive unit side connector (3M)
Connector: 10120-3000VE
Shell kit : 10320-52F0-008
</td><td>Power supply unit side connector (3M)
Connector: 10120-3000VE
Shell kit : 10320-52F0-008
</td></tr>
<tr><td>Compatible part (Note 1)
(J.S.T)
Connector : MS-P20-L
Shell kit : MS20-2B-28</td><td>Compatible part (Note 1)
(J.S.T)
Connector : MS-P20-L
Shell kit : MS20-2B-28</td></tr>
<tr><td rowspan="2">For CN23</td><td rowspan="2">Contactor control output connector</td><td rowspan="2">CNU23SCV2(AWG14)
These connectors are supplied for each power supply unit.

Applicable cable size:
0.85mm² to 3.5mm²
Cable finish outside diameter:
to Φ4.2mm</td><td colspan="2">Power supply unit side connector
(J.S.T.)
03JFAT-SAXGSA-L
</td></tr>
<tr><td colspan="2">Connection lever
(J.S.T.)
J-FAT-OT-EXL
</td></tr>
<tr><td>For CN24</td><td>External emergency stop connector</td><td>CNU24S (AWG24)</td><td colspan="2">Power supply unit side connector
(DDK)
Connector : DK-2100D-08R
Contact : DK-2RECSLP1-100 (Note 2)
</td></tr>
</table>

(Note 1) The names of compatible parts may be changed at the manufacturer's discretion. Contact each manufacturer for more information.
(Note 2) Hand crimping tools:357J-22733

< Power backup unit (MDS-D/DH-PFU) cable and connector >

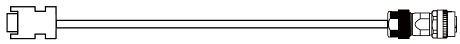
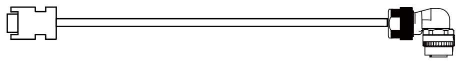
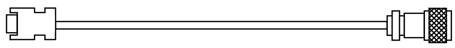
Item		Model	Contents
For power backup unit TE1	Power connector for MDS-D/DH-PFU	CNU01SPFU (AWG14)	For TE1 (For power supply) 05JFAT-SAXGSA-L (J.S.T.) 
			Connection lever J-FAT-OT-EXL (J.S.T.) 
For power backup unit CN43	Input/output connector for MDS-D/DH-PFU	CNU43S(AWG22)	For CN43 (DDK) Connector: DK-2100D-20R Contact: DK-2RECMLP1-100 (Note 1) 
For power backup unit CN41	Power supply communication cable	SH21 Length: 0.35, 0.5, 0.7, 1, 1.5, 2,2.5, 3, 3.5, 4, 4.5, 5, 6, 7, 8, 9, 10, 15, 20, 30m	Drive unit side connector (3M) Connector: 10120-6000EL Shell kit : 10320-3210-000 Power supply unit side connector (3M) Connector: 10120-6000EL Shell kit : 10320-3210-000 

(Note 1) Hand crimping tools:357J-22734

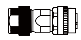
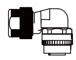
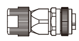
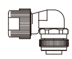
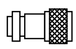
< STO input connector >

Item		Model	Contents
For CN8	STO cable	MR-D05UDL3M-B	Connector set：2069250-1 (Tyco Electronics) 
	STO short-circuit connector	These connectors are supplied for each drive unit.	Required when not using dedicated wiring STO function. Drive unit side connector (Japan Aviation Electronics Industry) DZ02B008DC1 

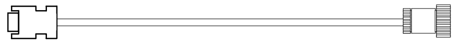
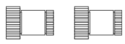
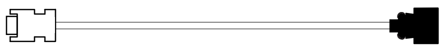
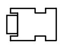
< Servo motor/Tool spindle motor cable and connector >

Item		Model	Contents	
For CN2/3 For CN3L/ CN3M/ CN3S	For HG/HG-H, HQ-H, HK/HK-H, HG-JR Motor side encoder cable (for D47/D48/D51/D74/G48) Ball screw side encoder cable (OSA405ET2AS, OSA676ET2AS)	CNV2E-8P- ☐ M ☐ : Length 2, 3, 4, 5, 7, 10, 15, 20, 25, 30m	Drive unit side connector (3M) Receptacle: 36210-0100PL Shell kit : 36310-3200-008 	Motor encoder/ Ball screw side encoder side connector (DDK) Plug : CMV1-SP10S-M2 Contact: CMV1-#22ASC-S1
			Compatible part (Note 1) (MOLEX) Connector set : 54599-1019 (J.S.T.) Plug connector : XV-10P-03-L-R Cable kit : XV-PCK10-R	
		CNV2E-9P- ☐ M ☐ : Length 2, 3, 4, 5, 7, 10, 15, 20, 25, 30m	Drive unit side connector (3M) Receptacle: 36210-0100PL Shell kit : 36310-3200-008 	Motor encoder/ Ball screw side encoder side connector (DDK) Plug : CMV1-AP10S-M2 Contact: CMV1-#22ASC-S1
			Compatible part (Note 1) (MOLEX) Connector set : 54599-1019 (J.S.T.) Plug connector : XV-10P-03-L-R Cable kit : XV-PCK10-R	
	For HG-H1502 Motor side encoder cable (for D48/ D51/D74)	MR-ENE4CBL ☐ M-H-MTH ☐ : Length 5, 10, 20, 30m	Drive unit side connector (3M) Receptacle: 36210-0100PL Shell kit: 36310-3200-008 	Motor encoder encoder side connector (DDK) Connector: D/MS3106A20-29S Clamp: CE3057-12A-3(D240)(R1)
			Compatible part (Note 1) (MOLEX) Connector set : 54599-1019 (J.S.T.) Plug connector : XV-10P-03-L-R Cable kit : XV-PCK10-R	

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

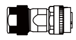
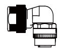
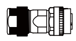
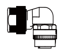
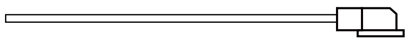
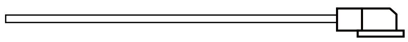
Item		Model	Contents
For motor encoder/ Ball screw side encoder	For HG/HG-H/HQ-H/HK/HK-H/ HG-JR Motor side encoder connector (for D47/D48/D51/D74/ G48)/ Ball screw side encoder connector (OSA405ET2AS, OSA676ET2AS)	CNE10-R10S(9) Applicable cable outline Φ6.0 to 9.0mm	Motor encoder/ Ball screw side encoder side connector (DDK) Plug : CMV1-SP10S-M2 Contact: CMV1-#22ASC-S1 
		CNE10-R10L(9) Applicable cable outline Φ6.0 to 9.0mm	Motor encoder/ Ball screw side encoder side connector (DDK) Plug : CMV1-AP10S-M2 Contact: CMV1-#22ASC-S1 
		CNE10S-R10S(9) Applicable cable outline Φ6.0 to 9.0mm (Threaded mating type)	Motor encoder/ Ball screw side encoder side connector (DDK) Plug : CMV1S-SP10S-M2 Contact: CMV1-#22ASC-S1 
		CNE10S-R10L(9) Applicable cable outline Φ6.0 to 9.0mm (Threaded mating type)	Motor encoder/ Ball screw side encoder side connector (DDK) Plug : CMV1S-AP10S-M2 Contact: CMV1-#22ASC-S1 
	For HG-H1502 Motor side encoder connector (for D48/D51/D74)	CNE20-29S(10) Applicable cable outline Φ6.8 to 10mm	Motor encoder encoder side connector (DDK) Connector: D/MS3106A20-29S Clamp: CE3057-12A-3(D240)(R1) 

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

Item		Model	Contents	
CN3	MDS-EX-HR unit cable	CNV2E-HP- □ M □ : Length 2, 3, 4, 5, 7, 10, 15, 20, 25, 30m	Drive unit side connector (3M) Receptacle: 36210-0100PL Shell kit : 36310-3200-008	MDS-EX-HR unit side connector (Hirose Electric) Plug : RM15WTPZ-8S (71) Clamp: JR13WCCA-10(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	
For MDS-EX-HR unit	MDS-EX-HR connector (For DRIVE, CON1,2: 1) (For SCALE, CON3: 1)	CNEHRS(10) Applicable cable outline Φ8.5 to 11mm	MDS-EX-HR unit side connector (Hirose Electric) Plug : RM15WTPZ-8S(71) (for DRIVE, CON1, 2) RM15WTPZ-12P (71) (for SCALE, CON3) Clamp: JR13WCCA-10 (72) * Two clamps are enclosed. 	
CN3	MDS-B-SD unit cable	CNV2E-D- □ M □ : Length 2, 3, 4, 5, 7, 10, 15, 20, 25, 30m	Drive unit side connector (3M) Receptacle: 36210-0100PL Shell kit : 36310-3200-008	MDS-B-SD unit side connector (3M) Connector: 10120-3000VE Shell kit : 10320-52F0-008
				
			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: MS-P20-L Shell kit: MS20-2B-28
For MDS-B-SD unit	MDS-B-SD connector (Two-piece set)	FCUA-CS000	MDS-B-SD unit side connector (3M) Connector: 10120-3000VE Shell kit : 10320-52F0-008 	MDS-B-SD unit side connector (J.S.T) Connector: 10120-3000VE Shell kit : 10320-52F0-008 
			Compatible part (Note 1) (J.S.T.) Connector: MS-P20-L Shell kit: MS20-2B-28	Compatible part (Note 1) (J.S.T.) Connector: MS-P20-L Shell kit: MS20-2B-28
For CN2/3	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	

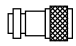
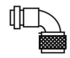
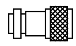
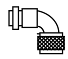
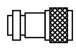
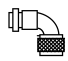
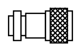
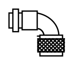
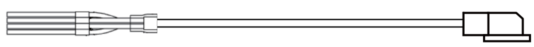
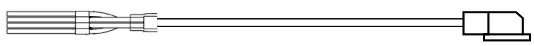
(Note 1) The names of compatible parts may be changed at the manufacturer's discretion. Contact each manufacturer for more information.

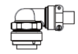
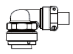
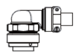
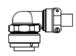
< Brake cable and connector >

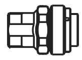
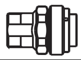
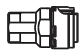
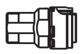
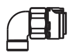
Item		Model	Contents
For motor brake	Brake connector for < 200V series > HG (Except for HG46, 56, 96), HK < 400V series > HG-H, HQ-H, HK-H	CNB10-R2S(6) Applicable cable outline Φ4.0 to 6.0mm	Servo motor side brake connector (DDK) Plug : CMV1-SP2S-S Contact: CMV1-#22BSC-S2 
		CNB10-R2L(6) Applicable cable outline Φ4.0 to 6.0mm	Servo motor side brake connector (DDK) Plug : CMV1-AP2S-S Contact: CMV1-#22BSC-S2 
		CNB10S-R2S(6) Applicable cable outline Φ4.0 to 6.0mm (Threaded mating type)	Servo motor side brake connector (DDK) Plug : CMV1S-SP2S-S Contact: CMV1-#22BSC-S2 
		CNB10S-R2L(6) Applicable cable outline Φ4.0 to 6.0mm (Threaded mating type)	Servo motor side brake connector (DDK) Plug : CMV1S-AP2S-S Contact: CMV1-#22BSC-S2 
	Brake cable for < 200V series > HG46, 56, 96	MR-BKS1CBL ☐ M-A1-H Lead out in direction of motor shaft ☐ : Length 2, 3, 5, 7, 10m	Servo motor side brake connector (Japan Aviation Electronics Industry) Plug : JN4FT02SJ1-R Contact: ST-TMH-S-C1B-100-(A534G) 
		MR-BKS1CBL ☐ M-A2-H Lead out in opposite direction of motor shaft ☐ : Length 2, 3, 5, 7, 10m	Servo motor side brake connector (Japan Aviation Electronics Industry) Plug : JN4FT02SJ1-R Contact: ST-TMH-S-C1B-100-(A534G) 
For CN20	Brake connector for motor brake control output	CNU23S(AWG14)	Servo drive unit side connector (DDK) Connector : DK-3200M-06RXY Contact: DK-3RECLLP1-100 (Note 1) 

(Note 1) Hand crimping tools: 357J-22112

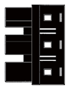
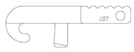
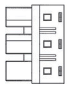
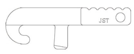
< Power connector >

Item		Model	Contents
For motor power	Power connector for < 200V series > HG75,105,54,104,154,224, 123, 223, 142 HG-JR73, 153 □ -S105003 < 400V series > HG-H75,105,54,104,154, 224 HG-JR734, 1534 □ - S105003	CNP18-10S(14) Applicable cable outline Φ10.5 to 14mm	Motor side power connector (DDK) Plug: CE05-6A18-10SD-D-BSS(R1) Clamp: CE3057-10A-1-D(R1) 
		CNP18-10L(14) Applicable cable outline Φ10.5 to 14mm	Motor side power connector (DDK) Plug: CE05-8A18-10SD-D-BAS(R1) Clamp: CE3057-10A-1-D(R1) 
	Power connector for < 200V series > HG204,354,303,453,603, 302 < 400V series > HG-H204,354,453,703	CNP22-22S(16) Applicable cable outline Φ12.5 to 16mm	Motor side power connector (DDK) Plug: CE05-6A22-22SD-D-BSS(R1) Clamp: CE3057-12A-1-D(R1) 
		CNP22-22L(16) Applicable cable outline Φ12.5 to 16mm	Motor side power connector (DDK) Plug: CE05-8A22-22SD-D-BAS(R1) Clamp: CE3057-12A-1-D(R1) 
	Power connector for < 200V series > HG702,703,903,1103 < 400V series > HG-H903 HQ-H903,1103	CNP32-17S(23) Applicable cable outline Φ22 to 23.8mm	Motor side power connector (DDK) Plug: CE05-6A32-17SD-D-BSS(R1) Clamp: CE3057-20A-1-D(R1) 
		CNP32-17L(23) Applicable cable outline Φ22 to 23.8mm	Motor side power connector (DDK) Plug: CE05-8A32-17SD-D-BAS(R1) Clamp: CE3057-20A-1-D(R1) 
	Power connector for < 200V series > HG75, 105 □ -S105010 HG-JR73, 153 □ -S105010 < 400V series > HG-H75, 105 □ -S105010 HG-JR734, 1534 □ - S105010	CNP14-2S(12) Applicable cable outline Φ10 to 12mm	Motor side power connector (DDK) Plug: CE05-6A14S-2SD-D-BSS(D111)(R1) Clamp: CE3057-8A-1D(R1) 
		CNP14-2L(12) Applicable cable outline Φ10 to 12mm	Motor side power connector (DDK) Plug: CE05-8A14S-2SD-D-BAS(D111)(R1) Clamp: CE3057-8A-1D(R1) 
	Power cable for < 200V series > HG46, 56, 96	MR-PWS1CBL □ M-A1-H Lead out in direction of motor shaft □ : Length 2, 3, 5, 7, 10m	Motor side power connector (Japan Aviation Electronics Industry) Plug: JN4FT04SJ1-R Contact: ST-TMH-S-C1B-100-(A534G) 
		MR-PWS1CBL □ M-A2-H Lead out in opposite direction of motor shaft □ : Length 2, 3, 5, 7, 10m	Motor side power connector (Japan Aviation Electronics Industry) Plug: JN4FT04SJ1-R Contact: ST-TMH-S-C1B-100-(A534G) 

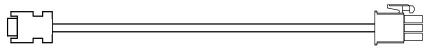
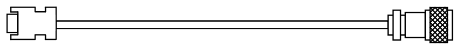
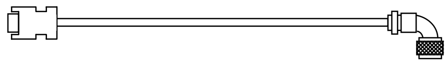
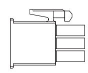
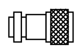
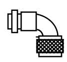
Item		Model	Contents
For motor power	Power connector for < 200V series > HK76, 105, 55, 104, 123, 142, 154, 223, 224 < 400V series > HK-H76, 105, 55, 104, 123, 154, 223, 224	Applicable cable outline Φ8.0 to 11.0mm	Motor side power connector (Japan Aviation Electronics Industry) Plug: JL10-6A18-10SE-EB Clamp: JL04-18CK(10)-R 
		Applicable cable outline Φ11.0 to 14.1mm	Motor side power connector (Japan Aviation Electronics Industry) Plug: JL10-6A18-10SE-EB Clamp: JL04-18CK(13)-R 
		Applicable cable outline Φ8.0 to 11.0mm	Motor side power connector (Japan Aviation Electronics Industry) Plug: JL10-8A18-10SE-EB Clamp: JL04-18CK(10)-R 
		Applicable cable outline Φ11.0 to 14.1mm	Motor side power connector (Japan Aviation Electronics Industry) Plug: JL10-8A18-10SE-EB Clamp: JL04-18CK(13)-R 
		Applicable cable outline Φ8.0 to 11.0mm (Threaded mating type)	Motor side power connector (Japan Aviation Electronics Industry) Plug: JL04V-6A18-10SE-EB-R Clamp: JL04-18CK(10)-R 
		Applicable cable outline Φ11.0 to 14.1mm (Threaded mating type)	Motor side power connector (Japan Aviation Electronics Industry) Plug: JL04V-6A18-10SE-EB-R Clamp: JL04-18CK(13)-R 
		Applicable cable outline Φ8.0 to 11.0mm (Threaded mating type)	Motor side power connector (Japan Aviation Electronics Industry) Plug: JL04V-8A18-10SE-EBH-R Clamp: JL04-18CK(10)-R 
		Applicable cable outline Φ11.0 to 14.1mm (Threaded mating type)	Motor side power connector (Japan Aviation Electronics Industry) Plug: JL04V-8A18-10SE-EBH-R Clamp: JL04-18CK(13)-R 

Item		Model	Contents
For motor power	Power connector for < 200V series > HK204, 302, 303, 354, 453, 603, 702, 703 < 400V series > HK-H204, 302, 303, 354, 453, 603, 702, 703	Applicable cable outline Φ9.5 to 13.0mm	Motor side power connector (Japan Aviation Electronics Industry) Plug: JL10-6A22-22SE-EB Clamp: JL04-2022CK(12)-R 
		Applicable cable outline Φ12.9 to 16.0mm	Motor side power connector (Japan Aviation Electronics Industry) Plug: JL10-6A22-22SE-EB Clamp: JL04-2022CK(14)-R 
		Applicable cable outline Φ9.5 to 13.0mm	Motor side power connector (Japan Aviation Electronics Industry) Plug: JL10-8A22-22SE-EB Clamp: JL04-2022CK(12)-R 
		Applicable cable outline Φ12.9 to 16.0mm	Motor side power connector (Japan Aviation Electronics Industry) Plug: JL10-8A22-22SE-EB Clamp: JL04-2022CK(14)-R 
		Applicable cable outline Φ9.5 to 13.0mm (Threaded mating type)	Motor side power connector (Japan Aviation Electronics Industry) Plug: JL04V-6A22-22SE-EB-R Clamp: JL04-2022CK(12)-R 
		Applicable cable outline Φ12.9 to 16.0mm (Threaded mating type)	Motor side power connector (Japan Aviation Electronics Industry) Plug: JL04V-6A22-22SE-EB-R Clamp: JL04-2022CK(14)-R 
		Applicable cable outline Φ9.5 to 13.0mm (Threaded mating type)	Motor side power connector (Japan Aviation Electronics Industry) Plug: JL04V-8A22-22SE-EBH-R Clamp: JL04-2022CK(12)-R 
		Applicable cable outline Φ12.9 to 16.0mm (Threaded mating type)	Motor side power connector (Japan Aviation Electronics Industry) Plug: JL04V-8A22-22SE-EBH-R Clamp: JL04-2022CK(14)-R 

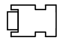
<table>
<tr><th colspan="2">Item</th><th>Model</th><th>Contents</th></tr>
<tr><td rowspan="4">For TE1</td><td rowspan="2">Power connector for
MDS-E-V1-20 to 160W
MDS-E-V2-20 to 160W
MDS-E-V3-20 to 80
MDS-E-SP-20 to 80
MDS-E-SP2-20 to 80
MDS-E-SP2-16080 (M-axis)

MDS-EH-V1-10 to 80W
MDS-EH-V2-10 to 160
MDS-EH-V3-40
MDS-EH-SP-20 to 80</td><td rowspan="2">- All axes
CNU01SEF(AWG14)
- L-axis only
CNU01SEL(AWG14)
- M-axis only
CNU01SEM(AWG14)
- S-axis only
CNU01SES(AWG14)</td><td>Drive unit side power connector
(J.S.T)
Connector : 03JFAT-SAFGDK-P15 (All axes)
: 03JFAT-SAXGDK-P15 (L-axis only)
: 03JFAT-SAYGDK-P15 (M-axis only)
: 03JFAT-SAZGDK-P15 (S-axis only)
</td></tr>
<tr><td>Connection lever
J-FAT-OT-P
(J.S.T)
</td></tr>
<tr><td rowspan="2">Power connector for
MDS-E-CV-37/75</td><td rowspan="2">CNU01SECV (AWG14)</td><td>Drive unit side power connector (J.S.T)
Connector : 03JFAT-SAZGDS-P15 (CV-37/75 only)
</td></tr>
<tr><td>Connection lever
J-FAT-OT-P
(J.S.T)
</td></tr>
</table>

< Spindle encoder cable and connector >

Item		Model	Contents	
For CN2	Motor side PLG cable Spindle side accuracy encoder TS5690 cable	CNP2E-1- ☐ M ☐ : Length 2, 3, 4, 5, 7, 10, 15, 20, 25, 30m	Spindle drive unit side connector (3M) Receptacle: 36210-0100PL Shell kit : 36310-3200-008 	Spindle motor side connector (Tyco Electronics) Connector: 172169-1 Contact:170363-1(AWG26-22) 170364-1(AWG22-18)
			Compatible part (Note 1) (MOLEX) Connector set: 54599-1019 (J.S.T.) Plug connector : XV-10P-03-L-R Cable kit : XV-PCK10-R	
For CN3	Spindle side encoder OSE-1024 cable	CNP3EZ-2P- ☐ M ☐ : Length 2, 3, 4, 5, 7, 10, 15, 20, 25, 30m	Spindle drive unit side connector (3M) Receptacle: 36210-0100PL Shell kit : 36310-3200-008 	Spindle motor side connector (DDK) Connector: D/MS3106A20-29S Clamp: CE3057-12A-3(D240)(R1)
			Compatible part (Note 1) (MOLEX) Connector set: 54599-1019 (J.S.T.) Plug connector : XV-10P-03-L-R Cable kit : XV-PCK10-R	
		CNP3EZ-3P- ☐ M ☐ : Length 2, 3, 4, 5, 7, 10, 15, 20, 25, 30m	Spindle drive unit side connector (3M) Receptacle: 36210-0100PL Shell kit : 36310-3200-008 	Spindle motor side connector (DDK) Connector: D/MS3108B20-29S Clamp: CE3057-12A-3(D240)(R1)
			Compatible part (Note 1) (MOLEX) Connector set: 54599-1019 (J.S.T.) Plug connector : XV-10P-03-L-R Cable kit : XV-PCK10-R	
For spindle motor	Motor side PLG connector Spindle side accuracy encoder TS5690 connector	CNEPGS		Spindle motor side connector (Tyco Electronics) Connector: 172169-1 Contact:170363-1(AWG26-22) 170364-1(AWG22-18) 
For spindle motor	Spindle side encoder OSE-1024 cable	CNE20-29S(10) Applicable cable outline Φ6.8 to 10mm		Spindle motor side connector (DDK) Connector:D/MS3106A20-29S Clamp: CE3057-12A-3(D240)(R1) 
		CNE20-29L(10) Applicable cable outline Φ6.8 to 10mm		Spindle motor side connector (DDK) Connector:D/MS3108B20-29S Clamp: CE3057-12A-3(D240)(R1) 

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

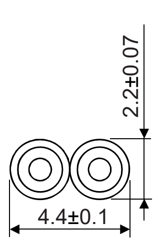
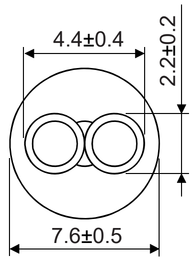
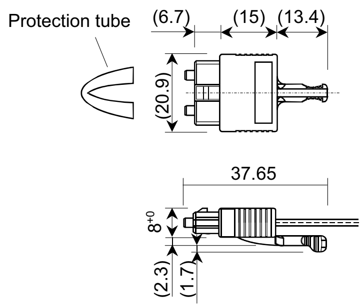
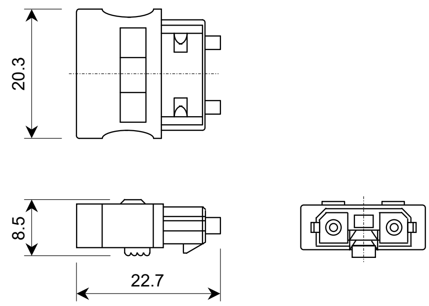
Item		Model	Contents
For CN2/3	Spindle encoder drive unit side connector	CNU2S(AWG18)	Spindle drive unit side connector (3M) Receptacle: 36210-0100PL Shell kit : 36310-3200-008 
			Compatible part (Note 1) (MOLEX) Connector set: 54599-1019 (J.S.T.) Plug connector : XV-10P-03-L-R Cable kit : XV-PCK10-R

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

< Contact information >
- Japan Aviation Electronics Industry, Limited: http://www.jae.com/en/index.html
- HIROSE ELECTRIC CO., LTD.: https://www.hirose.com/?lang=en
- 3M: http://www.3m.com/
- J.S.T. Mfg. Co., Ltd.: http://www.jst-mfg.com/index_e.php
- DDK Ltd.: http://www.ddknet.co.jp/English/index.html
- Tyco Electronics Japan G.K.: http://www.te.com/en/home.html
- Molex, LLC.: http://www.molex.com/

5.5.3 Optical Communication Cable Specifications

(1) Specifications

Cable model		J396 L □ M	J395 L □ M	G380 L □ M
Specification application		For wiring inside panel	For wiring outside panel	For wiring outside panel For long distance wiring
Cable length		0.3, 0.5, 1.0, 2.0, 3.0, 5.0m	3, 5, 7, 10m	5, 10, 12, 15, 20, 25, 30m
Optical communication cable	Minimum bend radius	25mm	Enforced covering cable: 50mm cord: 30mm	
	Tension strength	140N	980N (Enforced covering cable)	
	Temperature range for use (Note1)	-40 to 85°C	-20 to 70°C	
	Ambient	Indoors (no direct sunlight) No solvent or oil		
	Cable appearance [mm]			
	Connector appearance [mm]			

(Note 1) This temperature range for use is the value for optical cable (cord) only. Temperature condition for the connector is the same as that for drive unit.

(Note 2) 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.)

(2) Cautions for using optical communication cable

Optical communication cable is made from optical fiber. If optical fiber is added a power such as a major shock, lateral pressure, haul, sudden bending or twist, its inside distorts or breaks, and optical transmission will not be available. Especially, as optical fiber for J396 L□M is made of synthetic resin, it melts down if being left near the fire or high temperature. Therefore, do not make it touched the part, which becomes high temperature, such as radiator or regenerative brake option of drive unit.

Read described item in this section carefully and handle it with caution.

(a) Minimum bend radius

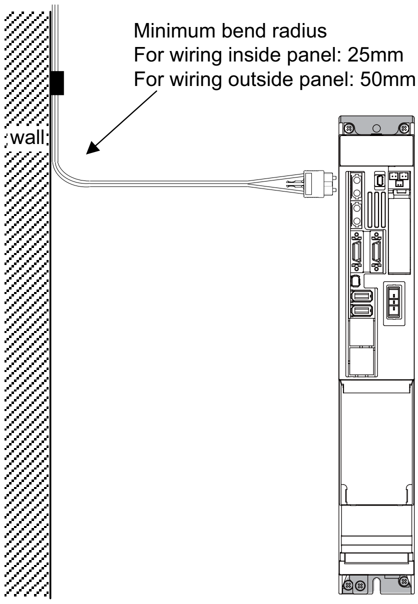
Make sure to lay the cable with greater radius than the minimum bend radius. Do not press the cable to edges of equipment or others. For the optical communication cable, the appropriate length should be selected with due consideration for the dimensions and arrangement of drive unit so that the cable bend will not become smaller than the minimum bend radius in cable laying. When closing the door of control box, pay careful attention for avoiding the case that optical communication cable is hold down by the door and the cable bend becomes smaller than the minimum bend radius.

Lay the cable so that the numbers of bends will be less than 10 times.

(b) Bundle fixing

When using optical communication cable of 3m or longer, fix the cable at the closest part to the connector with bundle material in order to prevent optical communication cable from putting its own weight on CN1A/CN1B connector of drive unit. Optical cord should be given loose slack to avoid from becoming smaller than the minimum bend radius, and it should not be twisted.

When tightening up the cable with nylon band, the sheath material should not be distorted. Fix the cable with tightening force of 1 to 2kg or less as a guide.



When laying cable, fix and hold it in position with using cushioning such as sponge or rubber which does not contain plasticizing material. If it is fixed by a cable tie and the like without using cushioning, the wire breakage may occur. Never use vinyl tape for cord. Plasticizing material in vinyl tape goes into optical fiber and lowers the optical characteristic. At worst, it may cause wire breakage. If using adhesive tape for cable laying, the fire resistant acetate cloth adhesive tape 570F (Teraoka Seisakusho Co., Ltd) is recommended.

If laying with other wires, do not make the cable touched wires or cables made from material which contains plasticizing material.

(c) Tension

If tension is added on optical fiber, the increase of transmission loss occurs because of external force which concentrates on the fixing part of optical fiber or the connecting part of optical connector. At worst, the breakage of optical fiber or damage of optical connector may occur. For cable laying, handle without putting forced tension.

(d) Lateral pressure

If lateral pressure is added on optical communication cable, the optical cable itself distorts, internal optical fiber gets stressed, and then transmission loss will increase. At worst, the breakage of optical cable may occur. As the same condition also occurs at cable laying, do not tighten up optical communication cable with a thing such as nylon band (TY-RAP).
Do not trample it down or tuck it down with the door of control box or others.

(e) Twisting

If optical fiber is twisted, it will become the same stress added condition as when local lateral pressure or bend is added. Consequently, transmission loss increases, and the breakage of optical fiber may occur at worst.

(f) Cable selection

- When wiring is outside the power distribution panel or machine cabinet, there is a highly possibility that external power is added. Therefore, make sure to use the cable for wiring outside panel (J395 L□M)
- If a part of the wiring is moved, use the cable for wiring outside panel.
- In a place where sparks may fly and flame may be generated, use the cable for wiring outside panel.

(g) Method to lay cable

When laying the cable, do not haul the optical fiver or connector of the optical communication cable strongly. If strong force is added between the optical fiver and connector, it may lead to a poor connection.

(h) Protection when not in use

When the CN1A/CN1B connector of the drive unite or the optical communication cable connector is not used such as pulling out the optical communication cable from drive unit, protect the joint surface with attached cap or tube for edge protection. If the connector is left with its joint surface bared, it may lead to a poor connection caused by dirty.

(i) Attaching /Detaching optical communication cable connector

With holding the connector body, attach/detach the optical communication cable connector. If attaching/detaching the optical communication cable with directly holding it, the cable may be pulled out, and it may cause a poor connection.
When pulling out the optical communication connector, pull out it after releasing the lock of clock lever.

(j) Cleaning

If CN1A and CN1B connector of the drive unit or optical communication cable connector is dirty, it may cause poor connection. If it becomes dirty, wipe with a bonded textile, etc. Do not use solvent such as alcohol.

(k) Disposal

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.

(l) Return in troubles

When asking repair of drive unit for some troubles, make sure to put a cap on CN1A/CN1B connector.
When the connector is not put a cap, the light device may be damaged at the transit. In this case, exchange and repair of light device is required.

6

Specifications of Peripheral Devices

6.1 Selection of Wire

Selected wires must be able to tolerate each unit and motor terminal part to which the wire is connected.
How to calculate tolerable current of an insulated wire or cable is shown in "Tolerable current of electric cable" (1) of Japanese Cable Makers' Association Standard (JCS)-168-E (1995), its electric equipment technical standards or JEAC regulates tolerable current, etc. wire.
When exporting wires, select them according to the related standards of the country or area to export.
Wire's tolerable current is different depending on conditions such as its material, structure, ambient temperature, etc.
Check the tolerable current described in the specification of the wire to use.

6.1.1 Wire Selection Standards for Each Product

Refer to the following table to select the wire which tolerates the selection-standard current of each product.

Product	Target	Standard	Reference
Servo motor	Power cable (U, V, W, earth)	Stall current	2.1 Servo Motor
Spindle motor	Power cable (U, V, W, earth)	Continuous rated current	2.2 Spindle Motor
Tool spindle motor	Power cable (U, V, W, earth)	Rated current	2.3 Tool Spindle Motor
Power supply unit	Main circuit power cable (L1, L2, L3, earth)	Input rated current	2.4.4 Power Supply Unit
	DC connection cable or link bar (L+, L-)	Output rated current	6.8 Selection of Link Connection
Common to each unit	Control power cable (L11, L21)	Control power maximum current	

(Note) In the UL standards, certification conditions are to use wires of 60°C and 75°C product. (UL508C)

6.1.2 Example of Wires by Unit

The following are examples of wire selections for each unit based on the certification standards.
The relation between wire size and tolerable current conforms to the requirements specified in IEC/EN60204-1, UL508C, JEAC8001. However, the tolerable current is different depending on the wire specifications of each manufacturer even among the wires of the same size.

(1) 600V vinyl insulated wire (IV wire) 60°C product (Example according to IEC/EN60204-1, UL508C)
< MDS-E Series >

Unit type		Terminal name					
		TE1 (U, V, W, ⏚)		TE2 (L+, L-)		TE3 (L11, L21, L12, L22)	
		mm^2	AWG	mm^2	AWG	mm^2	AWG
Power supply unit	MDS-E-CV-37	2	14	3.5	12	2	14
	MDS-E-CV-75	5.5	10	8	8		
	MDS-E-CV-110	14	6	22	4		
	MDS-E-CV-185	22	4	38	2		
	MDS-E-CV-300	-	-	Bar enclosed			
	MDS-E-CV-370	-	-				
	MDS-E-CV-450	-	-				
	MDS-E-CV-550	-	-				
Spindle drive unit	MDS-E-SP-20	2	14	Match with TE2 of selected power supply unit		2	14
	MDS-E-SP-40	2	14				
	MDS-E-SP-80	5.5	10				
	MDS-E-SP-160	22	4				
	MDS-E-SP-200	-	-				
	MDS-E-SP-240	-	-				
	MDS-E-SP-320	-	-				
	MDS-E-SP-400	-	-	Bar enclosed			
	MDS-E-SP-640	-	-				
Spindle drive unit (2-axis)	MDS-E-SP2-20	2	14	Match with TE2 of selected power supply unit		2	14
	MDS-E-SP2-40	2	14				
	MDS-E-SP2-80	5.5	10				
	MDS-E-SP2-16080	22 (5.5)	4 (10)				
Servo drive unit	MDS-E-V1-20	2	14	Match with TE2 of selected power supply unit		2	14
	MDS-E-V1-40	2	14				
	MDS-E-V1-80	3.5	12				
	MDS-E-V1-160	8	8				
	MDS-E-V1-160W	-	-				
	MDS-E-V1-320	-	-				
	MDS-E-V1-320W	-	-				
Servo drive unit (2-axis)	MDS-E-V2-20	2	14	Match with TE2 of selected power supply unit		2	14
	MDS-E-V2-40	2	14				
	MDS-E-V2-80	3.5	12				
	MDS-E-V2-160	8	8				
	MDS-E-V2-160W	-	-				
Servo drive unit (3-axis)	MDS-E-V3-20	2	14	Match with TE2 of selected power supply unit		2	14
	MDS-E-V3-40						
	MDS-E-V3-80	3.5	12				

(Note) The values inside of ( ) are M side.

Unit type		Terminal name					
		TE1 (U, V, W, ⏚)		TE2 (L+, L-)		TE3 (L11, L21, L12, L22)	
		mm^2	AWG	mm^2	AWG	mm^2	AWG
Power backup unit	MDS-D-PFU	2	14	22	4	2	14

< MDS-EH Series >

<table>
<tr><th colspan="2" rowspan="3">Unit type</th><th colspan="6">Terminal name</th></tr>
<tr><th colspan="2">TE1
(U, V, W, ⏚)</th><th colspan="2">TE2
(L+, L-)</th><th colspan="2">TE3
(L11, L21, L12, L22)</th></tr>
<tr><th>mm²</th><th>AWG</th><th>mm²</th><th>AWG</th><th>mm²</th><th>AWG</th></tr>
<tr><td rowspan="9">Power supply unit</td><td>MDS-EH-CV-37</td><td>2</td><td>14</td><td>2</td><td>14</td><td rowspan="9">2</td><td rowspan="9">14</td></tr>
<tr><td>MDS-EH-CV-75</td><td>2</td><td>14</td><td>3.5</td><td>12</td></tr>
<tr><td>MDS-EH-CV-110</td><td>3.5</td><td>12</td><td>5.5</td><td>10</td></tr>
<tr><td>MDS-EH-CV-185</td><td>14</td><td>6</td><td>14</td><td>6</td></tr>
<tr><td>MDS-EH-CV-300</td><td>22</td><td>4</td><td>38</td><td>2</td></tr>
<tr><td>MDS-EH-CV-370</td><td>38</td><td>2</td><td>60</td><td>1/0</td></tr>
<tr><td>MDS-EH-CV-450</td><td>38</td><td>2</td><td>60 or bar enclosed</td><td>1/0 or bar enclosed</td></tr>
<tr><td>MDS-EH-CV-550</td><td>-</td><td>-</td><td colspan="2" rowspan="2">Bar enclosed</td></tr>
<tr><td>MDS-EH-CV-750</td><td>-</td><td>-</td></tr>
<tr><td rowspan="9">Spindle drive unit</td><td>MDS-EH-SP-20</td><td>2</td><td>14</td><td colspan="2" rowspan="6">Match with TE2 of selected power supply unit</td><td rowspan="9">2</td><td rowspan="9">14</td></tr>
<tr><td>MDS-EH-SP-40</td><td>3.5</td><td>12</td></tr>
<tr><td>MDS-EH-SP-80</td><td>5.5</td><td>10</td></tr>
<tr><td>MDS-EH-SP-100</td><td>14</td><td>6</td></tr>
<tr><td>MDS-EH-SP-160</td><td>-</td><td>-</td></tr>
<tr><td>MDS-EH-SP-200</td><td>-</td><td>-</td></tr>
<tr><td>MDS-EH-SP-320</td><td>-</td><td>-</td><td colspan="2" rowspan="3">Bar enclosed</td></tr>
<tr><td>MDS-EH-SP-480</td><td>-</td><td>-</td></tr>
<tr><td>MDS-EH-SP-600</td><td>-</td><td>-</td></tr>
<tr><td rowspan="8">Servo drive unit</td><td>MDS-EH-V1-10</td><td>2</td><td>14</td><td colspan="2" rowspan="7">Match with TE2 of selected power supply unit</td><td rowspan="8">2</td><td rowspan="8">14</td></tr>
<tr><td>MDS-EH-V1-20</td><td>2</td><td>14</td></tr>
<tr><td>MDS-EH-V1-40</td><td>2</td><td>14</td></tr>
<tr><td>MDS-EH-V1-80</td><td>3.5</td><td>12</td></tr>
<tr><td>MDS-EH-V1-80W</td><td>5.5</td><td>10</td></tr>
<tr><td>MDS-EH-V1-160</td><td>8</td><td>8</td></tr>
<tr><td>MDS-EH-V1-160W</td><td>14</td><td>6</td></tr>
<tr><td>MDS-EH-V1-200</td><td>-</td><td>-</td><td colspan="2">Bar enclosed</td></tr>
<tr><td rowspan="6">Servo drive unit
(2-axis)</td><td>MDS-EH-V2-10</td><td>2</td><td>14</td><td colspan="2" rowspan="6">Match with TE2 of selected power supply unit</td><td rowspan="6">2</td><td rowspan="6">14</td></tr>
<tr><td>MDS-EH-V2-20</td><td>2</td><td>14</td></tr>
<tr><td>MDS-EH-V2-40</td><td>2</td><td>14</td></tr>
<tr><td>MDS-EH-V2-80</td><td>3.5</td><td>12</td></tr>
<tr><td>MDS-EH-V2-80W</td><td>5.5</td><td>10</td></tr>
<tr><td>MDS-EH-V2-160</td><td>8</td><td>8</td></tr>
<tr><td>Servo drive unit
(3-axis)</td><td>MDS-EH-V3-40</td><td>2</td><td>14</td><td colspan="2">Match with TE2 of selected power supply unit</td><td>2</td><td>14</td></tr>
</table>

(Note) The values inside of ( ) are M side.

<table>
<tr><th colspan="2" rowspan="3">Unit type</th><th colspan="6">Terminal name</th></tr>
<tr><th colspan="2">TE1
(U, V, W,⏚)</th><th colspan="2">TE2
(L+, L-)</th><th colspan="2">TE3
(L11, L21, L12, L22)</th></tr>
<tr><th>mm²</th><th>AWG</th><th>mm²</th><th>AWG</th><th>mm²</th><th>AWG</th></tr>
<tr><td>Power backup unit</td><td>MDS-DH-PFU</td><td>2</td><td>14</td><td>22</td><td>4</td><td>2</td><td>14</td></tr>
</table>

(2) 600V double (heat proof) vinyl insulated wire (HIV wire) 75°C product (Example according to IEC/EN60204-1, UL508C)

< MDS-E Series >

Unit type		Terminal name: TE1 (U, V, W, ⏚)		TE2 (L+, L-)		TE3 (L11, L21, L12, L22)	
		mm^2	AWG	mm^2	AWG	mm^2	AWG
Power supply unit	MDS-E-CV-37	2	14	3.5	12	2	14
	MDS-E-CV-75	5.5	10	5.5	10		
	MDS-E-CV-110	8	8	14	6		
	MDS-E-CV-185	14	6	22	4		
	MDS-E-CV-300	38	2	60 or bar enclosed	1/0 or bar enclosed		
	MDS-E-CV-370	60	1/0	Bar enclosed			
	MDS-E-CV-450	60	1/0				
	MDS-E-CV-550	80	3/0				
Spindle drive unit	MDS-E-SP-20	2	14	Match with TE2 of selected power supply unit		2	14
	MDS-E-SP-40	2	14				
	MDS-E-SP-80	5.5	10				
	MDS-E-SP-160	14	6				
	MDS-E-SP-200	22	4				
	MDS-E-SP-240	38	2				
	MDS-E-SP-320	60	1/0				
	MDS-E-SP-400	80	3/0	Bar enclosed			
	MDS-E-SP-640	100	4/0				
Spindle drive unit (2-axis)	MDS-E-SP2-20	2	14	Match with TE2 of selected power supply unit		2	14
	MDS-E-SP2-40	2	14				
	MDS-E-SP2-80	5.5	10				
	MDS-E-SP2-16080	14 (5.5)	6 (10)				
Servo drive unit	MDS-E-V1-20	2	14	Match with TE2 of selected power supply unit		2	14
	MDS-E-V1-40	2	14				
	MDS-E-V1-80	3.5	12				
	MDS-E-V1-160	8	8				
	MDS-E-V1-160W	8	8				
	MDS-E-V1-320	22	4				
	MDS-E-V1-320W	38	2				
Servo drive unit (2-axis)	MDS-E-V2-20	2	14	Match with TE2 of selected power supply unit		2	14
	MDS-E-V2-40	2	14				
	MDS-E-V2-80	3.5	12				
	MDS-E-V2-160	8	8				
	MDS-E-V2-160W	8	8				
Servo drive unit (3-axis)	MDS-E-V3-20	2	14	Match with TE2 of selected power supply unit		2	14
	MDS-E-V3-40						
	MDS-E-V3-80	3.5	12				

(Note) The values inside of ( ) are M side.

Unit type		Terminal name: TE1 (U, V, W, ⏚)		TE2 (L+, L-)		TE3 (L11, L21, L12, L22)	
		mm^2	AWG	mm^2	AWG	mm^2	AWG
Power backup unit	MDS-D-PFU	2	14	22	4	2	14

< MDS-EH Series >

Unit type		Terminal name					
		TE1 (U, V, W, ⏚)		TE2 (L+, L-)		TE3 (L11, L21, L12, L22)	
		mm²	AWG	mm²	AWG	mm²	AWG
Power supply unit	MDS-EH-CV-37	2	14	2	14	2	14
	MDS-EH-CV-75	2	14	3.5	12		
	MDS-EH-CV-110	3.5	12	5.5	10		
	MDS-EH-CV-185	8	8	8	8		
	MDS-EH-CV-300	14	6	22	4		
	MDS-EH-CV-370	22	4	38	2		
	MDS-EH-CV-450	22	4	60 or bar enclosed	1/0 or bar enclosed		
	MDS-EH-CV-550	38	2	Bar enclosed			
	MDS-EH-CV-750	60	1/0				
Spindle drive unit	MDS-EH-SP-20	2	14	Match with TE2 of selected power supply unit		2	14
	MDS-EH-SP-40	3.5	12				
	MDS-EH-SP-80	5.5	10				
	MDS-EH-SP-100	8	8				
	MDS-EH-SP-160	22	4				
	MDS-EH-SP-200	38	2				
	MDS-EH-SP-320	60	1/0	Bar enclosed			
	MDS-EH-SP-480	80 or 38 (two wires)	3/0 or 2 (two wires)				
	MDS-EH-SP-600	60 (two wires)	1/0 (two wires)				
Servo drive unit	MDS-EH-V1-10	2	14	Match with TE2 of selected power supply unit		2	14
	MDS-EH-V1-20	2	14				
	MDS-EH-V1-40	2	14				
	MDS-EH-V1-80	3.5	12				
	MDS-EH-V1-80W	5.5	10				
	MDS-EH-V1-160	8	8				
	MDS-EH-V1-160W	8	8				
	MDS-EH-V1-200	22	4	Bar enclosed			
Servo drive unit (2-axis)	MDS-EH-V2-10	2	14	Match with TE2 of selected power supply unit		2	14
	MDS-EH-V2-20	2	14				
	MDS-EH-V2-40	2	14				
	MDS-EH-V2-80	3.5	12				
	MDS-EH-V2-80W	5.5	10				
	MDS-EH-V2-160	8	8				
Servo drive unit (3-axis)	MDS-EH-V3-40	2	14	Match with TE2 of selected power supply unit		2	14

(Note) The values inside of ( ) are M side.

Unit type		Terminal name					
		TE1 (U, V, W,⏚)		TE2 (L+, L-)		TE3 (L11, L21, L12, L22)	
		mm²	AWG	mm²	AWG	mm²	AWG
Power backup unit	MDS-DH-PFU	2	14	22	4	2	14

(3) 600V bridge polyethylene insulated wire (IC) 105 °C product (Example according to JEAC8001)

< MDS-E Series >

Unit type		Terminal name					
		TE1 (U, V, W, ⏚)		TE2 (L+, L-)		TE3 (L11, L21, L12, L22)	
		mm^2	AWG	mm^2	AWG	mm^2	AWG
Power supply unit	MDS-E-CV-37	2	14	2	14	1.25 to 2	16 to 14
	MDS-E-CV-75	3.5	12	3.5	12		
	MDS-E-CV-110	5.5	10	14	6		
	MDS-E-CV-185	14	6	22	4		
	MDS-E-CV-300	38	2	50	1		
	MDS-E-CV-370	38	2	60	1/0		
	MDS-E-CV-450	60	1/0	60	1/0		
	MDS-E-CV-550	60	1/0	Bar enclosed			
Spindle drive unit	MDS-E-SP-20	2	14	Match with TE2 of selected power supply unit		1.25 to 2	16 to 14
	MDS-E-SP-40	2	14				
	MDS-E-SP-80	3.5	12				
	MDS-E-SP-160	8	8				
	MDS-E-SP-200	14	6				
	MDS-E-SP-240	22	4				
	MDS-E-SP-320	38	2				
	MDS-E-SP-400	60	1/0	Bar enclosed			
	MDS-E-SP-640	80	3/0				
Spindle drive unit (2-axis)	MDS-E-SP2-20	2	14	Match with TE2 of selected power supply unit		1.25 to 2	16 to 14
	MDS-E-SP2-40	2	14				
	MDS-E-SP2-80	3.5	12				
	MDS-E-SP2-16080	8 (3.5)	8 (12)				
Servo drive unit	MDS-E-V1-20	2	14	Match with TE2 of selected power supply unit		1.25 to 2	16 to 14
	MDS-E-V1-40	2	14				
	MDS-E-V1-80	2	14				
	MDS-E-V1-160	3.5	12				
	MDS-E-V1-160W	5.5	10				
	MDS-E-V1-320	14	6				
	MDS-E-V1-320W	22	4				
Servo drive unit (2-axis)	MDS-E-V2-20	2	14	Match with TE2 of selected power supply unit		1.25 to 2	16 to 14
	MDS-E-V2-40	2	14				
	MDS-E-V2-80	2	14				
	MDS-E-V2-160	3.5	12				
	MDS-E-V2-160W	5.5	10				
Servo drive unit (3-axis)	MDS-E-V3-20	2	14	Match with TE2 of selected power supply unit		2	14
	MDS-E-V3-40						
	MDS-E-V3-80					1.25 to 2	16 to 14

(Note) The values inside of ( ) are M side.

Unit type		Terminal name					
		TE1 (U, V, W, ⏚)		TE2 (L+, L-)		TE3 (L11, L21, L12, L22)	
		mm^2	AWG	mm^2	AWG	mm^2	AWG
Power backup unit	MDS-D-PFU	2	14	22	4	2	14

< MDS-EH Series >

Unit type		Terminal name					
		TE1 (U, V, W, ⏚)		TE2 (L+, L-)		TE3 (L11, L21, L12, L22)	
		mm^2	AWG	mm^2	AWG	mm^2	AWG
Power supply unit	MDS-EH-CV-37	2	14	2	14	1.25 to 2	16 to 14
	MDS-EH-CV-75	2	14	2	14		
	MDS-EH-CV-110	2	14	3.5	12		
	MDS-EH-CV-185	5.5	10	5.5	10		
	MDS-EH-CV-300	14	6	14	6		
	MDS-EH-CV-370	14	6	22	4		
	MDS-EH-CV-450	22	4	30	3		
	MDS-EH-CV-550	22	4	Bar enclosed			
	MDS-EH-CV-750	38	2				
Spindle drive unit	MDS-EH-SP-20	2	14	Match with TE2 of selected power supply unit		1.25 to 2	16 to 14
	MDS-EH-SP-40	2	14				
	MDS-EH-SP-80	3.5	12				
	MDS-EH-SP-100	5.5	10				
	MDS-EH-SP-160	14	6				
	MDS-EH-SP-200	22	4				
	MDS-EH-SP-320	38	2	Bar enclosed			
	MDS-EH-SP-480	60	1/0				
	MDS-EH-SP-600	60	1/0				
Servo drive unit	MDS-EH-V1-10	2	14	Match with TE2 of selected power supply unit		1.25 to 2	16 to 14
	MDS-EH-V1-20	2	14				
	MDS-EH-V1-40	2	14				
	MDS-EH-V1-80	2	14				
	MDS-EH-V1-80W	2	14				
	MDS-EH-V1-160	3.5	12				
	MDS-EH-V1-160W	5.5	10				
	MDS-EH-V1-200	14	6	Bar enclosed			
Servo drive unit (2-axis)	MDS-EH-V2-10	2	14	Match with TE2 of selected power supply unit		1.25 to 2	16 to 14
	MDS-EH-V2-20	2	14				
	MDS-EH-V2-40	2	14				
	MDS-EH-V2-80	2	14				
	MDS-EH-V2-80W	2	14				
	MDS-EH-V2-160	3.5	12				
Servo drive unit (3-axis)	MDS-EH-V3-40	2	14	Match with TE2 of selected power supply unit		1.25 to 2	16 to 14

(Note) The values inside of ( ) are M side.

Unit type		Terminal name					
		TE1 (U, V, W,⏚)		TE2 (L+, L-)		TE3 (L11, L21, L12, L22)	
		mm^2	AWG	mm^2	AWG	mm^2	AWG
Power backup unit	MDS-DH-PFU	2	14	22	4	2	14

⚠ CAUTION

1. Selection conditions follow IEC/EN60204-1, UL508C, JEAC8001.
   - Ambient temperature is maximum 40°C.
   - Cable installed on walls without ducts or conduits.

   To use the wire under conditions other than above, check the standards you are supposed to follow.
2. The maximum wiring length to the motor is 30m.
   If the wiring distance between the drive unit and motor is 20m or longer, use a thick wire so that the cable voltage drop is 2% or less.
3. Always wire the grounding wire.

6.2 Selection of Circuit Protector and Contactor

Always select the circuit protector and contactor properly, and install them to each power supply unit to prevent disasters.

6.2.1 Selection of Circuit Protector

Calculate a circuit protector selection current from the nominal input voltage (voltage supplied to the power supply unit) as in the expression below. And then select the minimum capacity circuit protector whose rated current meets the circuit protector selection current.

< MDS-E Series >

Circuit protector selection current [A] =
(Circuit protector selection current for 200V input [A] / Nominal input voltage [V]) × 200 [V]

Selection of circuit protector for 200V input

Unit type MDS-E-CV-	37	75	110	185	300	370	450	550
Circuit protector selection current for 200V input	15A	31A	45A	76A	124A	153A	186A	224A
Selection example of circuit protector (Mitsubishi Electric Corp.)	NF63-CW3P-20A	NF63-CW3P-40A	NF63-CW3P-50A	NF125-CW3P-100A	NF250-CW3P-125A	NF250-CW3P-175A	NF250-CW3P-200A	NF250-CW3P-225A
Rated current of the selection example of circuit protector	20A	40A	50A	100A	125A	175A	200A	225A

Option part: A circuit protector is not prepared as an NC unit accessory, so purchase the part from your dealer, etc.

(Example)
Select a circuit protector for using the MDS-E-CV-110 with a 220V nominal input voltage.
Circuit protector selection current = 45/220 × 200 = 40.9[A]
According to the table above, select "NF63-CW3P-50A".

< MDS-EH Series >

Circuit protector selection current [A] =
(Circuit protector selection current for 380V input [A] / Nominal input voltage [V]) × 380 [V]

Selection of circuit protector for 380V input

Unit type MDS-EH-CV-	37	75	110	185	300	370	450	550	750
Circuit protector selection current for 380V input	8A	16A	24A	40A	65A	80A	98A	119A	163A
Selection example of circuit protector (Mitsubishi Electric Corp.)	NF63-CW3P-10A	NF63-CW3P-20A	NF63-CW3P-30A	NF63-CW3P-40A	NF125-CW3P-75A	NF125-CW3P-100A	NF125-CW3P-100A	NF250-CW3P-125A	NF250-CW3P-200A
Rated current of the selection example of circuit protector	10A	20A	30A	40A	75A	100A	100A	125A	200A

Option part: A circuit protector is not prepared as an NC unit accessory, so purchase the part from your dealer, etc.

(Example)
Select a circuit protector for using the MDS-EH-CV-450 with a 480V nominal input voltage.
Circuit protector selection current = 98/480×380 = 77.6[A]
According to the table above, select "NF125-CW3P-100A".

< MDS-D/DH-PFU >

Unit type	MDS-D/DH-PFU
Selection example of circuit protector (Mitsubishi Electric Corp.)	NF50-SWU3P-10
Rated current of the selection example of circuit protector	10A

Option part: A circuit protector is not prepared as an NC unit accessory, so purchase the part from your dealer, etc.

⚠ CAUTION

1. It is dangerous to share a circuit protector for multiple power supply units, so do not share it. Always install the circuit protectors for each power supply unit.
2. If the control power (L11, L21) must be protected, select according to the section "Circuit protector ".

6.2.2 Selection of Contactor

Select the contactor selection current that is calculated from the nominal input voltage (voltage supplied to the power supply unit) as in the expression below. And then select the contactor whose conventional free-air thermal current meets the contactor selection current.

< MDS-E Series >

Contactor selection current [A]=
(Contactor selection current for 200V input [A] / Nominal input voltage [V]) × 200 [V]

Selection of contactor for 200V input

Unit type MDS-E-CV-	37	75	110	185	300	370	450	550
Contactor selection current for 200V input	15A	31A	45A	76A	124A	153A	186A	224A
Selection example of contactor (Mitsubishi Electric Corp.)	S-T12 -AC200V	S-T35 -AC200V	S-T35 -AC200V	S-T65 -AC200V	S-T100 -AC200V	S-N150 -AC200V	S-N150 -AC200V	S-N180 -AC200V
Conventional freeair thermal current of the selection example of contactor	20A	60A	60A	100A	150A	200A	200A	260A

Option part: A contactor is not prepared as an NC unit accessory, so purchase the part from your dealer, etc.

(Example)
Select a contactor for using the MDS-E-CV-110 with a 220V nominal input voltage.
Contactor selection current = 45/220 × 200 = 40.9[A]
According to the table above, select "S-T35-AC200V".

< MDS-EH Series >

Contactor selection current [A] =
(Contactor selection current for 380V input [A] / Nominal input voltage [V]) × 380 [V]

Selection of contactor for 380V input

Unit type MDS-EH-CV-	37	75	110	185	300	370	450	550	750
Contactor selection current for 380V input	8A	16A	24A	40A	65A	80A	98A	119A	163A
Selection example of contactor (Mitsubishi Electric Corp.)	S-T12- AC400V	S-T12- AC400V	S-T21- AC400V	S-T35- AC400V	S-T50- AC400V	S-T65- AC400V	S-T65- AC400V	S-T80- AC400V	S-N150- AC400V
Conventional freeair thermal current of the selection example of contactor	20A	20A	32A	60A	80A	100A	100A	120A	200A

Option part: A contactor is not prepared as an NC unit accessory, so purchase the part from your dealer, etc.

(Example)
Select a contactor for using the MDS-EH-CV-450 with a 480V nominal input voltage.
Contactor selection current = 98/480×380 = 77.6[A]
According to the table above, select "S-T50-AC400V".

POINT

1. Use an alternating contactor.
2. If the contactor selection current is 20A or less, select the S-T12 product for the contactor.
3. Select a contactor whose excitation coil does not operate at 15mA or less.

6.3 Selection of Earth Leakage Breaker

When installing an earth leakage breaker, select the breaker on the following basis to prevent the breaker from malfunctioning by the higher frequency earth leakage current generated in the servo or spindle drive unit.

(1) Selection

Obtaining the earth leakage current for all drive units referring to the following table, select an earth leakage breaker within the "rated non-operation sensitivity current".
Usually use an earth leakage breaker for inverter products that function at a leakage current within the commercial frequency range (50 to 60Hz).
If a product sensitive to higher frequencies is used, the breaker could malfunction at a level less than the maximum earth leakage current value.

Earth leakage current for each unit

Series	Drive unit	Maximum earth leakage current
MDS-E	MDS-E-SP-20 to 640	15mA
	MDS-E-SP2-20 to 16080	30mA
	MDS-E-V1-20 to 320W	2mA
	MDS-E-V2-20 to 160W	4mA (for two axes)
	MDS-E-V3-20 to 80	6mA (for three axes)
MDS-EH	MDS-EH-SP-20 to 600	15mA
	MDS-EH-V1-10 to 200	2mA
	MDS-EH-V2-10 to 160	4mA (for two axes)
	MDS-EH-V3-40	6mA (for three axes)

(Note1) Maximum earth leakage current: Value that considers wiring length and grounding, etc.(Commercial frequency 50/60Hz)

(Note2) The earth leakage current in the power supply unit side is included in the drive unit side.

(2) Measurement of earth leakage current

When actually measuring the earth leakage current, use a product that is not easily affected by the higher frequency earth leakage current. The measurement range should be 50 to 60Hz.

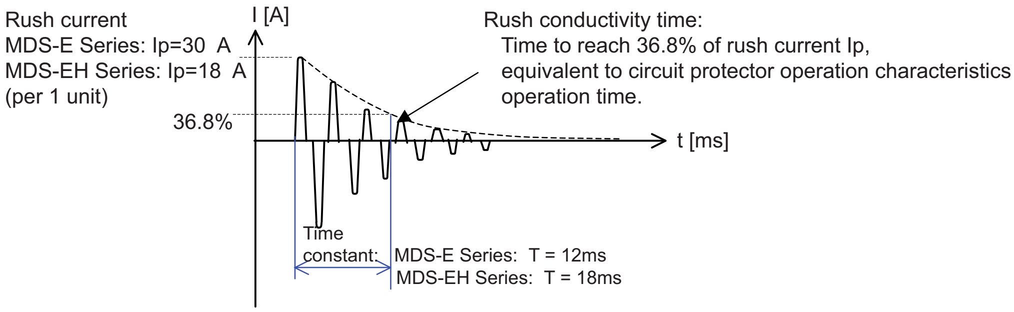
POINT

1. The earth leakage current tends to increase as the motor capacity increases.
2. A higher frequency earth leakage current will always be generated because the inverter circuit in the drive unit switches the transistor at high speed. Always ground to reduce the higher frequency earth leakage current as much as possible.
3. An earth leakage current containing higher frequency may reach approx. several hundreds of mA. According to IEC479-2, this level is not hazardous to the human body.

6.4 Branch-circuit Protection (for Control Power Supply)

6.4.1 Circuit Protector

This breaker is used to switch the control power and to provide overload and short-circuit protection.
When connecting a circuit protector to the power input (TE3 terminals L11 and L21) for the control circuit, use a product that does not trip (incorrectly activate) by a rush current when the power is turned ON. To prevent unnecessary tripping, select a product with inertial delay for the control power circuit protector.
The rush current and rush conductivity time differ according to the power impedance and power ON timing, so select a product that does not trip even under the conditions listed in the following table.



POINT

When collectively protecting the control circuit power for multiple units, select a circuit protector that satisfies the total sum of the rush current Ip.
The largest value is used for the rush conductivity time T.

6.4.2 Fuse Protection

The fuse of branch-circuit protection must use UL class CC, J or T. In the selection, please consider rush current and rush conductive time.

Selection of branch-circuit protection fuse

Connected total of unit	Fuse (Class CC)		Wire Size
	Rated [V]	Current [A]	AWG
1 to 4	600	20	16 to 14
5 to 8		35	

CAUTION

For continued protection against risk of fire, replace only with same type 600 V, 80 A or 35 A (UL CLASS CC) fuse.

WARNING

Before replacing fuse, confirm all power controlling the drive system is shut-OFF. Be sure to look out the power source to prevent the power from being turned ON while maintenance is being performed.

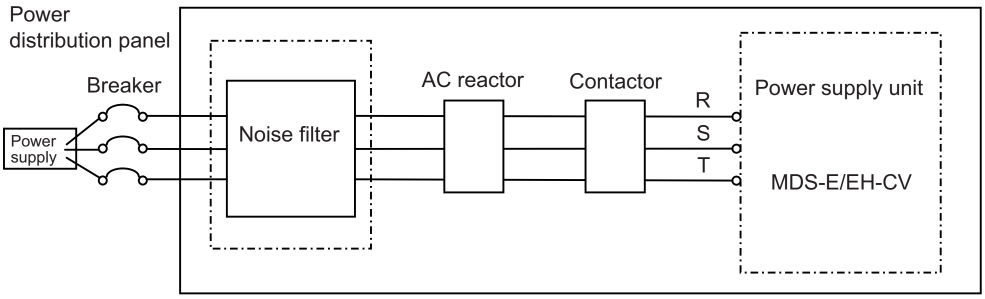
6.5 Noise Filter

(1) Selection

Use an EMC noise filter if the noise conducted to the power line must be reduced. Select an EMC noise filter taking the power supply unit's input rated voltage and input rated current into consideration.

(2) Noise filter mounting position

Install the noise filter to the power supply unit's power input as the diagram below indicates.



(Note) The noise filter must be prepared by the user.

Recommended devices:
MDS-E/EH Series
Soshin Electric HF3000C-SZA Series

Contact:
Soshin Electric Co., Ltd. http://www.soshin-ele.com/

(Note) The above devices may be changed at the manufacturer's discretion.
Contact each manufacturer for more information.

6.6 Surge Absorber

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

(1) Selection of varistor

When a varistor is installed in parallel with the coil, the surge voltage can be adsorbed as heat to protect a circuit. Commonly a 82V product is applied. When the brake operation time is delayed, use a 120V product. Always confirm the operation with an actual machine.

(2) Specifications

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

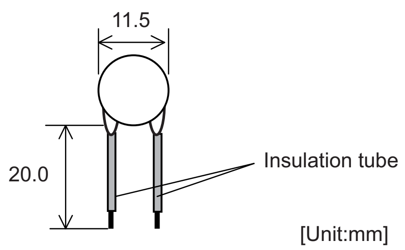
Varistor specification

Varistor type	Varistor voltage rating (range)	Rating							Max. limit voltage	Electrostatic capacity (reference value)
		Tolerable circuit voltage		Surge current withstand level (A)		Energy withstand level (J)		Power		
	(V)	AC(V)	DC(V)	1 time	2 times	10/ 1000μs	2ms	(W)	(V)	(pF)
ERZV10D820 **TNR10V820K**	82 (74 to 90)	50	65	3500	2500	14	10	0.4	135	2000
ERZV10D121 **TND10V121K**	120 (108 to 132)	75	100	3500	2500	20	14.5	0.4	200	1400

(Note) ERZV10D820 and ERZV10D121 are manufactured by Panasonic Corporation.
TNR10V820K and TNR10V121K are manufactured by Nippon Chemi-Con Corporation.
Contact: Panasonic Corporation http://www.panasonic.com/global/home.html
Nippon Chemi-Con Corporation http://www.chemi-con.co.jp/e/index.html

(3) Outline dimension drawing

ERZV10D820, ERZV10D121



POINT

Normally use a product with 82V varistor voltage. If there is no allowance for the brake operation time, use the 120V product. A varistor whose voltage exceeds 120V cannot be used, as such varistor will exceed the specifications of the relay in the unit.

6.7 Relay

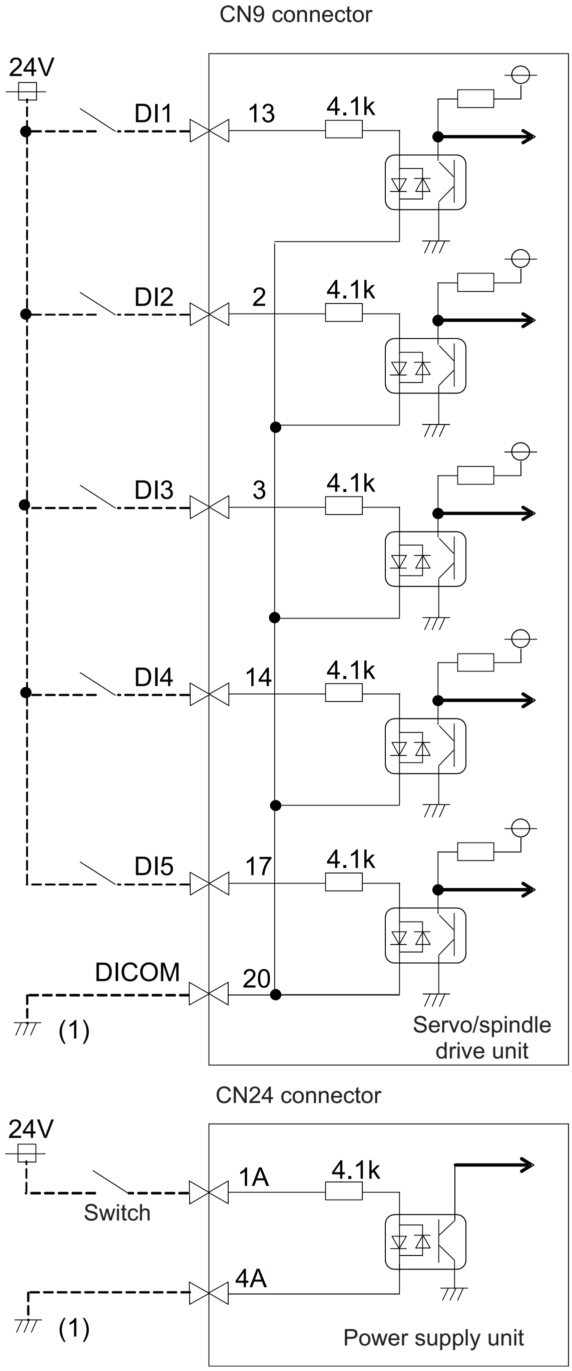
CN9 connector is equipped with 24V input/output circuit for the control of external devices and the control by an external signal.
Set the relevant parameters and use them with care for the wiring since some signals are changeover type, which can be switched over by parameters. Refer to the description of each function in relevant sections for details on the function specifications and settings.

Connector	Input condition		Connector	Output condition	
CN9	**Switch ON**	18VDC to 25.2VDC 4.3mA or more	**CN9**	**Output voltage**	24VDC ±5%
	Switch OFF	4VDC or less 2mA or less		**Tolerable output current**	50mA or less
CN24	**Switch ON**	18VDC to 25.2VDC 4.3mA or more			
	Switch OFF	4VDC or less 2mA or less			

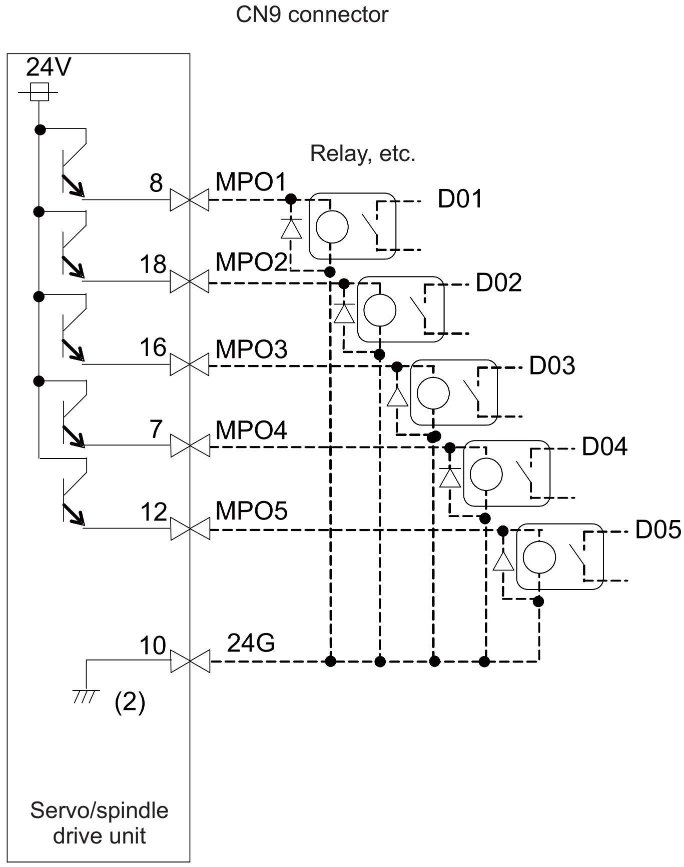
For a switch or relay to be wired, use a switch or relay that satisfies the input/output (voltage, current) conditions.

Interface name	Selection example
For digital input signal (CN24,CN9)	Use a minute signal switch which is stably contacted and operated even with low voltage or current. < Example > OMRON: G2A, G6B type, MY type, LY type
For digital output signal (CN9)	Use a compact relay operated with rating of 24VDC, 40mA or less. < Example > OMRON: G6B type, MY type

Input circuit



Output circuit



The part indicated by the " _ _ _ _ _ " must be prepared by the user.

(Note) Do not connect "(1)" or "(2)".
If a ground of the external 24V power is same as the 24V power in the drive unit, a fault or abnormal operation could occur.

Servo input/output signal (CN9 connector)

	Device name	Connector pin No.	Signal name	Signal changeover parameter
Servo input signal	MPI1	CN9-13	(Reservation)	
	MPI2	CN9-2	(Reservation)	
	MPI3	CN9-3	(Reservation)	
	MPI4	CN9-14	(Reservation)	
	MPI5	CN9-17	(Reservation)	
Servo output signal	MPO1	CN9-8	SBC1 relay control	
	MPO2	CN9-18	Servo specified speed signal	SV082/bit9,8=01
	MPO3	CN9-16	SBC2 relay control	
	MPO4	CN9-7	(Reservation)	
	MPO5	CN9-12	(Reservation)	

Spindle input/output signal (CN9 connector)

	Device name	Connector pin No.	Signal name	Signal changeover parameter
Spindle input signal	MPI1	CN9-13	(Reservation)	
			Orientation function Proximity switch signal	SP227/bitF-C=4
	MPI2	CN9-2	(Reservation)	
	MPI3	CN9-3	(Reservation)	
	MPI4	CN9-14	(Reservation)	
	MPI5	CN9-17	(Reservation)	
Spindle output signal	MPO1	CN9-8	Coil changeover signal (L axis)	
	MPO2	CN9-18	Spindle specified speed signal	SP229/bitC=1
	MPO3	CN9-16	(Reservation)	
	MPO4	CN9-7	(Reservation)	
	MPO5	CN9-12	Coil changeover signal (M axis)	

CAUTION

The different signal changeover parameter setting is not available for the same connector pin number of each axis in 2-axis or 3-axis drive unit.

6.8 Selection of Link Connection

6.8.1 Connection of L11 and L21 Link

Regardless of the power supply unit and drive unit capacities, the wire size must be IV2SQ or more. When using a conductor bar, the conductor cross-sectional area must be $1mm^2$ or more.
The wire size between the circuit protector and L11, L21 must also be IV2SQ or more.

6.8.2 Connection of L+ and L- Link

< Selection method 1 > To unify the wire or conductor bar sizes for L+ and L- links

To unify the wire or conductor bar sizes for L+ and L- links, select the following size or larger for the L+ and L- links based on the power supply unit capacity.

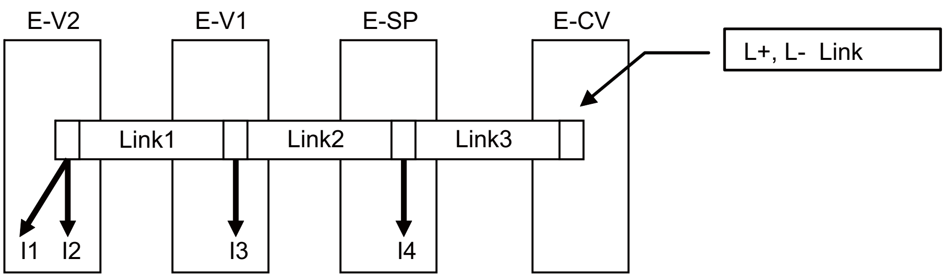
Model	E-CV-37	E-CV-75	E-CV-110	E-CV-185	E-CV-300
Rated output current	17A	30A	41A	76A	144A
Wire size	IV3.5SQ HIV3.5SQ	IV8SQ HIV5.5SQ	IV22SQ HIV14SQ	IV38SQ HIV22SQ	HIV60SQ
Conductor bar cross-sectional area	$5mm^2$ or more	$8mm^2$ or more	$11mm^2$ or more	$19mm^2$ or more	$36mm^2$ or more

Model	EH-CV-37	EH-CV-75	EH-CV-110	EH-CV-185	EH-CV-300	EH-CV-370	EH-CV-450
Rated output current	7.1A	15A	21A	38A	72A	82A	99A
Wire size	IV2.0SQ HIV2.0SQ	IV3.5SQ HIV3.5SQ	IV5.5SQ HIV5.5SQ	IV14SQ HIV8SQ	IV38SQ HIV22SQ	IV60SQ HIV38SQ	IV60SQ HIV60SQ
Conductor bar cross-sectional area	$2mm^2$ or more	$4mm^2$ or more	$6mm^2$ or more	$10mm^2$ or more	$18mm^2$ or more	$21mm^2$ or more	$25mm^2$ or more

When using E-CV-370, E-CV-450, E-CV-550, EH-CV-550, and EH-CV-750, use the dedicated bar or refer to < Selection method 2 >.

< Selection method 2 > To suppress the wire or conductor bar sizes for L+ and L- links to the minimum required for each unit

To suppress the wire or conductor bar sizes for L+ and L- links to the minimum required for each unit, select as shown below based on the current value that actually flows to the L+ and L- links.
In this section, the case when two servo drive units and one spindle drive unit are connected to one power supply unit is explained. The same selection methods apply in all other cases.



(1) If the current which flows through the L+ and L- bus bars of each drive unit is I1 to I4 as shown above, the current that flows through each link (Link1 to Link3) is the following equation [1]. Thus, the wire and conductor bar for each L+, L- link should tolerate the above current.
However, if the above current (I(Link□)) exceeds the rated output current in < Selection method 1 >, use the wire and conductor bar for L+ and L- link in < Selection method 1 >.

$$\left.\begin{aligned} I(Link1) &= I1 + I2 \\ I(Link2) &= I1 + I2 + I3 \\ I(Link3) &= I1 + I2 + I3 + I4 \end{aligned}\right\} \cdots [1]$$

(2) The I1 to I4 values are actually obtained with the following equation [2].

(I1 to I4) = Motor output current × 1.1 ··· [2]

Note that the value of the following table (a) Compatible spindle drive unit capacity for spindle motor or (b) Compatible servo motor type for servo motor is substituted into "Motor output current" in the equation [2].

(a) Compatible spindle drive unit capacity

Spindle drive unit capacity	E-SP-20	E-SP-40	E-SP-80	E-SP-160	E-SP-200	E-SP-240	E-SP-320	E-SP-400	E-SP-640
Motor output current	9.0A	15A	27A	54A	85A	94A	150A	180A	225A

Spindle drive unit capacity	EH-SP-20	EH-SP-40	EH-SP-80	EH-SP-100	EH-SP-160	EH-SP-200	EH-SP-320	EH-SP-480	EH-SP-600
Motor output current	11A	18A	27A	43A	75A	90A	125A	180A	200A

(b) Compatible servo motor type

Servo motor type	HG46	HG56	HG96
Motor output current	1.4A	2.6A	4.8A

Servo motor type	HG75	HG105	HG54	HG104	HG154	HG224	HG204	HG354
Motor output current	3.2A	4.6A	3.2A	6.6A	11A	15A	15A	22A

Servo motor type	HG123	HG223	HG303	HG453	HG603	HG702	HG703	HG903
Motor output current	6.4A	11A	16A	28A	33A	24A	37A	56A

Servo motor type	HG1103	HG142	HG302
Motor output current	76A	6.4A	11A

Servo motor type	HK76	HK105	HK55	HK104	HK123	HK142	HK154	HK154 (V3-40)	HK154 (V3-80)
Motor output current	4.9A	5.6A	4.4A	9.5A	6.0A	6.0A	13A	11A	9.8A

Servo motor type	HK223	HK224	HK204	HK302	HK303	HK354	HK453	HK603	HK702
Motor output current	11A	16A	16A	11A	16A	25A	28A	33A	31A

Servo motor type	HK703
Motor output current	37A

Servo motor type	HG-H75	HG-H105	HG-H54	HG-H104	HG-H154	HG-H224	HG-H204	HG-H354
Motor output current	1.6A	2.3A	1.6A	3.3A	5.5A	7.4A	7.3A	14A

Servo motor type	HG-H453	HG-H703	HG-H903	HG-H1502
Motor output current	17A	19A	28A	48A

Servo motor type	HQ-H903	HQ-H1103
Motor output current	32A	46A

Servo motor type	HK-H76	HK-H105	HK-H55	HK-H104	HK-H123	HK-H154	HK-H154 (V3-40)	HK-H223	HK-H224
Motor output current	2.3A	2.3A	2.2A	4.8A	2.3A	6.5A	4.9A	4.9A	7.6A

Servo motor type	HK-H224 (V1/V2-80)	HK-H204	HK-H302	HK-H303	HK-H354	HK-H453	HK-H603	HK-H702	HK-H703
Motor output current	7.9A	7.6A	7.7A	7.7A	13A	17A	17A	16A	19A

(3) Obtain I (Bar1) to I (Bar3) using the equations [1] based on I1 to I4 obtained with the equation (2)[2]. Match that value against the following table, and select the IV wire size.
When using a conductor bar, calculate the value at 4A (reference value) per $1mm^2$ of conductor area.

Wire size	Tolerable current	
	IV wire (60°C)	HIV wire (75°C)
2SQ	15A	15A
3.5SQ	20A	20A
5.5SQ	28A	30A
8SQ	34A	46A
14SQ	50A	65A
22SQ	65A	85A
38SQ	92A	115A
60SQ	124A	150A

(Ambient temperature is 40°C or less)

⚠ CAUTION

1. When the number of units is an odd number, install and adjust the height by spacer etc. because the bar of the final axis floats by the thickness of the bar.
2. Unify the thickness of the bar to prevent a contact failure due to the inclination at thread fastening.
   The thickness for two-ply bar must be 6.4mm or less.
3. To ensure the contact area of the bar, 15 to 16mm is recommended for the bar width.
4. The following material and plating are recommended for the DC connection bar.
   Material: Tough-pitch copper (C1100)
   Plating: Tin plating

7

Selection

7.1 Selection of the Servo Motor

7.1.1 Outline

It is important to select a servo motor matched to the purpose of the machine that will be installed. If the servo motor and machine to be installed do not match, the motor performance cannot be fully realized, and it will also be difficult to adjust the parameters. Be sure to understand the servo motor characteristics in this chapter to select the correct motor.

(1) Motor inertia

The servo motor has an optimum load inertia scale. If the load inertia exceeds the optimum range, the control becomes unstable and the servo parameters become difficult to adjust. When the load inertia is too large, decelerate with the gears (The motor axis conversion load inertia is proportional to the square of the deceleration ratio.), or change to a motor with a large inertia.

(2) Rated speed

Even with motors having the same capacity, the rated speed will differ according to the motor.
The motor's rated output is designed to be generated at the rated speed, and the output P (W) is expressed with expression (7-1). Thus, even when the motors have the same capacity, the rated torque will differ according to the rated speed.

$$P = 2\pi NT \text{ (W)} \qquad \text{---(7-1)}$$

N: Motor speed (1/sec)
T: Output torque (N.m)

In other words, even with motors having the same capacities, the one with the lower rated speed will generate a larger torque. If generated torque is the same, the drive unit capacity can be downsized. When actually mounted on the machine, if the positioning distance is short and the motor cannot reach the maximum speed, the motor with the lower rated speed will have a shorter positioning time. When selecting the motor, consider the axis stroke and usage methods, and select the motor with the optimum rated speed.

7.1.2 Selection of Servo Motor Capacity

The following three elements are used to determine the servo motor capacity.

1. Load inertia ratio
2. Short time characteristics (acceleration/deceleration torque)
3. Continuous characteristics (continuous effective load torque)

Carry out appropriate measures, such as increasing the motor capacity, if any of the above conditions is not fulfilled.

(1) Load inertia ratio

Each servo motor has an appropriate load inertia ratio (load inertia/motor inertia). The control becomes unstable when the load inertia ratio is too large, and the servo parameter adjustment becomes difficult. It becomes difficult to improve the surface precision in the feed axis, and the positioning time cannot be shortened in the positioning axis because the settling time is longer.

If the load inertia ratio exceeds the recommended value in the servo specifications list, increase the motor capacity, and select so that the load inertia ratio is within the recommended range.

Note that the recommended value for the load inertia ratio is strictly one guideline. This does not mean that controlling of the load with inertia exceeding the recommended value is impossible.

POINT

1. When selecting feed axis servo motors for NC unit machine tools, place importance on the surface precision during machining. To do this, always select a servo motor with a load inertia ratio within the recommended value. Select the lowest value possible within that range.
2. The load inertia ratio for the motor with brakes must be judged based on the motor inertia for the motor without brakes.

(2) Short time characteristics

In addition to the continuous operation range, the servo motor has the short time operation range that can be used only in a short time such as acceleration/deceleration. This range is expressed by the maximum torque and the torque characteristics. The maximum torque or the torque characteristics differ according to each motor, so confirm the specifications in section "2.1 Servo Motor".

The torque required for the servo motor’s acceleration/deceleration differs according to the CNC’s command pattern or the servo’s position control method.

Determine the required maximum motor torque from the following expression, and select the servo motor capacity.

(a) Selection with the maximum torque characteristics

In a low-speed rotation range (approximately less than half of the servo motor maximum speed), the linear acceleration/deceleration time constant "ta" that can be driven depends on the motor maximum torque. That can be approximated from the machine specifications using the expression (7-2).

$$ta = \frac{1.05 \times 10^{-2} \times (J_L/\eta + J_M) \times N}{(0.8 \times T_{MAX} - T_L)} \quad \text{(ms)} \quad \cdots (7\text{-}2)$$

N	: Motor reach speed	(r/min)
J_L	: Motor shaft conversion load inertia	($\times 10^{-4}$kg•m^2)
J_M	: Motor inertia	($\times 10^{-4}$kg•m^2)
η	: Drive system efficiency (Normally 0.8 to 0.95)	
T_{MAX}	: Maximum motor torque	(N•m)
T_L	: Motor shaft conversion load (friction, unbalance) torque	(N•m)

Using the approximate linear acceleration/deceleration time constant "ta" calculated above, confirm the torque characteristics of the high-speed rotation range in the CNC’s command pattern or the servo’s position control method.

(b) Approximation when using the NC command linear acceleration/deceleration pattern + servo standard position control
This is a normal command pattern or servo standard position control method.
Using the expression (7-3) and (7-4), approximate the maximum torque "Ta1" and maximum torque occurrence speed "Nm" required for this acceleration/deceleration pattern.

$$T_a1 = \frac{1.05 \times 10^{-2} \times (J_L/\eta + J_M) \times N}{ta} \times (1 - e^{\frac{-Kp \times ta}{1000}}) + T_L \quad (N\cdot m) \quad \cdots (7\text{-}3)$$

$$Nm = N \times \{1 - \frac{1000}{Kp \times ta} \times (1 - e^{\frac{-Kp \times ta}{1000}})\} \quad (r/min) \quad \cdots (7\text{-}4)$$

ta	: Acceleration/deceleration time constant	(ms)
Kp	: Position loop gain (SV003)	(rad/s)
N	: Motor reach speed	(r/min)
J_L	: Motor shaft conversion load inertia	($\times 10^{-4}$kg•m^2)
J_M	: Motor inertia	($\times 10^{-4}$kg•m^2)
η	: Drive system efficiency (Normally 0.8 to 0.95)	
T_L	: Motor shaft conversion load (friction, unbalance) torque	(N•m)

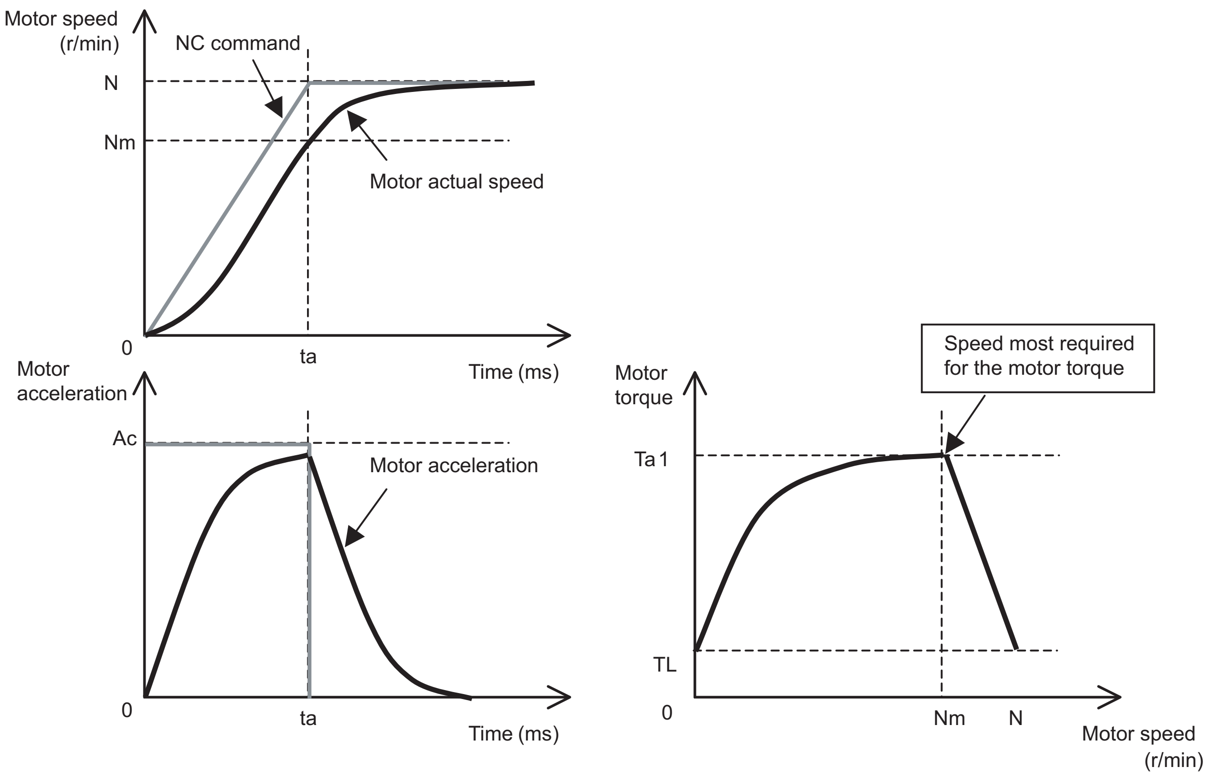


Fig.1 Speed, acceleration and torque characteristics when using the NC command linear acceleration/deceleration pattern + servo standard position control

(c) Approximation when using the NC command linear acceleration/deceleration pattern + servo SHG control (option)
This is a servo's position control method to achieve a normal command pattern and high precision. SHG control improves the position loop gain by stably controlling a delay of the position loop in the servo system. This allows the settling time to be reduced and a high precision to be achieved.
Using the expression (7-5) and (7-6), approximate the maximum torque "Ta1" and maximum torque occurrence speed "Nm" required for this acceleration/deceleration pattern.

$$T_a1 = \frac{1.05 \times 10^{-2} \times (J_L/\eta + J_M) \times N}{ta} \times (1 - 0.586 \times e^{\frac{-2 \times Kp \times ta}{1000}}) + T_L \quad (N\cdot m) \quad \cdots (7\text{-}5)$$

$$Nm = N \times \{1 - \frac{1000}{1.3 \times Kp \times ta} \times (1 - 1.5 \times e^{\frac{-2 \times Kp \times ta}{1000}})\} \quad (r/min) \quad \cdots (7\text{-}6)$$

ta	: Acceleration/deceleration time constant	(ms)
Kp	: Position loop gain (SV003)	(rad/s)
N	: Motor reach speed	(r/min)
J_L	: Motor shaft conversion load inertia	($\times 10^{-4}$kg•m^2)
J_M	: Motor inertia	($\times 10^{-4}$kg•m^2)
η	: Drive system efficiency (Normally 0.8 to 0.95)	
T_L	: Motor shaft conversion load (friction, unbalance) torque	(N•m)

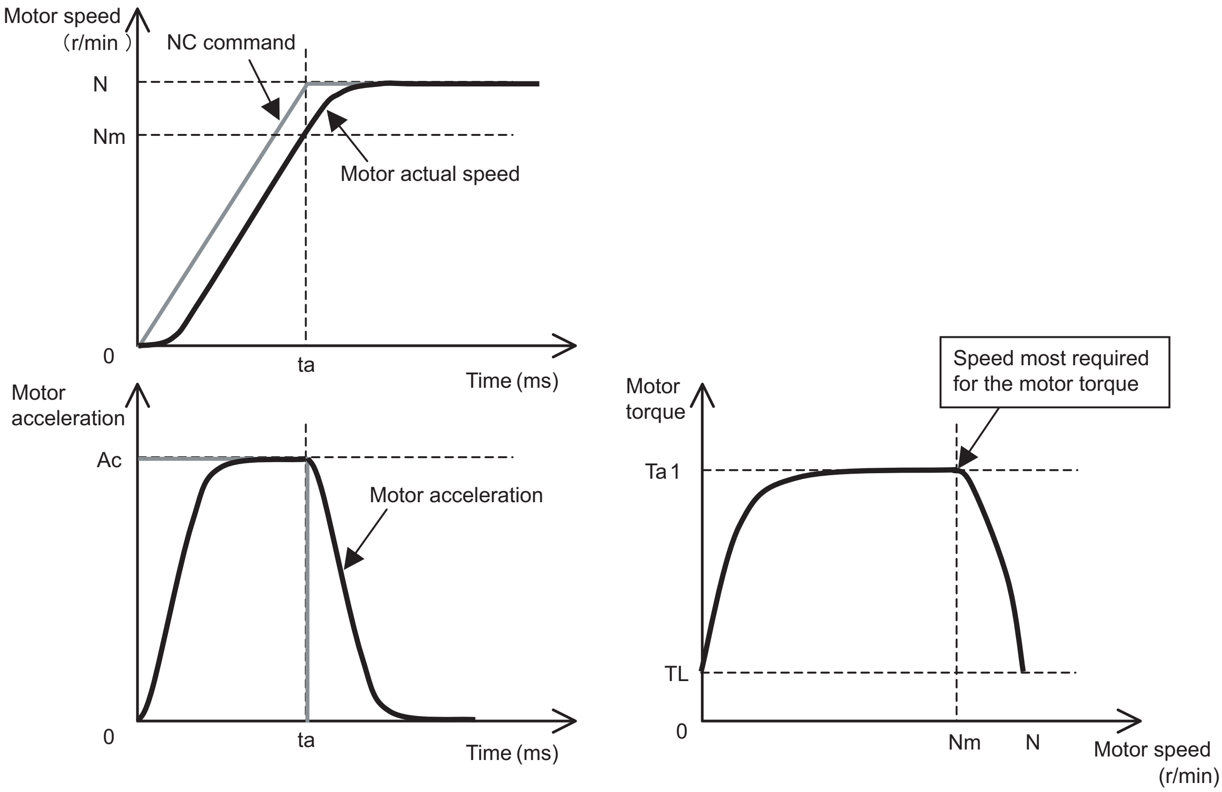


Fig.2 Speed, acceleration and torque characteristics when using the NC command linear acceleration/deceleration pattern + servo SHG control

(d) Approximation when using the NC command soft acceleration/deceleration pattern + feed forward control
This is an approximation when using high-speed high-accuracy control and OMR-FF control.
If the feed forward amount is set properly, the delay of the servo position loop is guaranteed. Therefore, this command acceleration pattern can be approximated to the NC command and does not depend on the servo position control method.
Using the expression (7-7) and (7-8), approximate the maximum torque "Ta1" and maximum torque occurrence speed "Nm" required for this acceleration/deceleration pattern.

$$T_a1 = \frac{1.05 \times 10^{-2} \times (J_L/\eta + J_M) \times N}{ta} + T_L \quad (N\cdot m) \quad \cdots (7\text{-}7)$$

$$Nm = N \times \left(1 - \frac{1}{2} \times \frac{tb}{ta}\right) \quad (r/min) \quad \cdots (7\text{-}8)$$

ta	: Acceleration/deceleration time constant	(ms)
tb	: Acceleration/deceleration time constant	(ms)
N	: Motor reach speed	(r/min)
J_L	: Motor shaft conversion load inertia	($\times 10^{-4}$kg•m^2)
J_M	: Motor inertia	($\times 10^{-4}$kg•m^2)
η	: Drive system efficiency (Normally 0.8 to 0.95)	
T_L	: Motor shaft conversion load (friction, unbalance) torque	(N•m)

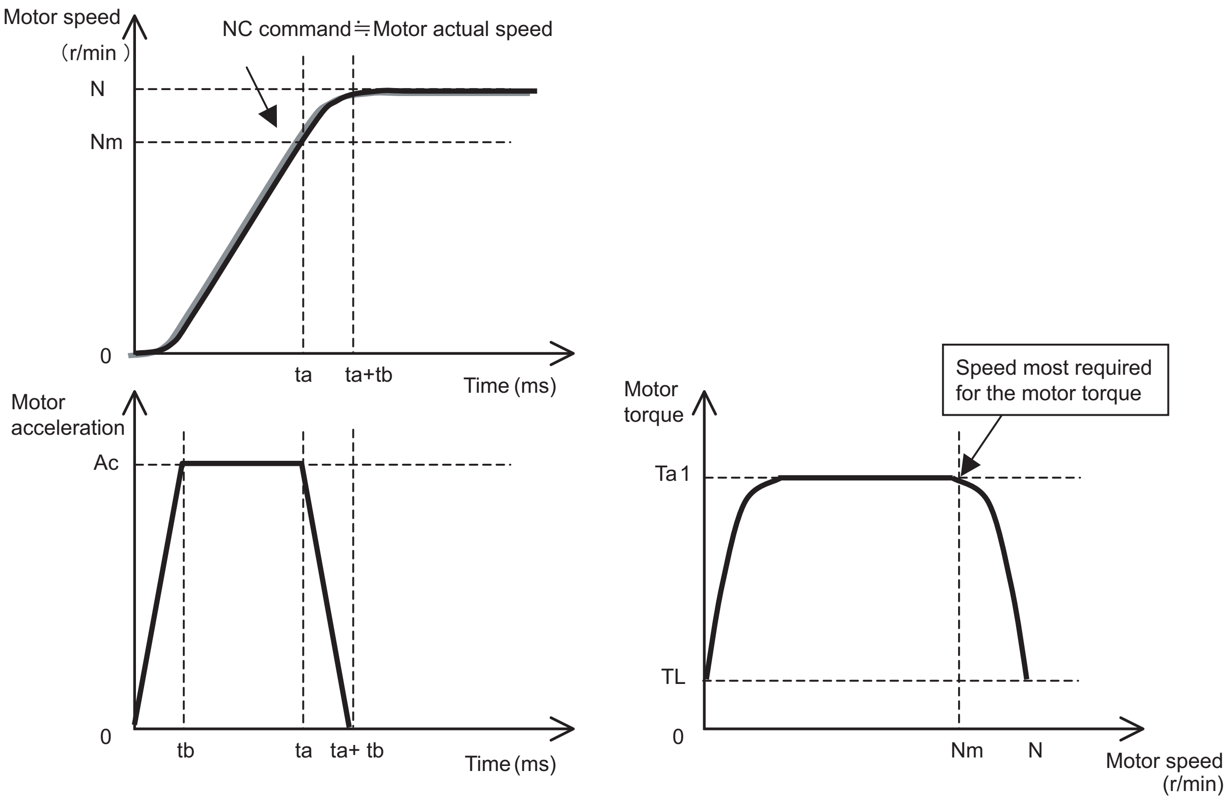
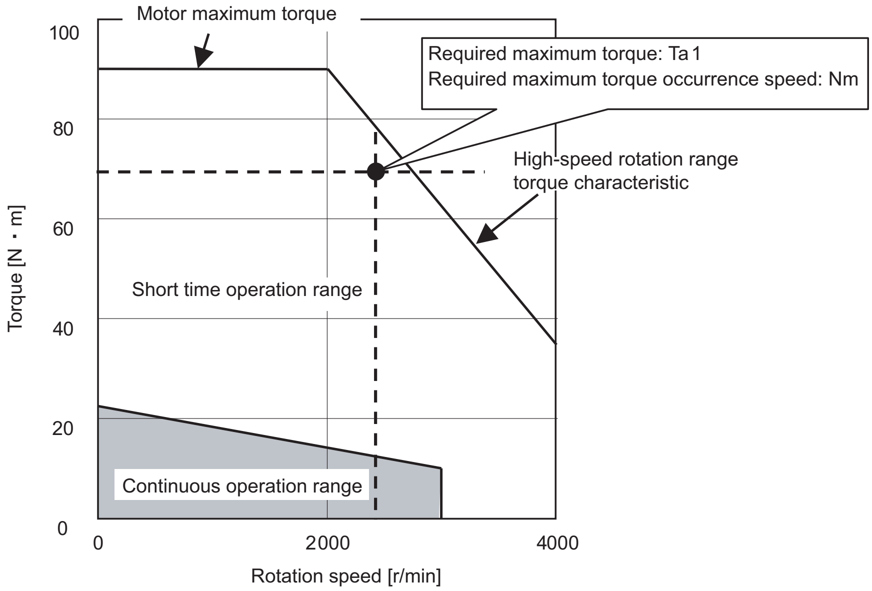


Fig 3. Speed, acceleration and torque characteristic when using the NC command soft acceleration/deceleration pattern + feed forward control

(e) Confirmation in the torque characteristics

Confirm whether the maximum torque "Ta1" and maximum torque occurrence speed "Nm" required for this acceleration/deceleration pattern calculated in the item "(b)" to "(d)" are in the short time operation range of the torque characteristics.



Motor torque characteristics

If they are not in the short time operation range, return to the item "(b)" to "(d)" and make the linear acceleration/deceleration time constant "ta" large.

If the acceleration specification cannot be changed (the linear acceleration/deceleration time constant cannot be increased), reconsider the selection, such as increasing the motor capacity.

POINT

1. In selecting the maximum torque "Ta1" required for this acceleration/deceleration pattern, the measure of it is 80% of the motor maximum torque "T_{MAX} "
2. In high-speed rotation range, confirm that the maximum torque "Ta1" and maximum torque occurrence speed "Nm" required for this acceleration/deceleration is in the short time operation range.
3. The drive system efficiency is normally approx. 0.95 in the ball screw mechanism and approx. 0.8 in the gear mechanism
4. For the torque characteristics in the motor high-speed rotation range, the AC input voltage is 200V (200V series) or 380V (400V series). If the input voltage is low or if the power wire connecting the servo motor and drive unit is long (20m length), the short time operation range is limited. In this case, an allowance must be provided for the selection of the high-speed rotation range.

(3) Continuous characteristics

A typical operation pattern is assumed, and the motor's continuous effective load torque (Trms) is calculated from the motor shaft conversion and load torque. If numbers <1> to <8> in the following drawing were considered a one cycle operation pattern, the continuous effective load torque is obtained from the root mean square of the torque during each operation, as shown in the expression (7-9).

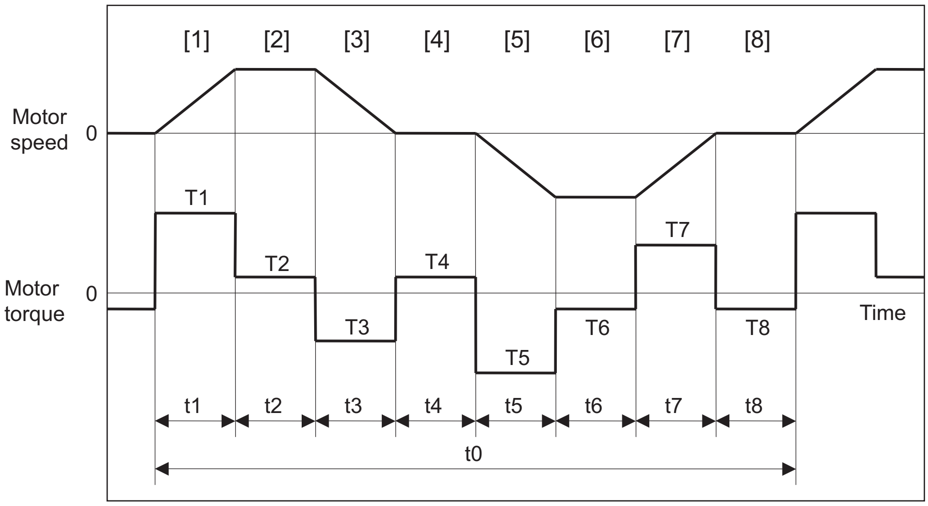


Fig. 1 Continuous operation pattern

$$Trms = \sqrt{\frac{T1^2 \cdot t1 + T2^2 \cdot t2 + T3^2 \cdot t3 + T4^2 \cdot t4 + T5^2 \cdot t5 + T6^2 \cdot t6 + T7^2 \cdot t7 + T8^2 \cdot t8}{t0}} \quad \cdots (7\text{-}9)$$

Select a motor so that the continuous effective load torque Trms is 80% or less of the motor stall torque Tst.

$$Trms \leqq 0.8 \cdot Tst \quad \cdots (7\text{-}10)$$

The amount of acceleration torque (Ta) shown in tables 7-3 and 7-4 is the torque to accelerate the load inertia in a frictionless state. It can be calculated by the expression (7-11). (For Acceleration/deceleration)

$$T_a = \frac{1.05 \times 10^{-2} \times (J_L/\eta + J_M) \times N}{ta} \quad (N \cdot m) \quad \cdots (7\text{-}11)$$

N	: Motor reach speed	(r/min)
J_L	: Motor shaft conversion load inertia	($\times 10^{-4}$kg•m^2)
J_M	: Motor inertia	($\times 10^{-4}$kg•m^2)
ta	: Acceleration/deceleration time constant	(ms)
η	: Drive system efficiency (Normally 0.8 to 0.95)	

For an unbalance axis, select a motor so that the motor shaft conversion load torque (friction torque + unbalance torque) is 60% or less of the stall. Also, select a motor so that the unbalance torque is equal to or less than the static friction torque of the magnetic brake.

$$TL \leqq 0.6 \cdot Tst \quad \cdots (7\text{-}12)$$

(a) Horizontal axis load torque

When operations [1] to [8] are for a horizontal axis, calculate so that the following torques are required in each period.

Table 7-3 Load torques of horizontal axes

Period	Load torque calculation method	Explanation
[1]	(Amount of acceleration torque) + (Kinetic friction torque)	Normally the acceleration/deceleration time constant is calculated so that this torque is 80% of the maximum torque of the motor.
[2]	(Kinetic friction torque)	
[3]	(Amount of deceleration torque) + (Kinetic friction torque)	The absolute value of the acceleration torque amount is same as the one of the deceleration torque amount. The signs for the amount of acceleration torque and amount of deceleration torque are reversed.
[4]	(Static friction torque)	Calculate so that the static friction torque is always required during a stop.
[5]	- (Amount of acceleration torque) - (Kinetic friction torque)	The signs are reversed with period [1] when the kinetic friction does not change according to movement direction.
[6]	- (Kinetic friction torque)	The signs are reversed with period [2] when the kinetic friction does not change according to movement direction.
[7]	- (Amount of deceleration torque) - (Kinetic friction torque)	The signs are reversed with period [3] when the kinetic friction does not change according to movement direction.
[8]	- (Static friction torque)	Calculate so that the static friction torque is always required during a stop.

(b) Unbalance axis load torque

When operations [1] to [8] are for an unbalance axis, calculate so that the following torques are required in each period. Note that the forward speed shall be an upward movement.

Table 7-4 Load torques of unbalance axes

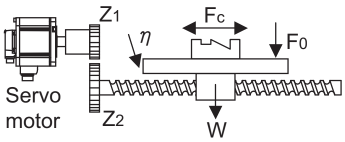
Period	Load torque calculation method	Explanation
[1]	(Amount of acceleration torque) + (Kinetic friction torque) + (Unbalance torque)	Normally the acceleration/deceleration time constant is calculated so that this torque is 80% of the maximum torque of the motor.
[2]	(Kinetic friction torque) + (Unbalance torque)	
[3]	(Amount of deceleration torque) + (Kinetic friction torque) + (Unbalance torque)	The absolute value of the acceleration torque amount is same as the one of the deceleration torque amount. The signs for the amount of acceleration torque and amount of deceleration torque are reversed.
[4]	(Static friction torque) + (Unbalance torque)	The holding torque during a stop becomes fairly large. (Upward stop)
[5]	- (Amount of acceleration torque) - (Kinetic friction torque) + (Unbalance torque)	
[6]	- (Kinetic friction torque) + (Unbalance torque)	The generated torque may be in the reverse of the movement direction, depending on the size of the unbalance torque.
[7]	- (Amount of deceleration torque) - (Kinetic friction torque) + (Unbalance torque)	
[8]	- (Static friction torque) + (Unbalance torque)	The holding torque becomes smaller than the upward stop. (Downward stop)

POINT

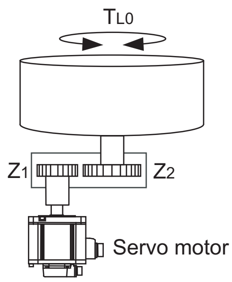
During a stop, the static friction torque may constantly be applied. The static friction torque and unbalance torque may be applied during an unbalance axis upward stop, and the torque during a stop may become extremely large. Therefore, caution is advised.

7.1.3 Motor Shaft Conversion Load Torque

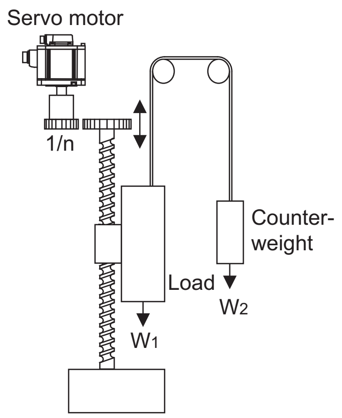
The calculation method for a representative load torque is shown.

<table>
<tr><th>Type</th><th>Mechanism</th><th>Calculation expression</th></tr>
<tr>
<td>Linear movement</td>
<td>
</td>
<td>

$$T_L = \frac{F}{2\times10^3\pi\eta}\cdot\left(\frac{V}{N}\right) = \frac{F\cdot\Delta S}{2\times10^3\pi\eta}$$

T_L:Load torque (N•m)
F:Force in axial direction of the machine that moves linearly (N)
η: Drive system efficiency
V:Speed of object that moves linearly (mm/min)
N:Motor speed (r/min)
ΔS:Object movement amount per motor rotation (mm)
Z_1,Z_2:Deceleration ratio
F in the above expression is obtained from the expression below when the table is moved as shown on the left.
F=Fc+μ (W•g+F_0)
F_c:Force applied on axial direction of moving section (N)
F_0:Tightening force on inner surface of table guide (N)
W:Total mass of moving section (kg)
g:Gravitational acceleration = 9.8 (m/s^2)
μ:Friction coefficient</td>
</tr>
<tr>
<td>Rotary movement</td>
<td>
</td>
<td>

$$T_L = \frac{Z_1}{Z_2}\cdot\frac{1}{\eta}\cdot T_{L0}+T_F = \frac{1}{n}\cdot\frac{1}{\eta}\cdot T_{L0}+T_F$$

T_L:Load torque (N•m)
T_{L0}:Load torque on load shaft (N•m)
T_F:Motor shaft conversion load friction torque (N•m)
η:Drive system efficiency
Z_1,Z_2:Deceleration ratio
n:Deceleration ratio</td>
</tr>
<tr>
<td>Vertical movement</td>
<td>
</td>
<td>When rising $T_L=T_U+T_F$ When lowering $T_L= -T_U\cdot\eta^2+T_F$
T_L:Load torque (N•m)
T_U:Unbalanced torque (N•m)
T_F:Friction torque on moving section (N•m)

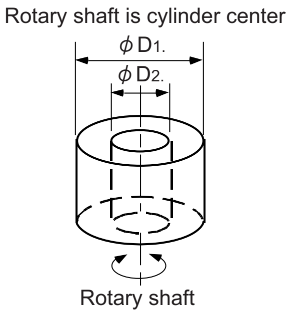
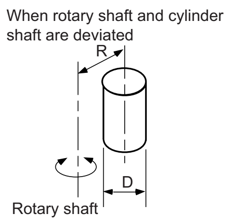
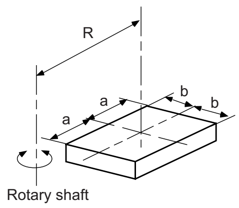
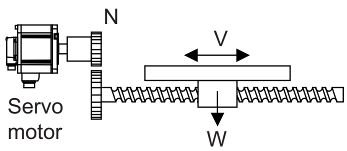
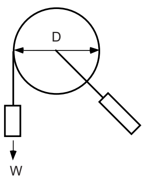
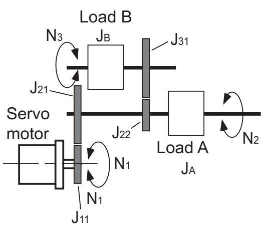
$$T_U = \frac{(W_1-W_2)\cdot g}{2\times10^3\pi\eta}\cdot\left(\frac{V}{N}\right) = \frac{(W_1-W_2)\cdot g\cdot\Delta S}{2\times10^3\pi\eta}$$

$$T_F = \frac{\mu\cdot(W_1+W_2)\cdot g\cdot\Delta S}{2\times10^3\pi\eta}$$

W_1:Load mass (kg)
W_2:Counterweight mass (kg)
η: Drive system efficiency
g:Gravitational acceleration = 9.8 (m/s^2)
V:Speed of object that moves linearly (mm/min)
N:Motor speed (r/min)
ΔS:Object movement amount per motor rotation (mm)
μ:Friction coefficient</td>
</tr>
</table>

7.1.4 Expressions for Load Inertia Calculation

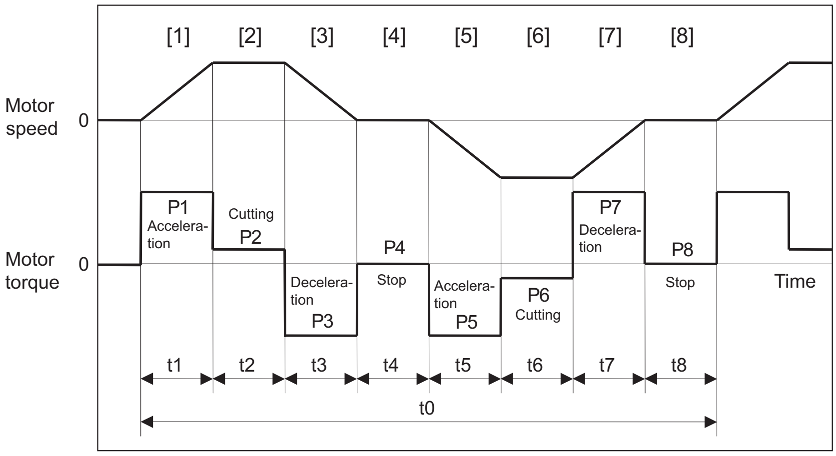
The calculation method for a representative load inertia is shown.

Type	Mechanism	Calculation expression
Cylinder		$J_L = \frac{\pi\cdot\rho\cdot L}{32}\cdot(D_1^4 - D_2^4) = \frac{W}{8}\cdot(D_1^2 + D_2^2)$ T_L:Load inertia (kg•cm^2) ρ: Density of cylinder material (kg/cm^3) L:Length of cylinder (cm) D_1:Outer diameter of cylinder (cm) D_2:Inner diameter of cylinder (cm) W:Mass of cylinder (kg) <Reference data (Material densities)> Iron:7.80×10^{-3}(kg/cm^3) Aluminum:2.70×10^{-3}(kg/cm^3) Copper:8.96×10^{-3}(kg/cm^3)
		$J_L = \frac{W}{8}\cdot(D^2 + 8R^2)$ J_L:Load inertia (kg•cm^2) W:Mass of cylinder (kg) D:Outer diameter of cylinder (cm) R:Distance between rotary axis and cylinder axis (cm)
Column		$J_L = W(\frac{a^2+b^2}{3} + R^2)$ J_L: Load inertia (kg•cm^2) W:Mass of column (kg) a,b,R:Left diagram (cm)
Object that moves linearly		$J_L = W(\frac{1}{2\pi N}\cdot\frac{V}{10})^2 = W(\frac{\Delta S}{20\pi})^2$ J_L:Load inertia (kg•cm^2) W:Mass of object that moves linearly (kg) N:Motor speed (r/min) V:Speed of object that moves linearly (mm/min) ΔS:Object movement amount per motor rotation (mm)
Suspended object		$J_L = W(\frac{D}{2})^2 + J_p$ J_L:Load inertia (kg•cm^2) W:Object mass (kg) D:Diameter of pulley (cm) Jp:Inertia of pulley (kg•cm^2)
Converted load		$J_L = J_{11} + (J_{21} + J_{22} + J_A)\cdot(\frac{N_2}{N_1})^2 + (J_{31} + J_B)\cdot(\frac{N_3}{N_1})^2$ J_L:Load inertia (kg•cm^2) J_A,J_B:Inertia of load A, B (kg•cm^2) J_{11} to J_{31}:Inertia (kg•cm^2) N_1 to N_3:Each shaft's speed (r/min)

7.2 Selection of the Spindle Motor

(1) Calculation of average output for spindle

In the machine which carries out the spindle's acceleration/deceleration frequently (example: tapping center), short-time rating is frequently used, and a rise in temperature become significant on the spindle motor or drive unit. Thus, calculate the average output (P_{AV}) from one cycle operation pattern and confirm that the calculated value is less than the continuous rating output of the selected spindle motor.



Output during acceleration/deceleration (kW)
= Actual acceleration/deceleration output (kW)

* Actual acceleration/deceleration output (kW) is 1.2-fold of "Standard output (kW) during acceleration/deceleration" or 1.2-fold of "Short time rated output (kW)".

Continuous operation pattern (example)

$$P_{AV} = \sqrt{\frac{P1^2 \cdot t1 + P2^2 \cdot t2 + P3^2 \cdot t3 + P4^2 \cdot t4 + P5^2 \cdot t5 + P6^2 \cdot t6 + P7^2 \cdot t7 + P8^2 \cdot t8}{t0}}$$

P1 to P8	:Output
t1 to t8	:Time
t0	:One cycle operation time

Continuous rated output ≧ One cycle operation pattern average output (P_{AV})

POINT

1. Calculate acceleration/deceleration time by the accurate load inertia because even if the rotation speed is the same, acceleration/deceleration time varies with a tool or workpiece mounted to the spindle.
   Refer to the section "Adjusting the Acceleration/Deceleration Operation" (1) in Instruction Manual.
2. Calculation method of synchronous tapping
   The acceleration/deceleration number of times is twice, for forward run and reverse run are carried out in one machining.
   The output guideline is 50% of the short-time rating. The time is tapping time constant.
3. Calculation method of spindle synchronization
   The output guideline is 70% of the short-time rating. The time is spindle synchronization time constant.

7.3 Selection of the Power Supply Unit

For the power supply unit, calculate the spindle motor output and servo motor output each, and select the capacity satisfying the required rated capacity and the maximum momentary output.

7.3.1 Calculation of Spindle Output

The spindle rated output and spindle maximum momentary rated output are calculated.

(1) Calculation of spindle rated output

The spindle rated output is calculated according to the following procedure.

(a) Spindle motor rated output

The spindle motor rated output is calculated from the following expression.

Spindle motor rated output =
MAX (continuous rated output, short-time rated output × short-time rated output coefficient α, %ED rated output × %ED rated output coefficient β)

(Note 1) For the spindle motor rated output, use the maximum value of "continuous rated output", "short-time rated output × short-time rated output coefficient α", and "%ED rated output × %ED rated output coefficient β".
(Note 2) Select the maximum value for the spindle motor with multiple %ED rated output characteristics.

For the spindle short-time rated output coefficient α, use the value in the "Table 1.1", and for the %ED rated output coefficient β, use the value in the "Table 1.2".

Table1.1 List of short-time rated output time and short-time rated output coefficient

Short-time rated output time	Short-time rated output coefficient α	Short-time rated output time	Short-time rated output coefficient α
1 minute	0.2	5 minutes	0.7
2 minutes	0.4	6 to 7 minutes	0.8
3 minutes	0.5	8 to 9 minutes	0.9
4 minutes	0.6	10 minutes or more	1.0

(Note 1) Select the set time for the short-time rated output of your spindle motor from the list.
E.g.) When the set time for the short-time rated output is "1/12h", it means "5 minutes".
(Note 2) For the motor with coil changeover specification, select the set time for the short-time rated output of the high-speed coil.

Table 1.2 List of %ED rated output time and %ED rated output coefficient

%ED rated output time	%ED rated output coefficient β
More than or equal to 10% but less than 20%	0.7
More than or equal to 20% but less than 30%	0.9
More than or equal to 30%	1.0

(b) Spindle rated output

The spindle rated output is calculated from the following expression.

Spindle rated output

=Spindle motor rated output × motor output coefficient γ of the combined spindle drive unit

For the spindle motor rated output of the above expression, use the value calculated in (a).
For the motor output coefficient of the combined spindle drive unit, use the value corresponding to the used spindle drive unit in the table 2.

Table 2. Motor output coefficient list of combined spindle drive unit

< MDS-E Series >

Spindle motor rated output	Combined spindle drive unit MDS-E-SP-								
	20	40	80	160	200	240	320	400	640
to 1.5kW	1.00	1.15	1.25	-	-	-	-	-	-
to 2.2kW	-	1.00	1.15	1.30	-	-	-	-	-
to 3.7kW	-	1.00	1.05	1.20	-	-	-	-	-
to 5.5kW	-	-	1.00	1.10	1.20	-	-	-	-
to 7.5kW	-	-	-	1.00	1.15	1.20	-	-	-
to 11.0kW	-	-	-	1.00	1.05	1.10	1.15	-	-
to 15.0kW	-	-	-	-	1.00	1.05	1.10	-	-
to 18.5kW	-	-	-	-	1.00	1.00	1.05	1.10	-
to 22kW	-	-	-	-	-	1.00	1.00	1.05	1.15
to 26kW	-	-	-	-	-	-	1.00	1.00	1.10
to 30kW	-	-	-	-	-	-	1.00	1.00	1.05
to 37kW	-	-	-	-	-	-	-	1.00	1.05
to 45kW	-	-	-	-	-	-	-	-	1.0
to 55kW	-	-	-	-	-	-	-	-	1.0

< MDS-EH Series >

Spindle motor rated output	Combined spindle drive unit MDS-EH-SP-								
	20	40	80	100	160	200	320	480	600
to 2.2kW	1.00	1.15	1.30	-	-	-	-	-	-
to 3.7kW	1.00	1.05	1.20	-	-	-	-	-	-
to 5.5kW	-	1.00	1.10	1.20	-	-	-	-	-
to 7.5kW	-	-	1.00	1.15	-	-	-	-	-
to 11.0kW	-	-	1.00	1.05	1.15	-	-	-	-
to 15.0kW	-	-	-	1.00	1.10	-	-	-	-
to 18.5kW	-	-	-	1.00	1.05	1.10	-	-	-
to 22kW	-	-	-	-	1.00	1.05	1.15	-	-
to 26kW	-	-	-	-	1.00	1.00	1.10	1.20	-
to 30kW	-	-	-	-	1.00	1.00	1.05	1.15	-
to 37kW	-	-	-	-	-	1.00	1.05	1.10	1.10
to 45kW	-	-	-	-	-	-	1.00	1.05	1.05
to 55kW	-	-	-	-	-	-	1.00	1.00	1.00
to 75kW	-	-	-	-	-	-	-	1.00	1.00

POINT

1. When the spindle motor applies to the wide range constant output specification or the high-torque specification, the spindle rated output may become large.
2. The spindle rated output is calculated from the motor output coefficient of the spindle drive unit used in combination with the spindle motor.

(2) Calculation of spindle maximum momentary output

The spindle maximum momentary output is calculated from the following expression.

Spindle maximum momentary output
=MAX (short-time rated output × 1.2, output at acceleration/deceleration × 1.2 or %ED rated output×1.2)

(Note) For the spindle rated output, use the larger one of "short-time rated output × 1.2" , "output at acceleration/deceleration × 1.2" or "%ED rated output×1.2".

7.3.2 Calculation of Servo Motor Output

(1) Selection with rated output

(2) Selection with maximum momentary output

For the rated output and maximum momentary output of the servo motor, use the value corresponding to the servo motor in the table 3.

Table 3. Data for servo motor output selection

< 200V series >

Motor HG	46	56	96
Rated output (kW)	0.2	0.4	0.75
Maximum momentary output (kW)	0.85	1.7	3.2

Motor HG	75	105	54	104	154	154 (V3-40)	224	204	354
Rated output (kW)	0.75	1.0	0.5	1.0	1.5	1.5	2.2	2.0	3.5
Maximum momentary output (kW)	2.2	3.5	2.3	5.0	9.0	5.4	12.3	8.0	18.0

Motor HG	123	223	303	453	603	702	703	903	1103	142	302
Rated output (kW)	1.2	2.2	3.0	4.5	6.0	7.0	7.0	9.0	11.0	1.4	3.0
Maximum momentary output (kW)	3.2	6.3	12.0	22.0	26.9	21.2	27.0	41.0	50.0	3.2	6.3

Motor HK	76	105	55	104	123	142	154	HK154 (V3-40)	HK154 (V3-80)
Rated output (kW)	0.75	1.0	0.5	1.0	1.2	1.4	1.5	1.5	1.5
Maximum momentary output (kW)	3.3	3.6	2.9	5.9	3.6	3.3	9.4	7.2	9.4

Motor HK	223	224	224 (V1/V2-160)
Rated output (kW)	2.2	2.2	2.2
Maximum momentary output (kW)	6.8	12.8	13.0

Motor HK	204	302	303	354	453	603	702	703
Rated output (kW)	2.0	3.0	3.0	3.5	4.5	6.0	7.0	7.0
Maximum momentary output (kW)	10.0	7.3	13.5	18.4	26.4	27.7	22.8	27.7

< 400V series >

Motor HG-H	75	105	54	104	154	224	204	354	453	703	903
Rated output (kW)	0.75	1.0	0.5	1.0	1.5	2.2	2.0	3.5	4.5	7.0	9.0
Maximum momentary output (kW)	2.2	3.5	2.3	5.0	9.0	13.1	8.0	18.0	22.0	27.0	41.0

Motor HG-H	1502
Rated output (kW)	15.0
Maximum momentary output (kW)	59.0

Motor HQ-H	903	1103
Rated output (kW)	9.0	11.0
Maximum momentary output (kW)	31.0	47.0

Motor HK-H	76	105	55	104	123	154	223	224	224 (V1/V2-80)
Rated output (kW)	0.75	1.0	0.5	1.0	1.2	1.5	2.2	2.2	2.2
Maximum momentary output (kW)	3.3	3.6	2.9	5.9	3.6	9.4	6.8	12.8	13.0

Motor HK-H	204	302	303	354	453	603	702	703
Rated output (kW)	2.0	3.0	3.0	3.5	4.5	6.0	7.0	7.0
Maximum momentary output (kW)	10.0	10.9	13.5	18.4	26.4	27.7	22.8	27.7

(Note) The maximum momentary output in this table is reference data for selecting the power supply unit and is not data which guarantees the maximum output.

7.3.3 Selection of the Power Supply Unit

Select the power supply unit from the total sum of the rated output and the maximum momentary output.

(1) Calculation of required rated output

Power supply unit rated capacity > Σ (Spindle rated output) + 0.3 Σ (Servo motor rated output)

Substitute the output calculated from "7.3.1(1)" and "7.3.2(1)" to the above expression, and calculate the total sum of the spindle rated output and servo motor rated output. According to this, select the power supply unit satisfying the rated capacity from the table 4.

(2) Calculation of required maximum momentary output

Maximum momentary rated capacity of power supply unit ≧
Σ (Spindle maximum momentary output) + Σ (Maximum momentary output of servomotor accelerating/ decelerating simultaneously)

Substitute the output calculated from "7.3.1(2)" and "7.3.2(2)" to the above expression, and calculate the total sum of the "spindle maximum momentary output" and "output of servo motor accelerating/decelerating simultaneously". According to this, select the power supply unit satisfying the maximum momentary rated capacity from the table 4.

(3) Selection of power supply unit

Select the power supply unit of which the capacity is larger than that selected in the item (1) and (2).

Table 4. Power supply unit rated capacity and maximum momentary rated capacity

< MDS-E Series >

Unit	MDS-E-CV-	37	75	110	185	300	370	450	550
Rated capacity (kW)		4.2	8	11.5	19	31	38	46	56
Maximum momentary rated capacity (kW)		16	23	39	60	92	101	125	175

< MDS-EH Series >

Unit	MDS-EH-CV-	37	75	110	185	300	370	450	550	750
Rated capacity (kW)		4.2	8	11.5	19	31	38	46	56	76
Maximum momentary rated capacity (kW)		16	23	39	60	92	101	125	175	180

⚠ CAUTION

1. When reducing the time constant replacing the conventional motor with the HG or HG-H Series motor, the power supply capacity may rise because the motor maximum momentary output increases more than the conventional motor. Therefore, make sure to check the selection with maximum momentary rated capacity.
2. When the large capacity drive unit (MDS-E-SP-400/640, MDS-EH-SP-200/320/480/600, MDS-EH-V1-200) is connected to the power supply unit, always install the drive unit proximally in the left side of the power supply unit and connect PN terminal with the dedicated DC connection bar.
3. When using two large capacity drive units or more, the power supply unit is required for each drive unit.

7.3.4 Required Capacity of Power Supply

For the power supply capacity, calculate the required spindle rated output and servo motor rated output each, and select the power supply capacity satisfying them.

(1) Spindle rated output required for power supply

The spindle rated output required for power supply is calculated from the following expression.

Spindle rated output required for power supply =
MAX (Spindle motor continuous rated output, Spindle motor output at accelerating/decelerating, Spindle motor short-time output)× motor output coefficient γ of combined spindle drive unit

(Note) For the spindle rated output required for the power supply, multiply the largest one of "spindle motor continuous rated output", "spindle motor output at acceleration/deceleration" and "spindle motor short-time output" by the motor output coefficient γ of the combined spindle drive unit.
For the motor output coefficient of the combined spindle drive unit, use the value corresponding to the used spindle drive unit in the table 2. of 7.3.1 (1).

(2) Servo motor rated output required for power supply

For the servo motor rated output required for power supply, use the value calculated in 7.3.2 (1).

(3) Calculation of rated output required for power supply

Rated capacity required for power supply =
Σ (Spindle rated output required for power supply) + 0.3 Σ (servo motor rated output required for power supply)

Substitute the output calculated from the item (1) and (2) to the above expression, and calculate the rated capacity required for the power supply.

(4) Calculation of required power supply

Power supply capacity (kVA) = Σ{(Required rated capacity calculated in the item (3)(kW) / Capacity of selected power supply unit (kW)) × Power supply capacity base value (kVA)}

The power supply capacity base value corresponding to the capacity of the selected power supply unit is as the following table.

< MDS-E Series >

Unit	MDS-E-CV-	37	75	110	185	300	370	450	550
Power supply capacity base value (kVA)		5.3	11.0	16.0	27.0	43.0	53.0	64.0	78.0

< MDS-EH Series >

Unit	MDS-EH-CV-	37	75	110	185	300	370	450	550	750
Power supply capacity base value (kVA)		5.3	11.0	16.0	27.0	43.0	53.0	64.0	78.0	107.0

7.3.5 Example for Power Supply Unit and Power Supply Facility Capacity

< MDS-E Series >

(Example 1)

Axis name	Motor	Drive unit	Rated output	Maximum momentary output
X-axis	HG354	(MDS-E-V2-160)	3.5kW	18kW
Y-axis	HG354	(MDS-E-V2-160)	3.5kW	18kW
Z-axis	HG354	(MDS-E-V1-160)	3.5kW	18kW
Spindle	Spindle motor 22kW	MDS-E-SP-320 (Output coefficient 1.0)	22kW	26.4kW
Total			0.3 × (3.5 × 3) + 22 = 25.15kW < 31kW (E-CV-300)	(18 × 3) + 26.4 = 80.4kW < 92kW (E-CV-300)

The power supply unit satisfying the total of the rated output and the maximum momentary output is MDS-E-CV-300.
Required power supply capacity (kVA) = (25.15 / 30) × 43 = 36.0 (kVA)

(Example 2)

Axis name	Motor	Drive unit	Rated output	Maximum momentary output
X1-axis	HG453	(MDS-E-V2-160)	4.5kW	22kW
X2-axis	HG453	(MDS-E-V2-160)	4.5kW	22kW
Y-axis	HG354	(MDS-E-V2-160)	3.5kW	18kW
Z-axis	HG354	(MDS-E-V2-160)	3.5kW	18kW
Spindle	Spindle motor 15kW	MDS-E-SP-200 (Output coefficient 1.0)	15kW	18kW
Total			0.3 × (4.5 × 2 + 3.5 x 2) + 15 = 19.8kW < 31kW (E-CV-300)	22 × 2 + 18 × 2 + 18 = 98.0kW < 101kW (E-CV-370)

The power supply unit satisfying the total of the rated output and the maximum momentary output is MDS-E-CV-370.
Required power supply capacity (kVA) = (19.8 / 37) × 53 = 28.4 (kVA)

(Example 3)

Axis name	Motor	Drive unit	Rated output	Maximum momentary output
X-axis	HG354	MDS-E-V1-160	3.5kW	18kW
Y-axis	HG204	MDS-E-V2-80	2.0kW	8kW
Z-axis	HG204	MDS-E-V2-80	2.0kW	8kW
Spindle	Spindle motor 15kW (High-torque motor)	MDS-E-SP-320 (Output coefficient 1.1)	16.5kW	18kW
Total			0.3 × (3.5 + 2.0 × 2) + 16.5 = 18.75kW < 19kW (E-CV-185)	18 + 8 × 2 + 18 = 52kW < 60kW (E-CV-185)

The power supply unit satisfying the total of the rated output and the maximum momentary output is MDS-E-CV-185.
Required power supply capacity (kVA) = (18.75 / 18.5) × 27 = 27.4 (kVA)

< MDS-EH Series >

(Example 1)

Axis name	Motor	Drive unit	Rated output	Maximum momentary output
X-axis	HG-H354	(MDS-EH-V2-80)	3.5kW	18kW
Y-axis	HG-H354	(MDS-EH-V2-80)	3.5kW	18kW
Z-axis	HG-H354	(MDS-EH-V1-80)	3.5kW	18kW
Spindle	Spindle motor 22kW	MDS-EH-SP-160 (Output 22kW)	22kW	26.4kW
Total			0.3×(3.5×3)+22 =25.15kW <31kW(EH-CV-300)	(18×3)+26.4 =80.4kW <92kW(EH-CV-300)

The power supply unit satisfying the total of the rated output and the maximum momentary output is MDS-EH-CV-300.
Required power supply capacity (kVA) = (25.15 / 30) x 43 = 36.0 (kVA)

(Example 2)

Axis name	Motor	Drive unit	Rated output	Maximum momentary output
X1-axis	HG-H453	(MDS-EH-V2-80)	4.5kW	22kW
X2-axis	HG-H453	(MDS-EH-V2-80)	4.5kW	22kW
Y-axis	HG-H354	(MDS-EH-V2-80)	3.5kW	18kW
Z-axis	HG-H354	(MDS-EH-V2-80)	3.5kW	18kW
Spindle	Spindle motor 15kW	MDS-EH-SP-100 (Output coefficient 1.0)	15kW	18kW
Total			0.3×(4.5×2+3.5×2)+15 =19.8kW <31kW(EH-CV-300)	22×2+18×2+18 =98.0kW <101kW(EH-CV-370)

The power supply unit satisfying the total of the rated output and the maximum momentary output is MDS-EH-CV-370.
Required power supply capacity (kVA) = (19.8 / 37) x 53 = 28.4 (kVA)

(Example 3)

Axis name	Motor	Drive unit	Rated output	Maximum momentary output
X-axis	HG-H354	MDS-EH-V1-160	3.5kW	18kW
Y-axis	HG-H204	MDS-EH-V2-80	2.0kW	8kW
Z-axis	HG-H204	MDS-EH-V2-80	2.0kW	8kW
Spindle	Spindle motor 15kW (High-torque motor)	MDS-EH-SP-320 (Output coefficient 1.1)	16.5kW	18kW
Total			0.3×(3.5+2.0×2)+16.5 =18.75kW <19kW(EH-CV-185)	18+8×2+18 =52kW <60kW(EH-CV-185)

The power supply unit satisfying the total of the rated output and the maximum momentary output is MDS-EH-CV-185.
Required power supply capacity (kVA) = (18.75 / 18.5) x 27 = 27.4 (kVA)

7.3.6 Selection of Regenerative Resistor for Power Backup Unit (R-UNIT-6,7) and Capacitor Unit for Power Backup Unit (MDS-D/DH-CU)

When using the retraction function at power failure with MDS-D/DH-PFU, select to satisfy the stop operation for the regenerative resistor and the continuous rated output of the spindle motor for the capacitor unit.

(1) Selection of regenerative resistor for power backup unit

When using the retraction function at power failure, a resistor unit is required to make the spindle deceleration and stop after the retraction is completed.

⚠ CAUTION

1. When not using a resistor unit, control to coast the spindle motor after the retraction operation is completed.
2. Only the designated combination can be used for the power backup unit and the regenerative resistor.

(2) Selection of capacitor unit for power backup unit

When using the retraction function at power failure, the required number of capacitor units is decided by the continuous rated output [kW] of the spindle motor. Select according to the following specifications.

List of spindle continuous rated output and number of capacitor unit

Spindle continuous rated output	Number of capacitor unit
3.7kW or less	1
5.5kW or less	2
7.5kW or less	3
11kW or less	4
15kW or less	5
22kW or less	6

8

Appx. 1: Cable and Connector Specifications

8.1 Selection of Cable

8.1.1 Cable Wire and Assembly

(1) Cable wire

The specifications of the wire used for each cable, and the machining methods are shown in this section. Mitsubishi uses the cables shown in the tables below. When manufacturing the encoder cable and battery connection cable, use the wires shown below or equivalent products.

(a) Heat resistant specifications cable

Wire type (other manufacturer's product)	Finish outer diameter	Sheath material	No. of pairs	Wire characteristics					
				Configuration	Conductive resistor	Withstand voltage	Insulation resistance	Heat resistance temperature	Flexibility
BD20288 Compound 6-pair shielded cable Specification No. Bangishi-17145 (Note 1)	8.7mm	Heat resistant PVC	2 ($0.5mm^2$)	100 strands/ 0.08mm	40.7Ω/km or less	500VAC/ 1min	1000 MΩ/km or more	105°C	70×10^4 times or more at R200
			4 ($0.2mm^2$)	40 strands/ 0.08mm	103Ω/km or less				

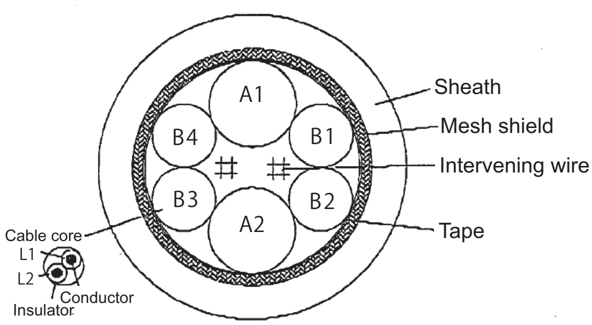
(b) General-purpose heat resistant specifications cable

Wire type (other manufacturer's product)	Finish outer diameter	Sheath material	No. of pairs	Wire characteristics					
				Configuration	Conductive resistor	Withstand voltage	Insulation resistance	Heat resistance temperature	Flexibility
BD20032 Compound 6-pair shielded cable Specification No. Bangishi-16903 Revision No. 3 (Note 1)	8.7mm	PVC	2 ($0.5mm^2$)	100 strands/ 0.08mm	40.7Ω/km or less	500VAC/ 1min	1000 MΩ/km or more	60°C	100×10^4 times or more at R200
			4 ($0.2mm^2$)	40 strands/ 0.08mm	103Ω/km or less				

(Note 1) BANDO Electric Wire (http://www.bew.co.jp/)

(Note 2) The Mitsubishi standard cable is the (a) Heat resistant specifications cable. When the working environment temperature is low and so higher flexibility is required, use the (b) General-purpose heat resistant specifications cable.

Compound 6-pair cable structure drawing

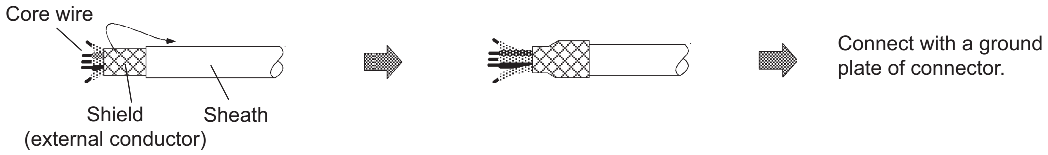


Core identification

Pair No.	Insulator color	
	L1	L2
A1 ($0.5mm^2$)	Red	White
A2 ($0.5mm^2$)	Black	White
B1 ($0.2mm^2$)	Brown	Orange
B2 ($0.2mm^2$)	Blue	Green
B3 ($0.2mm^2$)	Purple	White
B4 ($0.2mm^2$)	Yellow	White

(2) Cable assembly

Assemble the cable with the cable shield wire securely connected to the ground plate of the connector.

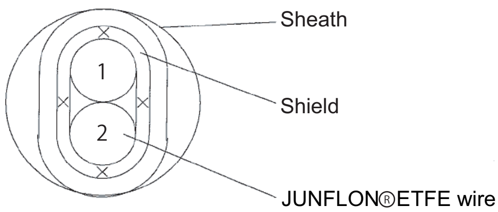


(Note) Shield processing of battery cable is unnecessary.

(3) Battery connection cable

Wire type (other manufacturer's product)	Finish outer diameter	Sheath material	No. of pairs	Wire characteristics					
				Configura-tion	Conductive resistor	Withstand voltage	Insulation resistance	Heat resistance temperature	Flexibility
J14B101224-00 Two core shield cable (Note 1)	3.3mm	PVC	1 ($0.2mm^2$)	7strands / 0.2mm	91.2Ω/km or less	500VAC/ 1min	1000MΩ/ km or less	80°C	R33mm

(Note 1) Junkosha Inc. http://www.junkosha.co.jp/english/index.html
Dealer: TOA ELECTRIC INDUSTRIAL CO.,LTD. http://www.toadenki.co.jp/en/



Two core shield cable structure drawing

Core identification

No.	Insulator color
1	Red
2	Black

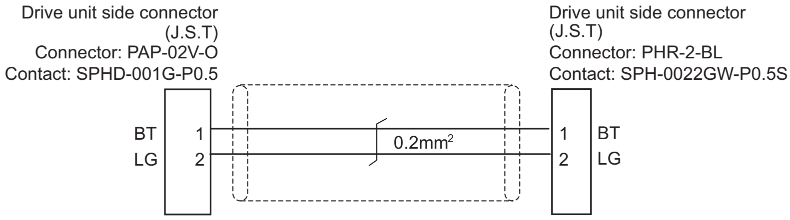
8.2 Cable Connection Diagram

⚠ CAUTION

1. Take care not to mistake the connection when manufacturing the encoder cable. Failure to observe this could lead to faults, runaway or fire.
2. When manufacturing the cable, do not connect anything to pins which have no description.

8.2.1 Battery Cable

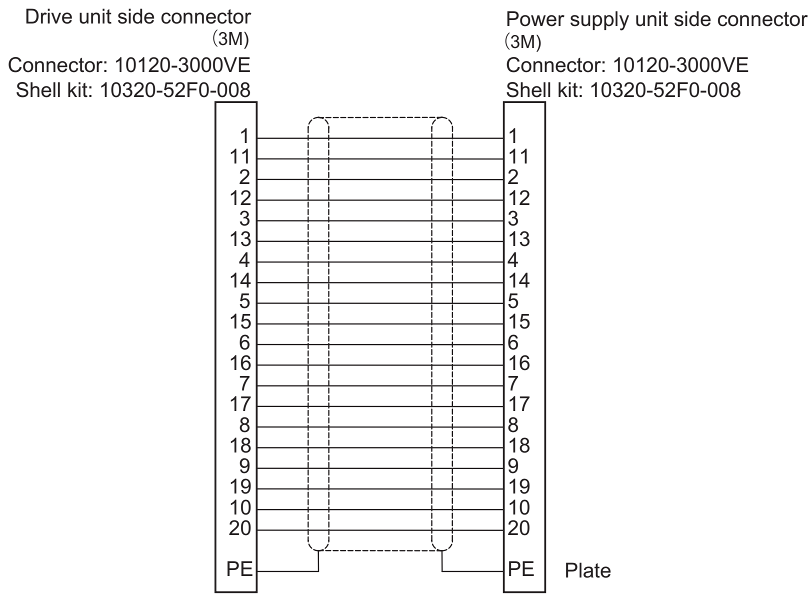
< DG30 cable connection diagram (Connection cable between drive unit and MDSBTBOX-LR2060 / between drive unit and drive unit) >



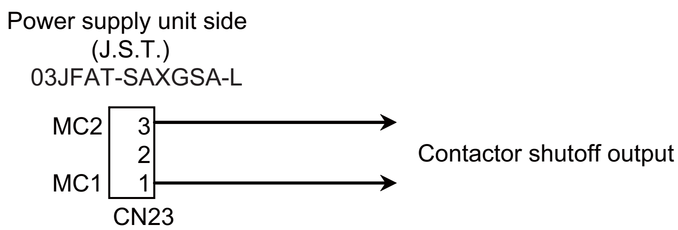
(Note) Shield processing of battery cable is unnecessary.

8.2.2 Power Supply Communication Cable and Connector

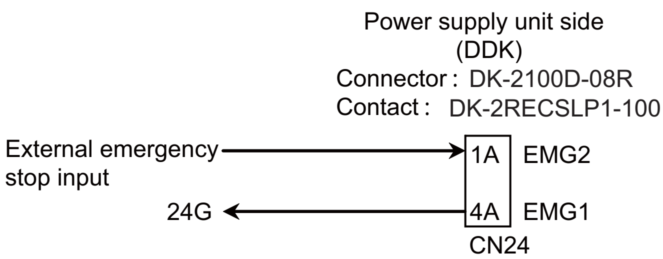
< SH21 cable connection diagram >



< CN23 contactor control output connector connection diagram >

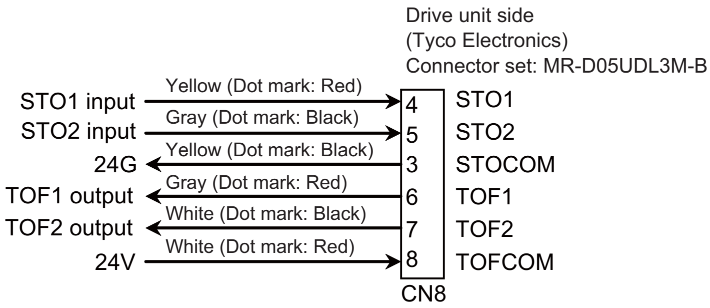


< CN24 external emergency stop connector connection diagram >



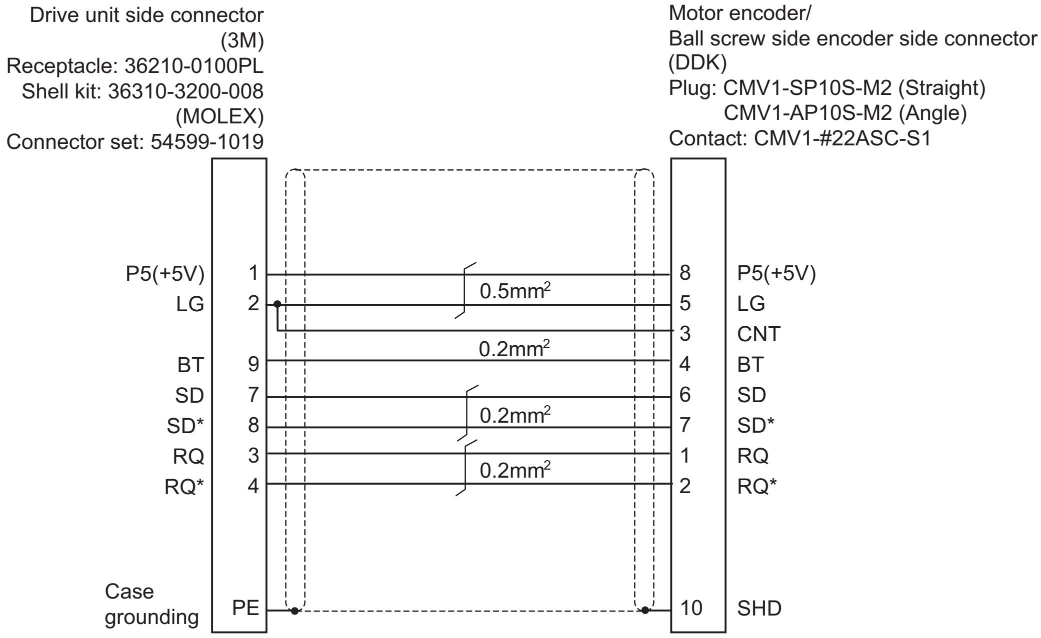
8.2.3 STO Cable

< CN8 STO input connector connection diagram >

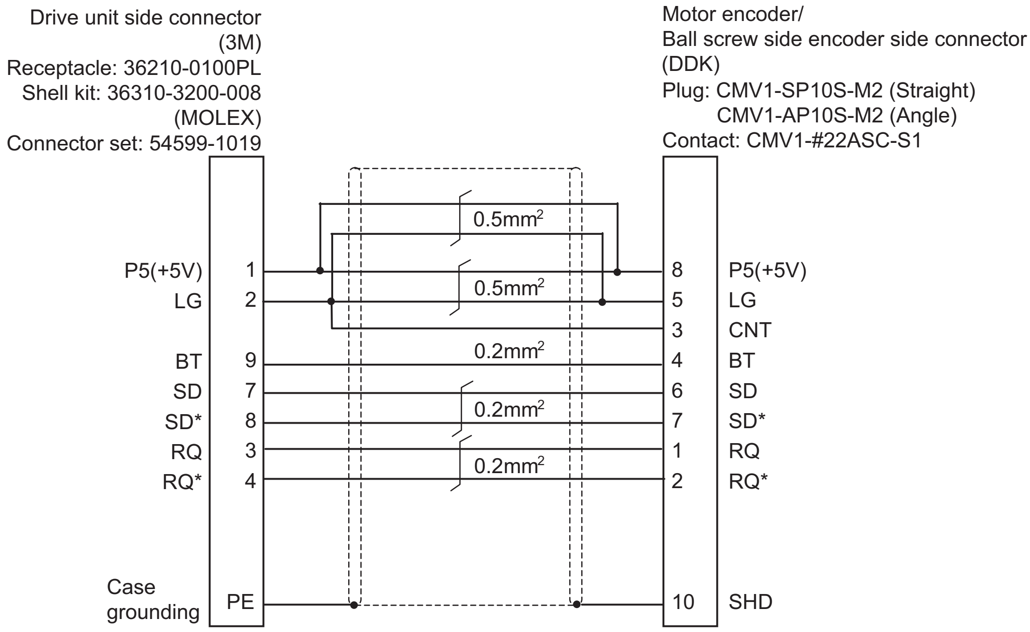


8.2.4 Servo Encoder Cable

< CNV2E-8P, CNV2E-9P cable connection diagram > (HG(-H), HQ-H Series)

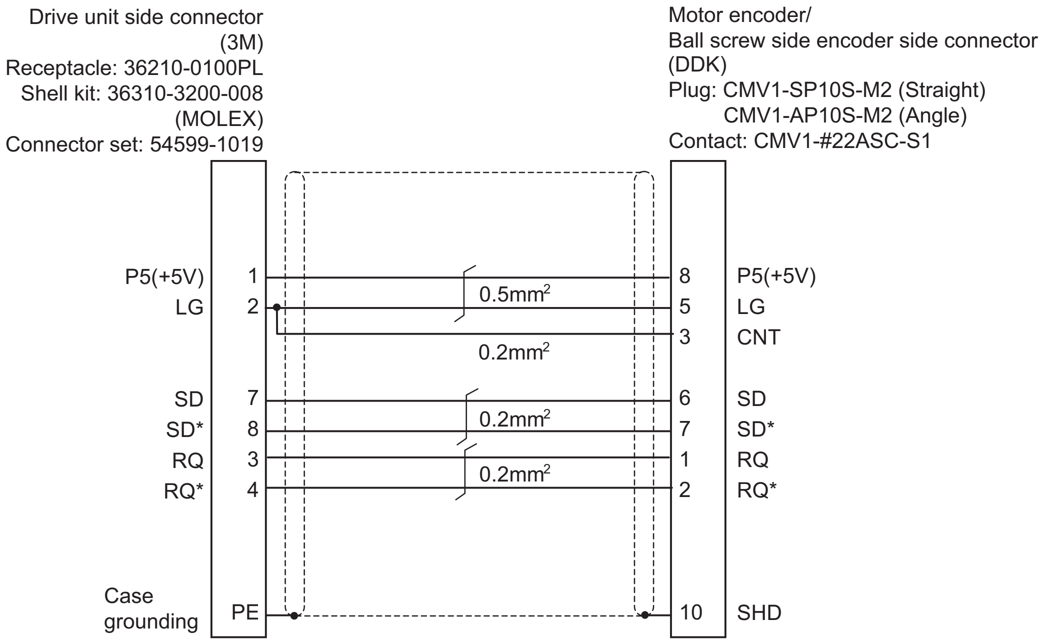


< For 15m or less >

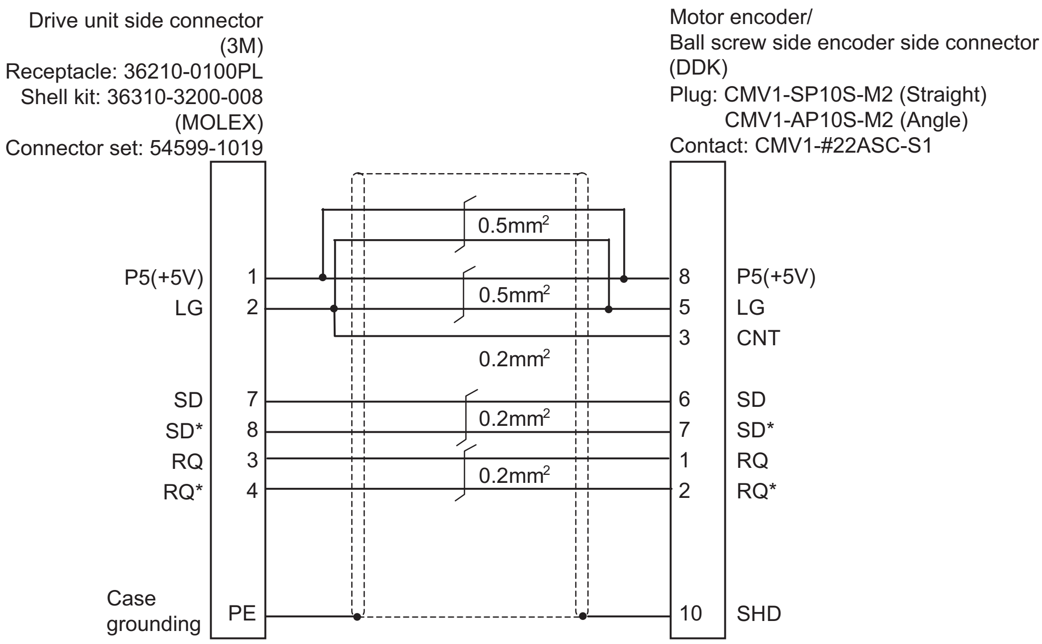


< For 15m to 30m >

< CNV2E-8P, CNV2E-9P cable connection diagram > (HK(-H) Series)

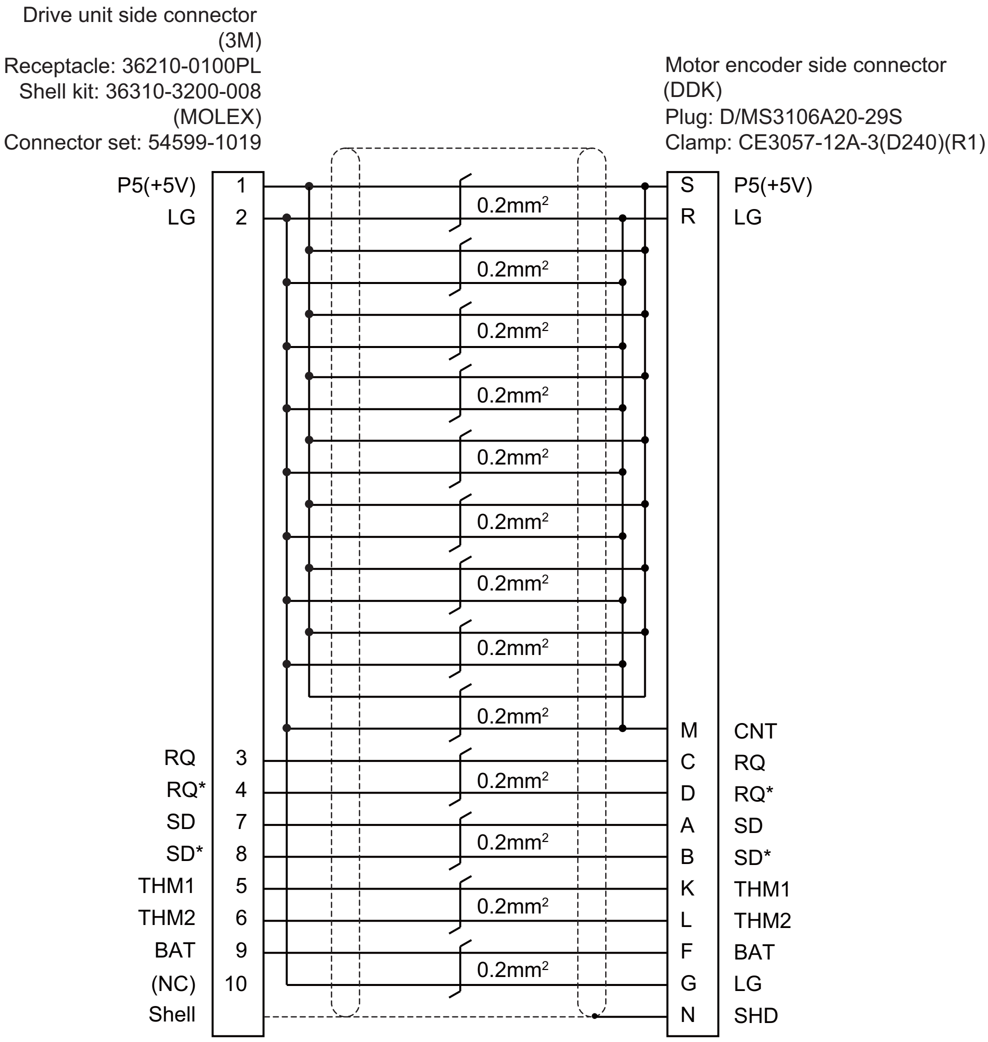


< For 15m or less >

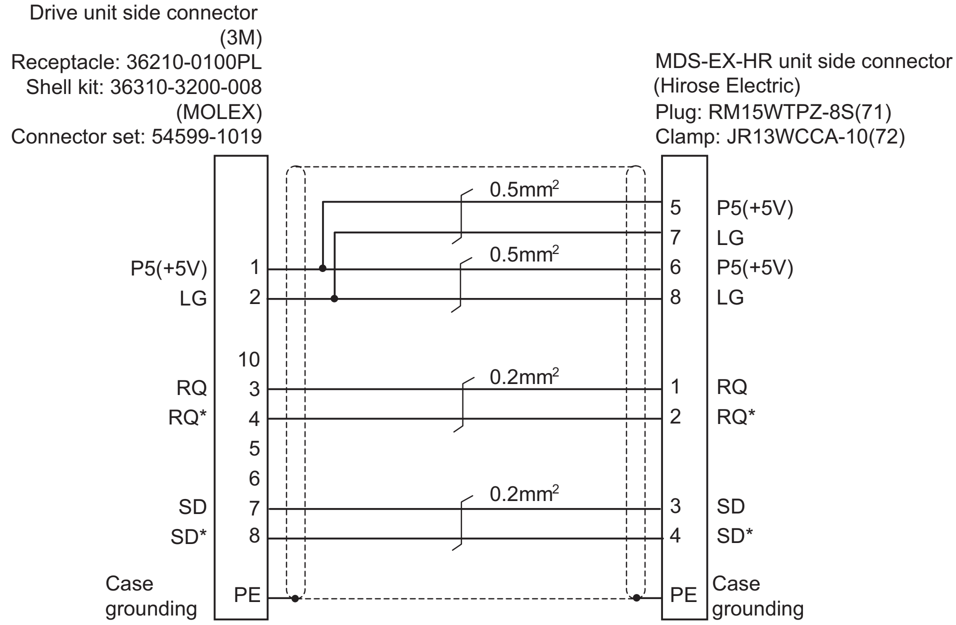


< For 15m to 30m >

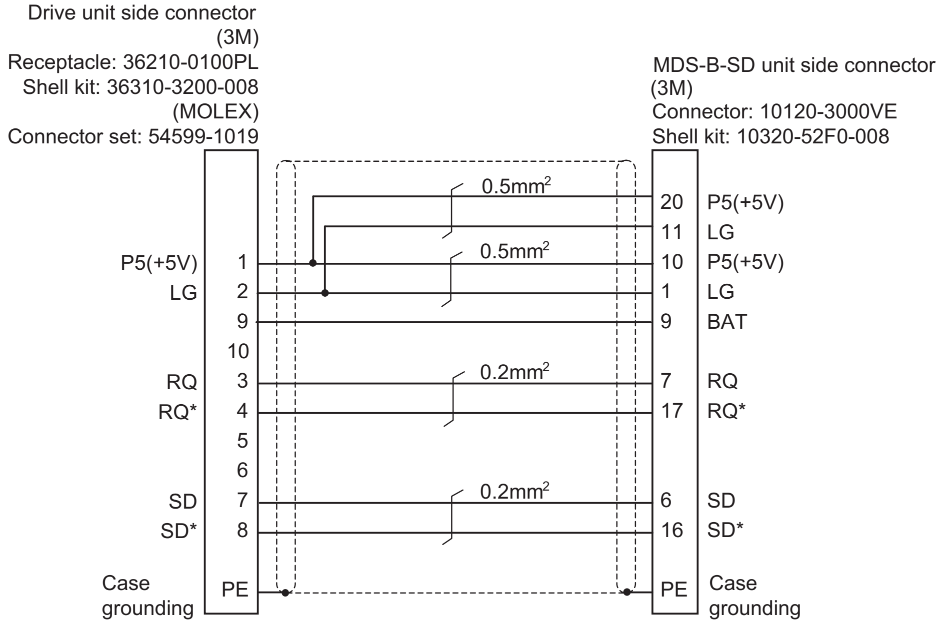
<MR-ENE4CBL□M-H-MTH cable connection diagram>



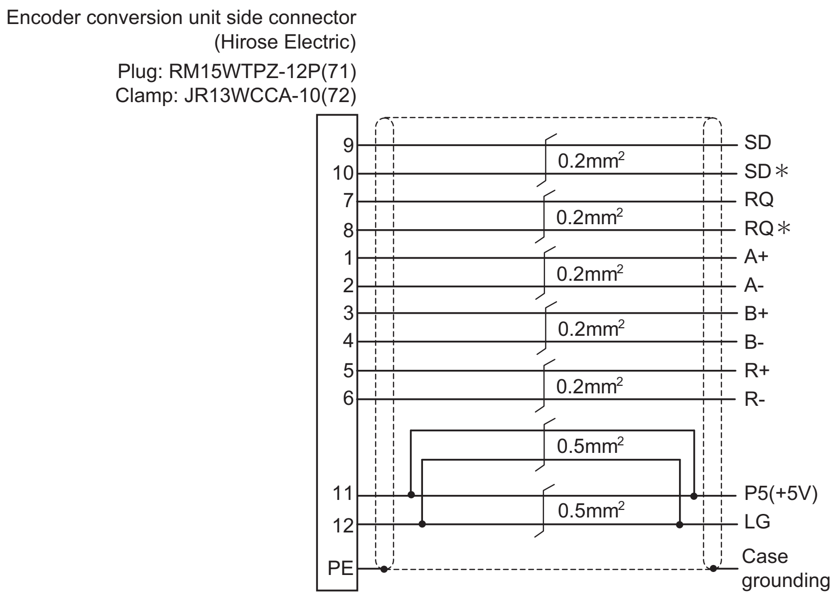
< CNV2E-HP cable connection diagram >



< CNV2E-D cable connection diagram >

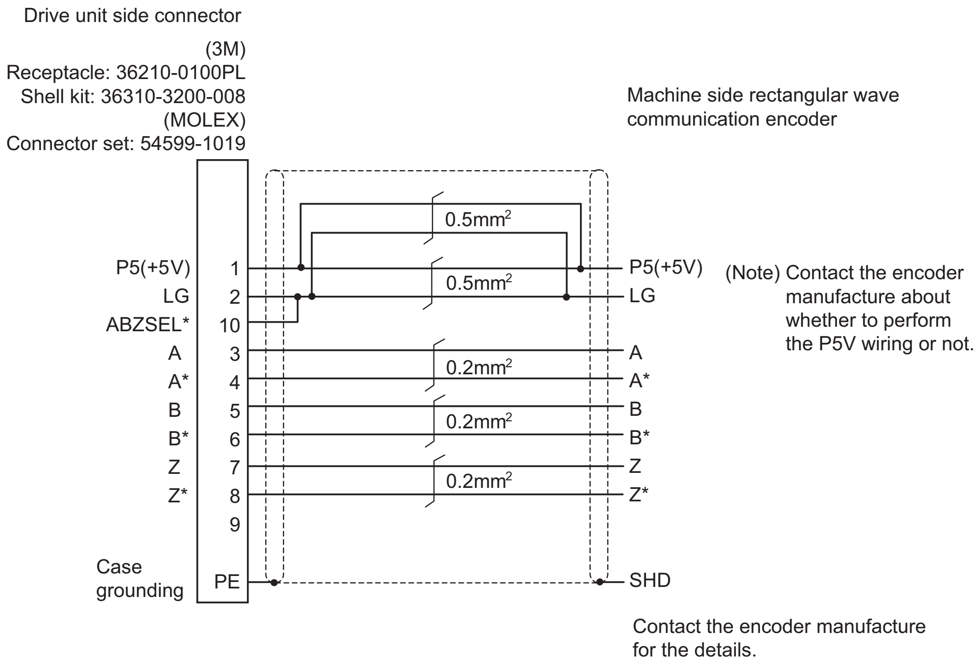


< Cable connection diagram between scale I/F unit and scale (CNLH3 cable, etc.) >



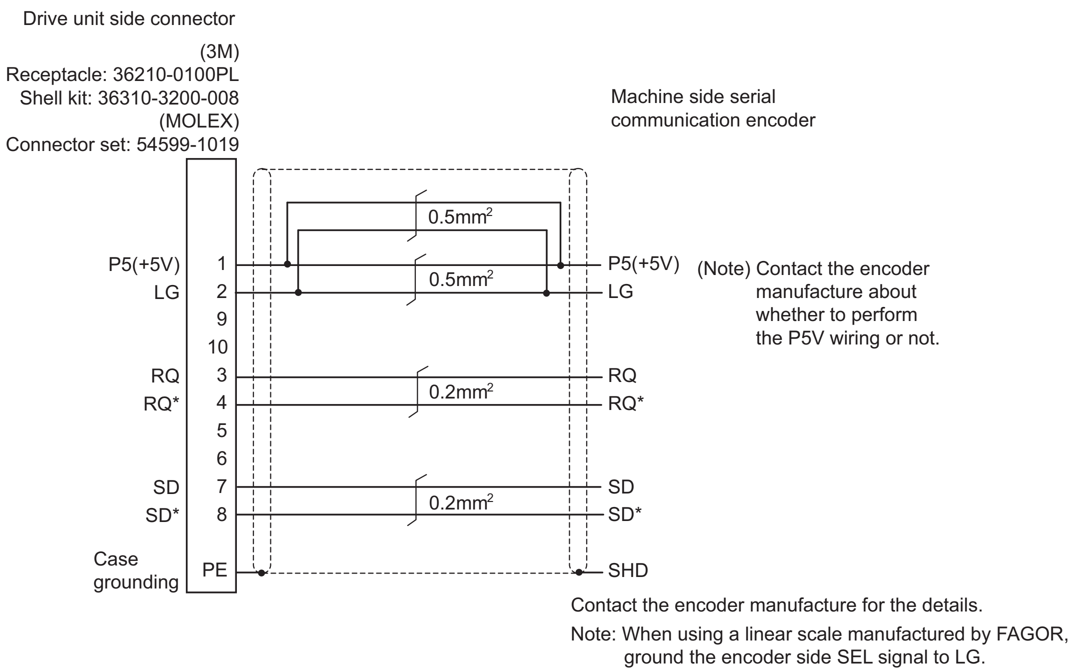
(Note) This cable must be prepared by the user.

< Rectangular wave communication encoder (linear scale, etc.) cable connection diagram >



(Note) This cable must be prepared by the user.

< Serial communication encoder (linear scale, etc.) cable connection diagram >



(Note) This cable must be prepared by the user.

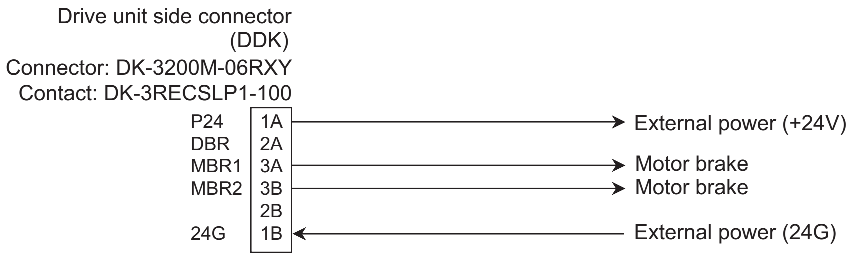
POINT

For compatible encoder, refer to the section "Servo option" in Specifications Manual.

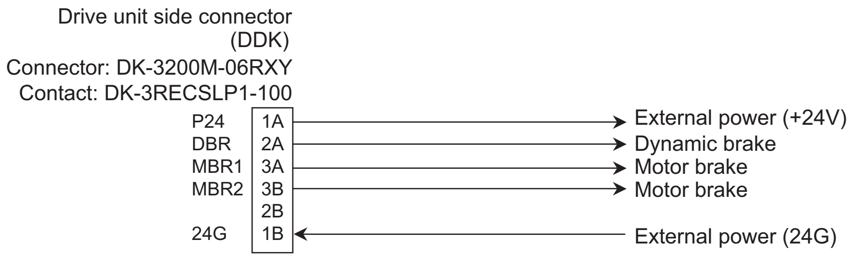
8.2.5 Brake Cable and Connector

< Moter brake connector connection diagram (Brake connector for motor brake control output) >

• For MDS-E-V1-320 or smaller and MDS-EH-V1-160 or smaller

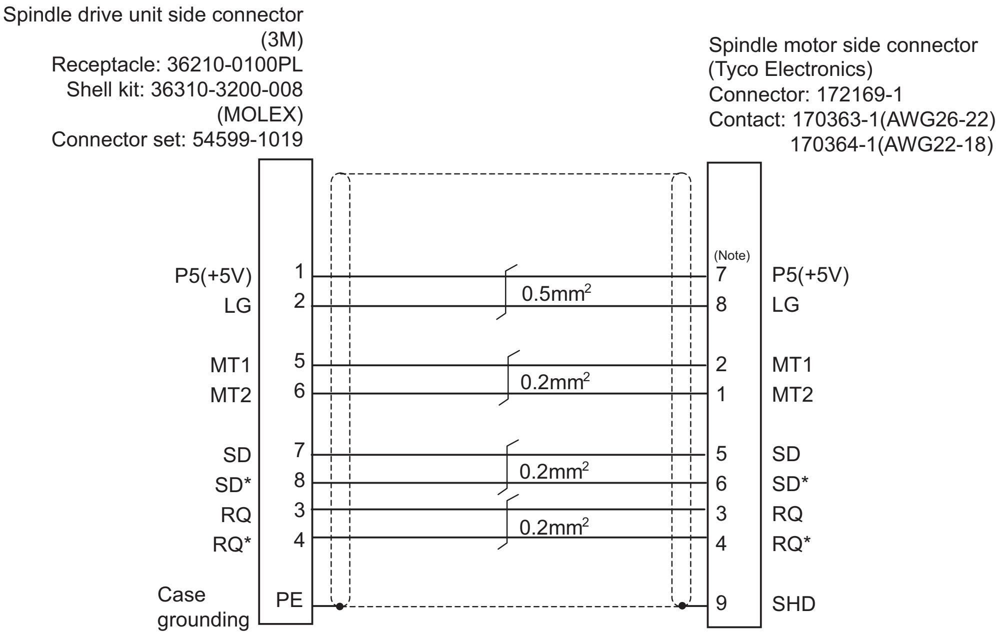


• For MDS-E-V1-320W or larger and MDS-EH-V1-160W or larger



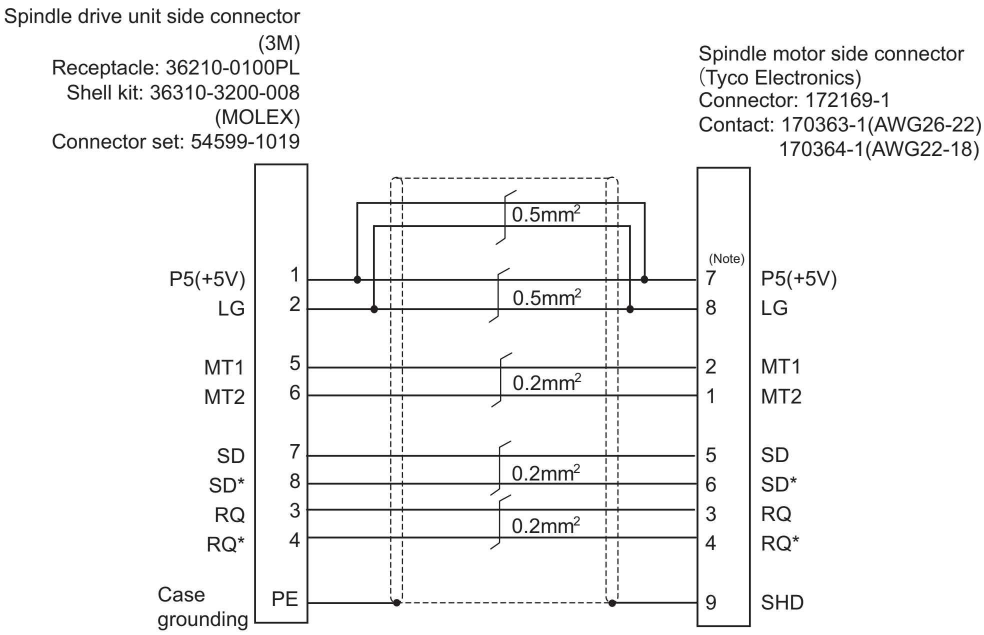
8.2.6 Spindle Encoder Cable

< CNP2E-1 cable connection diagram >



(Note) For the pin "7" or "8", use the contact "170364-1".
For the other pins, use the contact "170363-1".

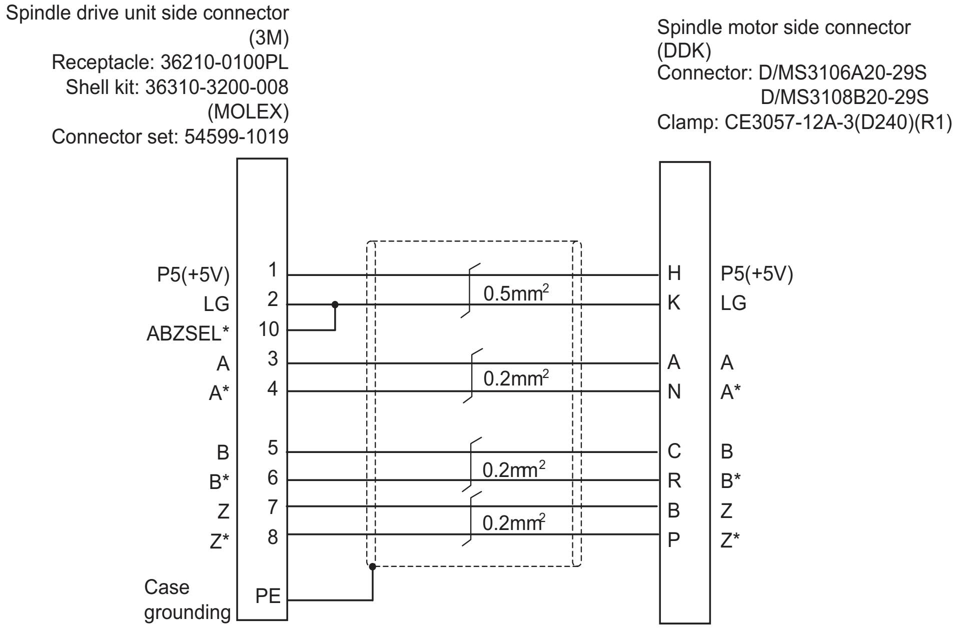
< For 15m or less >



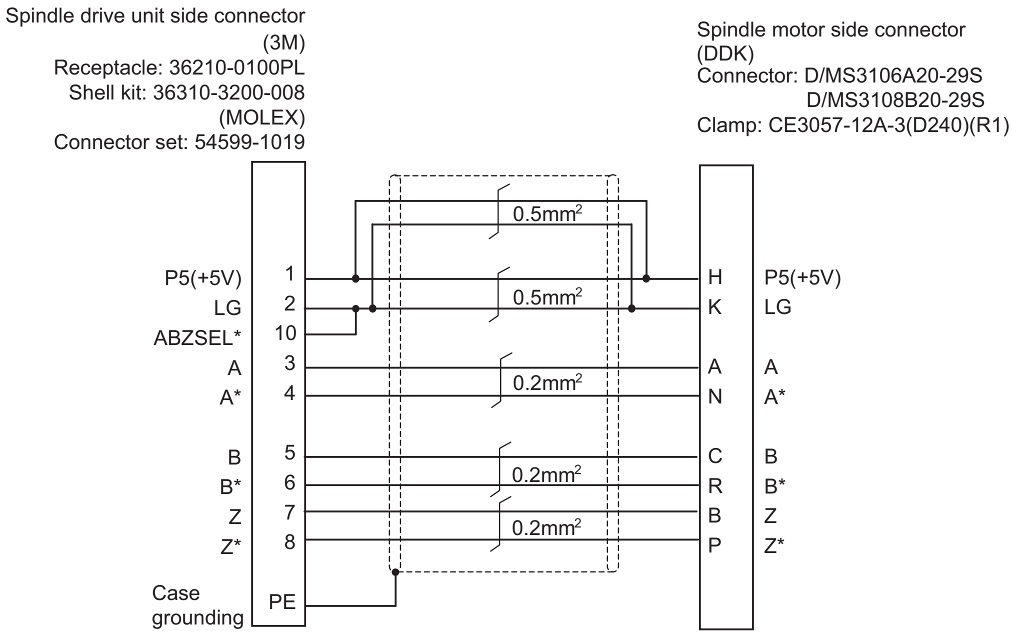
(Note) For the pin "7" or "8", use the contact "170364-1".
For the other pins, use the contact "170363-1".

< For 15m to 30m >

< CNP3EZ-2P, CNP3EZ-3P cable connection diagram >



< For 15m or less >



< For 15m to 30m >

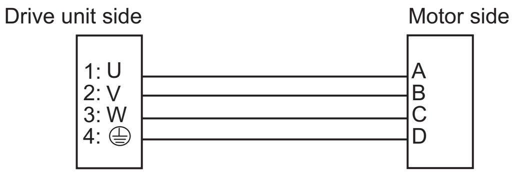
8.3 Main Circuit Cable Connection Diagram

The methods for wiring to the main circuit are shown below.

< DRSV1/DRSV2 cable connection diagram >

These cables are used to connect the drive unit's TE1 terminal and HG, HG-H series motor.

- DRSV1 cable: This is the power line for the single-axis unit (MDS-E/EH-V1-) and dual-axis integrated unit (MDS-E/EH-V2-) L axis.
- DRSV2 cable: This is the power line for the dual-axis integrated unit (MDS-E/EH-V2-) M axis.
- DRSV3 cable: This is the power line for the triple-axis integrated unit (MDS-E/EH-V3-) S axis.



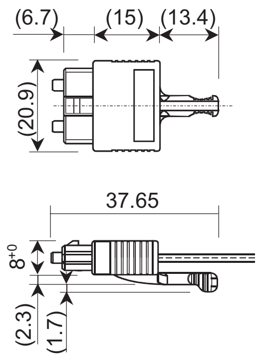
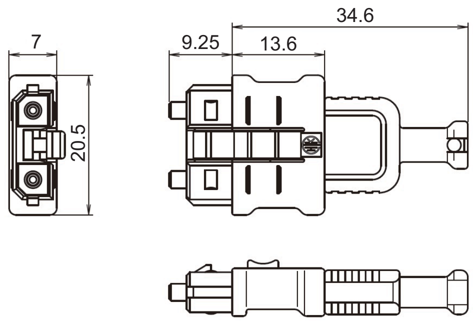
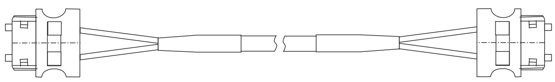
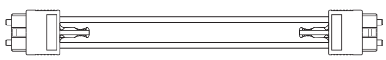
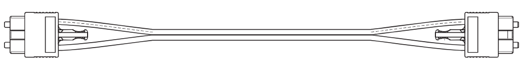
⚠ CAUTION

1. The main circuit cable must be manufactured by the user.
2. Refer to the section "Specification of Peripheral Devices" in Specifications Manual when selecting the wire material.
3. Lay out the terminal block on the drive unit side as shown in "DRIVE SYSTEM DATA BOOK".
4. Refer to "DRIVE SYSTEM DATA BOOK" for details on the motor's connectors and terminal block.

8.4 Connector Outline Dimension Drawings

8.4.1 Connector for Drive Unit

Optical communication cable connector

Optical communication connector	
For wiring between drive units **Manufacturer: Japan Aviation Electronics Industry** **< Type >** **Connector: CF-2D103-S**	**[Unit:mm]** 
For wiring between drive units **Manufacturer: Honda Tsushin Kogyo** **< Type >** **Connector: LGP-Z0007PK**	**[Unit:mm]** 
Cable appearance **< Type >** **Connector: LGP-Z0007PK** **(Honda Tsushin Kogyo)** **Optical fiber: PFDU-CD1002-22E60VT** **(Recommended: Toray Industries)**	
Cable appearance **< Type >** **Connector: LGP-Z0007PK** **(Honda Tsushin Kogyo)** **Optical fiber: PFDU-CD1002-22E60VT** **(Recommended: Toray Industries)**	（L≦0.1m）  （L≧0.2m） 

(Note 1) The POF fiber's light amount will drop depending on how the fibers are wound. So, try to avoid wiring the fibers.
(Note 2) Do not wire the optical fiber cable to moving sections.
(Note 3) Contact: Honda Tsushin Kogyo Co., Ltd. https://www.htk-jp.com/index_e.html

For wiring between NC and drive unit

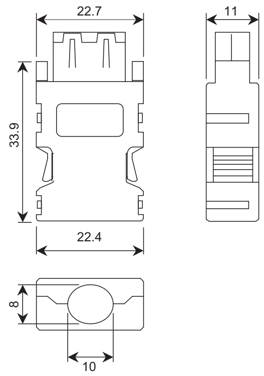
Refer to the instruction manual for CNC.

Connector for encoder cable

Spindle drive unit connector for CN2/CN3

[Unit:mm]

Manufacturer: 3M
< Type >
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



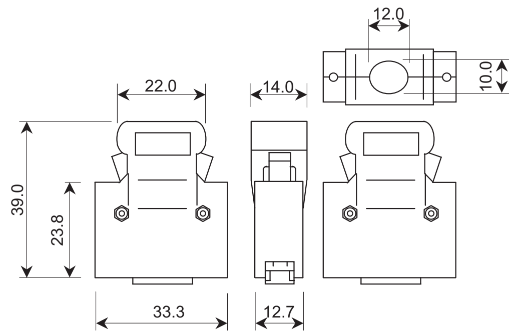
Connector for CN4/CN9

Connector for CN4/CN9

[Unit:mm]

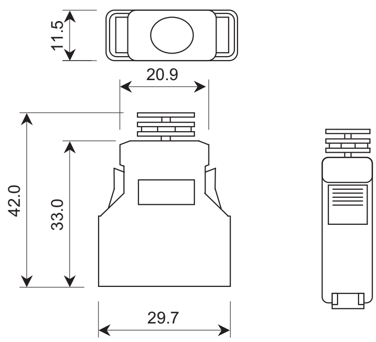
Manufacturer: 3M
< Type >
Connector: 10120-3000VE
Shell kit: 10320-52F0-008

Compatible part (Note 1)
(J.S.T.)
Connector: MS-P20-L
Shell kit: MS20-2B-28



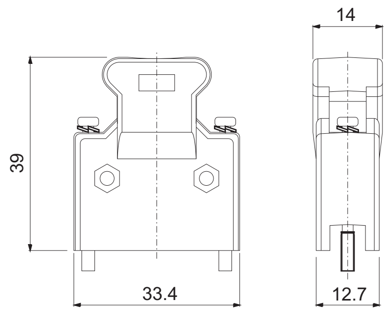
[Unit:mm]

Manufacturer: 3M
< Type >
Connector: 10120-6000EL
Shell kit: 10320-3210-000



[Unit:mm]

Manufacturer: J.S.T.
< Type >
Connector: MS-P20-L
Shell kit: MS20-2A-28



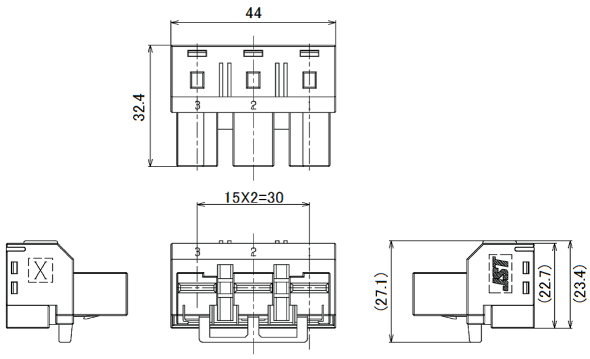
(Note 1) The names of compatible parts may be changed at the manufacturer's discretion. Contact each manufacturer for more information.

Power Connector

Drive unit power Connector for TE1

[Unit:mm]

Manufacturer: J.S.T.
< Type >
Connector
: 03JFAT-SAFGDK-P15 (All axis)
: 03JFAT-SAXGDK-P15 (L axis only)
: 03JFAT-SAYGDK-P15 (M axis only)
: 03JFAT-SAZGDK-P15 (S axis only)

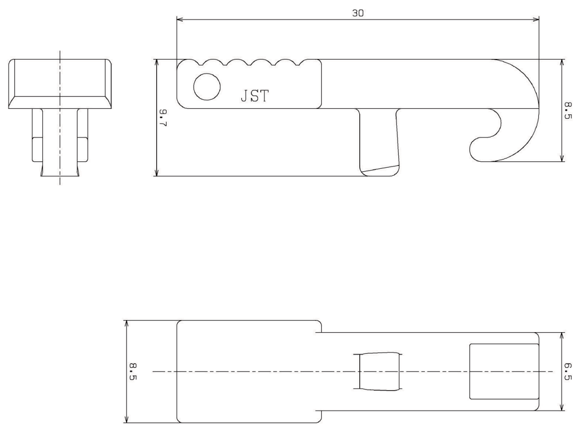


Connector fitting List

Type	L axis	M axis	S axis
03JFAT-SAFGDK-P15	○	○	○
03JFAT-SAXGDK-P15	○	×	×
03JFAT-SAYGDK-P15	×	○	×
03JFAT-SAZGDK-P15	×	×	○

[Unit:mm]

Manufacturer: J.S.T.
< Type >
Connector: J-FAT-OT-P

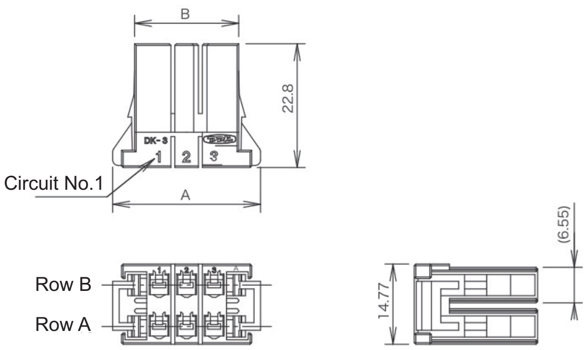


Connector for motor brake control output

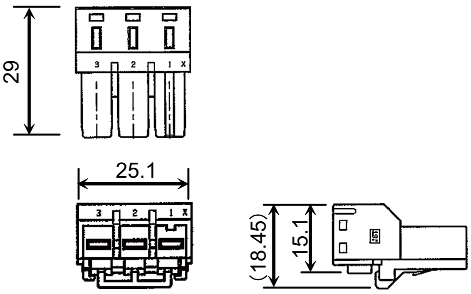
Brake connector for motor brake control output

[Unit:mm]

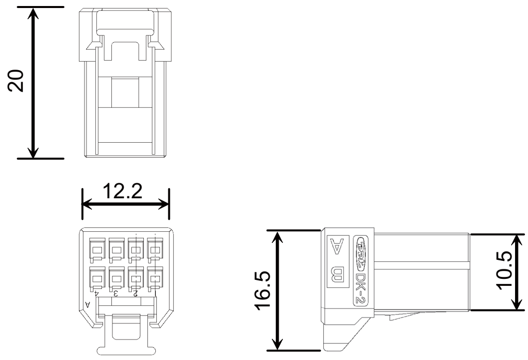
Manufacturer: DDK
< Type >
Connector: DK-3200M-06RXY



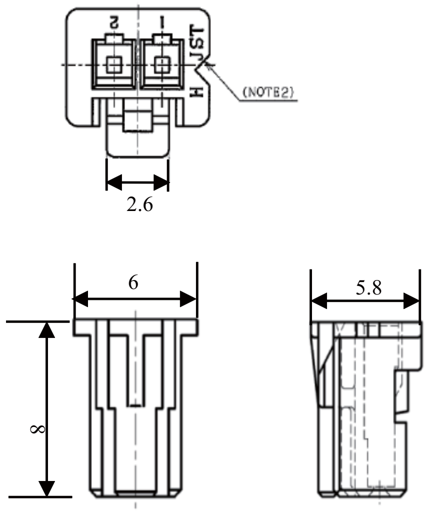
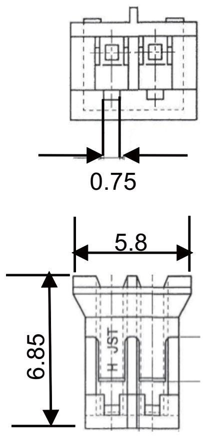
Connector for CN23 (Connector for contactor control output)

Power supply unit connector for CN23 (Connector for contactor control output)	
	[Unit:mm]
Manufacturer: J.S.T.< Type > 03JFAT-SAXGSA-L	

Connector for CN24 (Connector for external emergency stop)

Connector for CN24 (Connector for external emergency stop)	
	[Unit:mm]
Manufacturer: DDK < Type > Connector: DK-2100D-08R	

Battery power connector

Battery connector for drive unit	
Manufacturer: J.S.T < Type > Connector: PAP-02V-O	[Unit:mm] 
Manufacturer: J.S.T < Type > Connector: PHR-2-BL	[Unit:mm] 

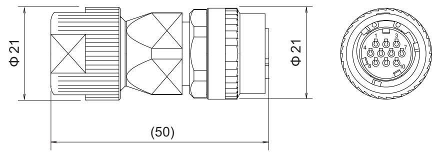
8.4.2 Connector for Servo

Motor encoder connector

Motor side encoder connector / Ball screw side encoder for connector

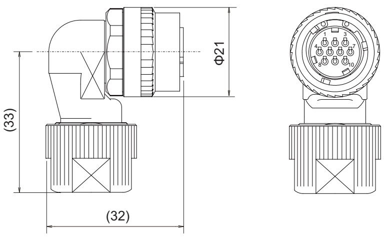
[Unit:mm]

Manufacturer: DDK
< Type >
Plug: CMV1-SP10S-M2



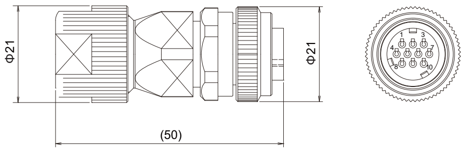
[Unit:mm]

Manufacturer: DDK
< Type >
Plug: CMV1-AP10S-M2



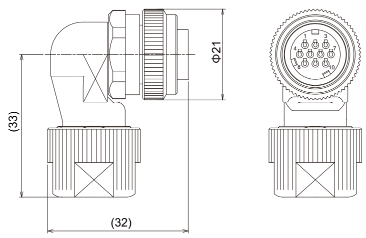
[Unit:mm]

Manufacturer: DDK
< Type >
Plug: CMV1S-SP10S-M2



[Unit:mm]

Manufacturer: DDK
< Type >
Plug: CMV1S-AP10S-M2



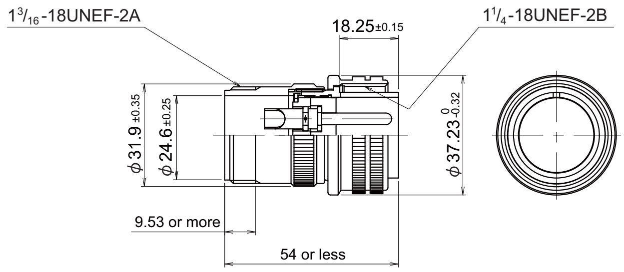
(Note) For the manufacturing method of CMV1 series connector, refer to the section "Cable and Connector Assembly" in Instruction Manual.
Contact: Fujikura Ltd. http://www.fujikura.co.jp/eng/

Servo side encoder connector (for HG-H1502)

Servo side encoder connector (for HG-H1502)

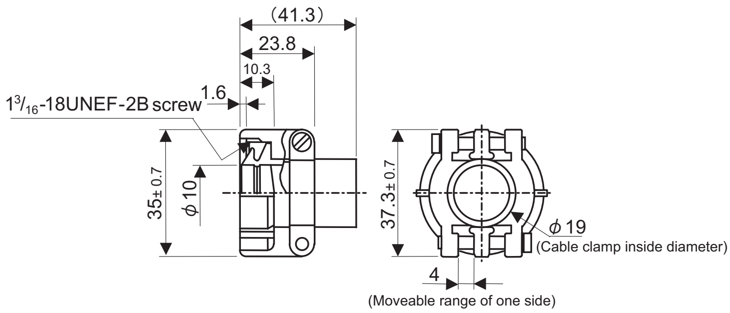
[Unit:mm]

Manufacturer: DDK
< Type >
Connector: D/MS3106A20-29S



[Unit:mm]

Manufacturer: DDK
< Type >
Cable clamp: CE3057-12A-3(D240)(R1)

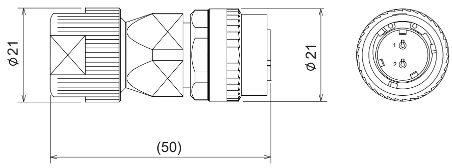


Brake connector

Brake connector

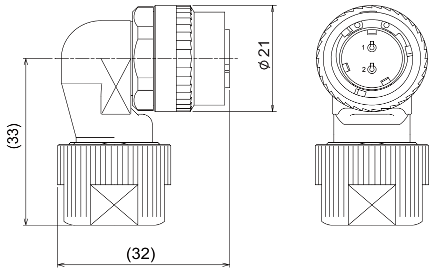
[Unit:mm]

Manufacturer: DDK
< Type >
Plug: CMV1-SP2S-S



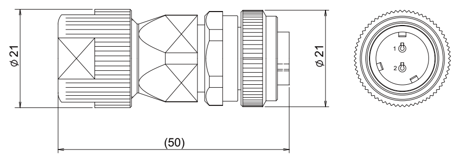
[Unit:mm]

Manufacturer: DDK
< Type >
Plug: CMV1-AP2S-S



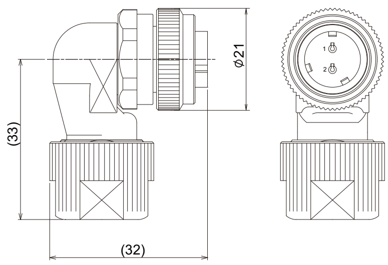
[Unit:mm]

Manufacturer: DDK
< Type >
Plug: CMV1S-SP2S-S



[Unit:mm]

Manufacturer: DDK
< Type >
Plug: CMV1S-AP2S-S



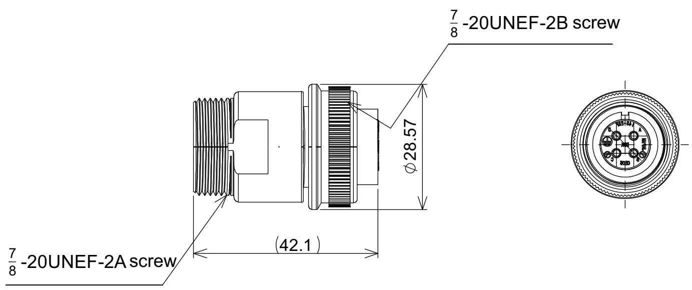
(Note) For the manufacturing method of CMV1 series connector, refer to the section "Cable and Connector Assembly" in Instruction Manual.

Cooling fan connector

Cooling fan connector

[Unit:mm]

Manufacturer: DDK
< Type >
Plug: CE05-6A14S-2SD-D-BSS(D111)(R1)

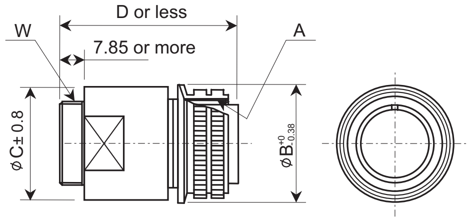


Motor power connector

Motor power connector

[Unit:mm]

Manufacturer: DDK

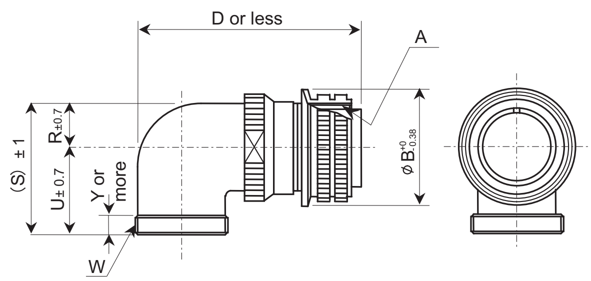


Plug:

Type	A	B +0 -0.38	C±0.8	D or less	W
CE05-6A18-10SD-D-BSS(R1)	$1^{1}/_{8}$-18UNEF-2B	34.13	32.1	57	1-20UNEF-2A
CE05-6A22-22SD-D-BSS(R1)	$1^{3}/_{8}$-18UNEF-2B	40.48	38.3	61	$1^{3}/_{16}$-18UNEF-2A
CE05-6A32-17SD-D-BSS(R1)	2-18UNS-2B	56.33	54.2	79	$1^{3}/_{4}$-18UNS-2A

[Unit:mm]

Manufacturer: DDK

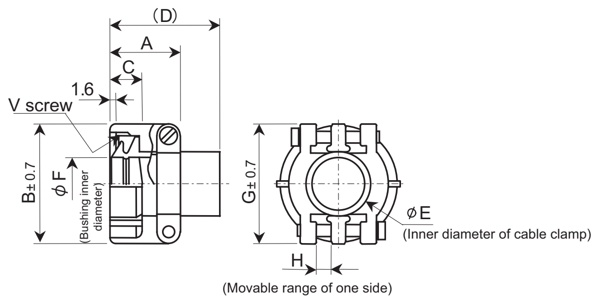


Plug:

Type	A	B +0 -0.38	D or less	W	R±0.7	U±0.7	(S)±1	Y or more
CE05-8A18-10SD-D-BAS(R1)	$1^{1}/_{8}$-18UNEF-2B	34.13	69.5	1-20UNEF-2A	13.2	30.2	43.4	7.5
CE05-8A22-22SD-D-BAS(R1)	$1^{3}/_{8}$-18UNEF-2B	40.48	75.5	$1^{3}/_{16}$-18UNEF-2A	16.3	33.3	49.6	7.5
CE05-8A32-17SD-D-BAS(R1)	2-18UNS-2B	56.33	93.5	$1^{3}/_{4}$-18UNS-2A	24.6	44.5	61.9	8.5

[Unit:mm]

Manufacturer: DDK

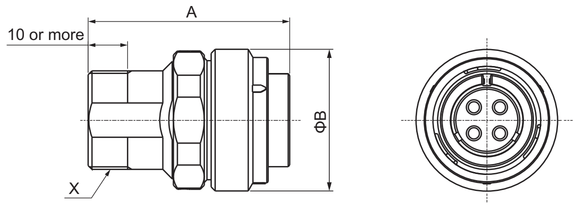


Clamp:

Type	Shell size	Total length A	Outer dia. B	Avail. screw length C	D	E	F	G	H	Fitting screw V	Bushing	Applicable cable
CE3057-10A-1-D(R1)	18	23.8	30.1	10.3	41.3	15.9	14.1	31.7	3.2	1-20UNEF-2B	CE3420-10-1	Φ10.5 to Φ14.1
CE3057-12A-1-D(R1)	20	23.8	35	10.3	41.3	19	16.0	37.3	4	$1^{3}/_{16}$-18UNEF-2B	CE3420-12-1	Φ12.5 to Φ16.0
CE3057-20A-1-D(R1)	32	27.8	51.6	11.9	43	31.7	23.8	51.6	6.3	$1^{3}/_{4}$-18UNS-2B	CE3420-20-1	Φ22.0 to Φ23.8

[Unit:mm]

Manufacturer: Japan Aviation Electronics Industry

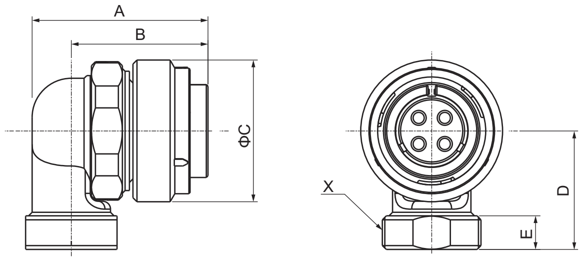


Plug:

Type	A	B	X
JL10-6A18-10SE-EB	51.05	35.85	1-20UNEF-2A
JL10-6A22-22SE-EB	58.65	42.2	$1^3/_{16}$-18UNEF-2A

[Unit:mm]

Manufacturer: Japan Aviation Electronics Industry

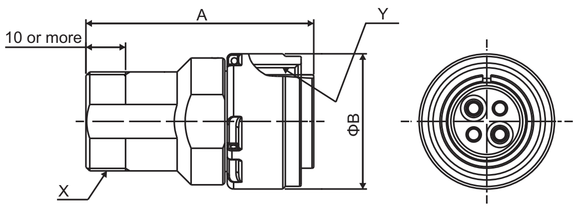


Plug:

Type	A	B	C	D	E	X
JL10-8A18-10SE-EB	44.45	34.55	35.85	30	8.5	1-20UNEF-2A
JL10-8A22-22SE-EB	51.85	40.65	42.2	37.4	10	$1^3/_{16}$-18UNEF-2A

[Unit:mm]

Manufacturer: Japan Aviation Electronics Industry

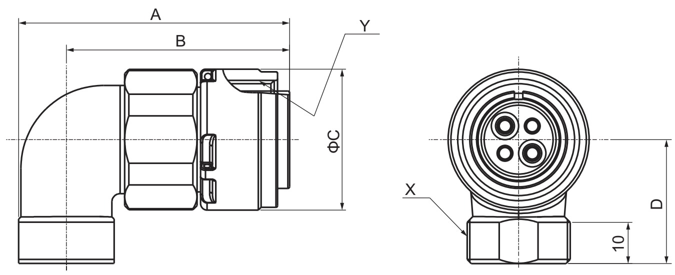


Plug:

Type	A	B	X	Y
JL04V-6A18-10SE-EB-R	57.4	34.1	1-20UNEF-2A	$1^1/_8$-18UNEF-2B
JL04V-6A22-22SE-EB-R	67.63	40.5	$1^3/_{16}$-18UNEF-2A	$1^3/_8$-18UNEF-2B

[Unit:mm]

Manufacturer: Japan Aviation Electronics Industry

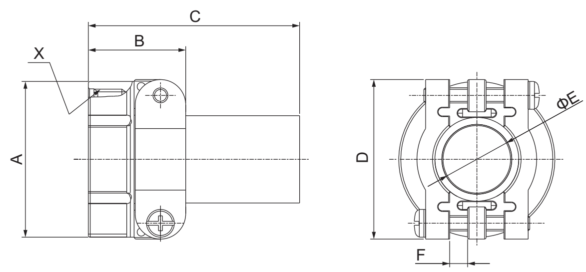


Plug:

Type	A	B	C	D	X	Y
JL04V-8A18-10SE-EBH-R	65.6	54	34.1	30	1-20UNEF-2A	$1^{1}/_{8}$-18UNEF-2B
JL04V-8A22-22SE-EBH-R	73	59	40.5	32	$1^{3}/_{16}$-18UNEF-2A	$1^{3}/_{8}$-18UNEF-2B

[Unit:mm]

Manufacturer: Japan Aviation Electronics Industry

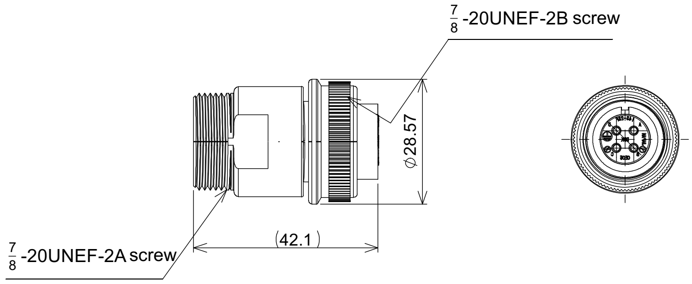


Clamp:

Type	Shell size	A	B	C	D	E	F	X	Cable outline (reference)
JL04-18CK(10)-R	18	30.2	24.1	53.8	31.8	11	3.2	1-20UNEF-2B	Φ8 to Φ11
JL04-18CK(13)-R						14.1			Φ11 to Φ14.1
JL04-2022CK(12)-R	22	34.9	24.3	53.8	37.3	13	4	$1^{3}/_{16}$-18UNEF-2B	Φ9.5 to Φ13
JL04-2022CK(14)-R						16			Φ12.9 to Φ16

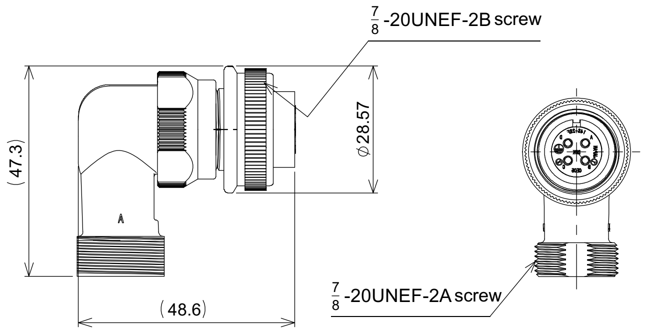
[Unit:mm]

Manufacturer: DDK
< Type >
Plug: CE05-6A14S-2SD-D-BSS(D111)(R1)



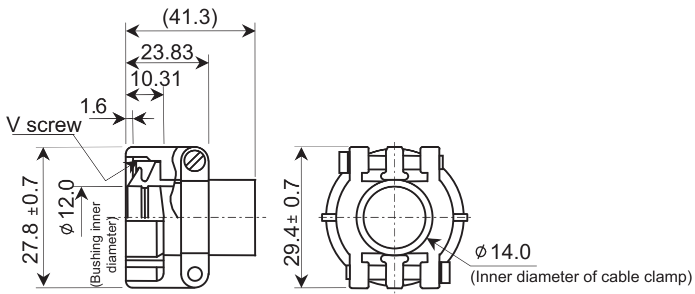
[Unit:mm]

Manufacturer: DDK
< Type >
Plug: CE05-8A14S-2SD-D-BAS(D111)(R1)

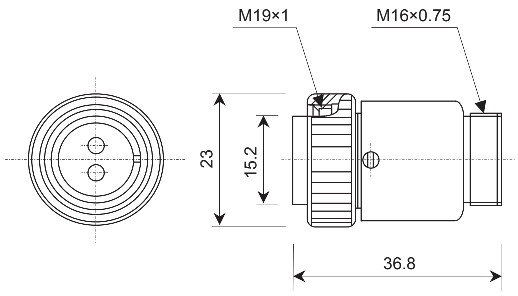
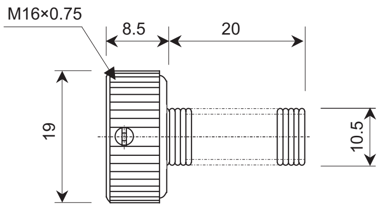


[Unit:mm]

Manufacturer: DDK
< Type >
Clamp: CE3057-8A-1D(R1)
Applicable cable: Φ10 to 12

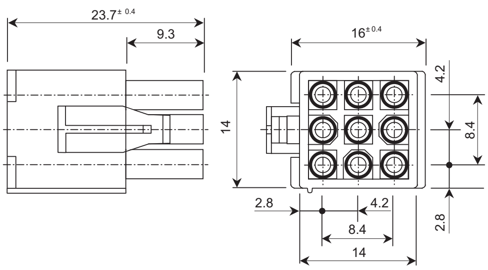


MDS-EX-HR connector

MDS-EX-HR connector	
Manufacturer: Hirose Electric **< Type >** **Plug:** **RM15WTPZ-8S(71) (for DRIVE, CON1,2)** **RM15WTPZ-12P(71) (for SCALE, CON3)** **RM15WTPZ-10P(71) (for CON4)**	**[Unit:mm]** 
Manufacturer: Hirose Electric **< Type >** **Clamp: JR13WCCA-10(72)**	**[Unit:mm]** 

8.4.3 Connector for Spindle

Motor encoder connector

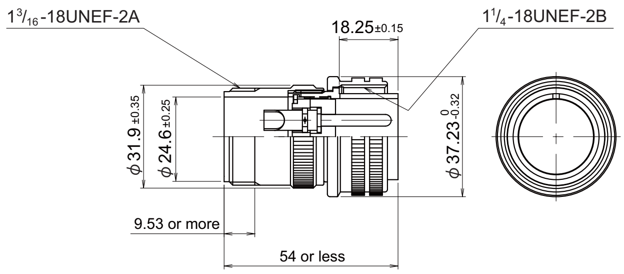
Motor side PLG (TS5690) connector	
Manufacturer: Tyco Electronics **< Type >** **Plug: 172169-1**	**[Unit:mm]** 

Spindle side encoder connector (for OSE-1024)

Spindle side encoder connector (for OSE-1024)

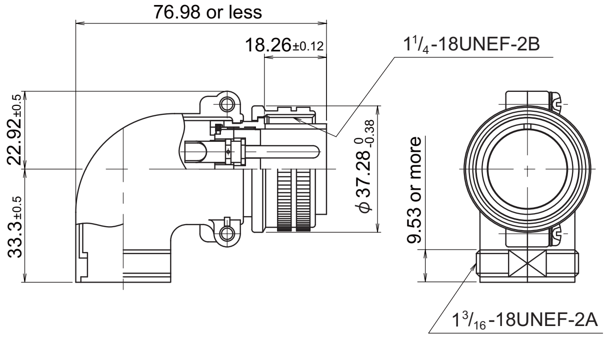
[Unit:mm]

Manufacturer: DDK
< Type >
Connector: D/MS3106A20-29S



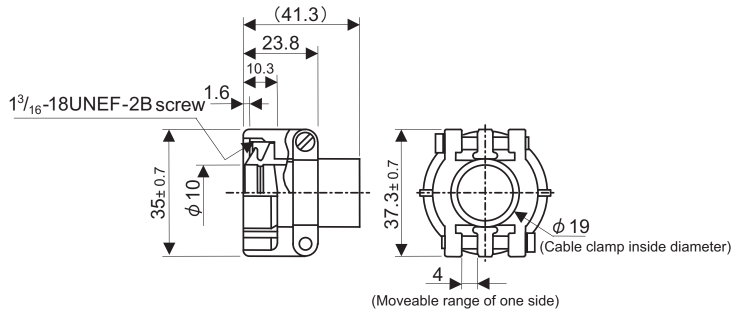
[Unit:mm]

Manufacturer: DDK
< Type >
Connector: D/MS3108B20-29S



[Unit:mm]

Manufacturer: DDK
< Type >
Cable clamp: CE3057-12A-3(D240)(R1)

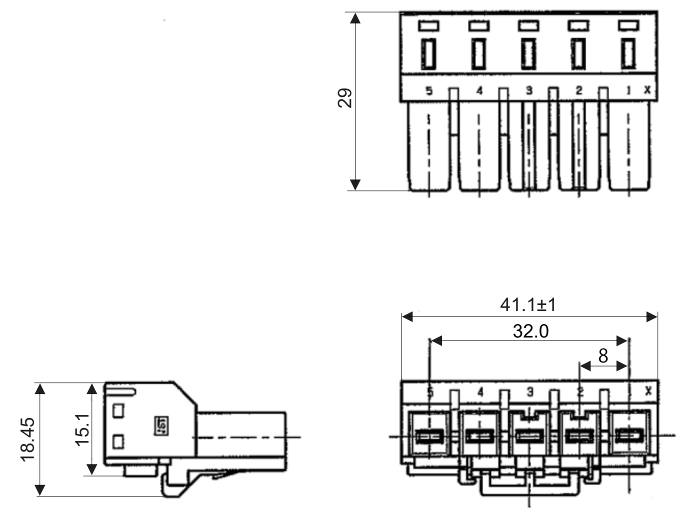


8.4.4 Power Backup Unit Connector

Connector for power backup unit TE1

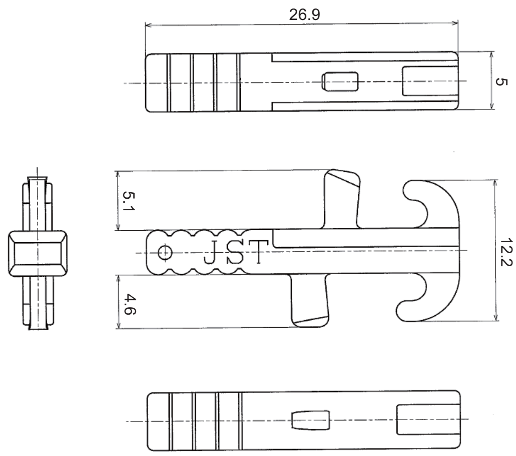
［Unit : mm］

Manufacturer: J.S.T.
< Type >
Connector: 05JFAT-SAXGSA-L



［Unit : mm］

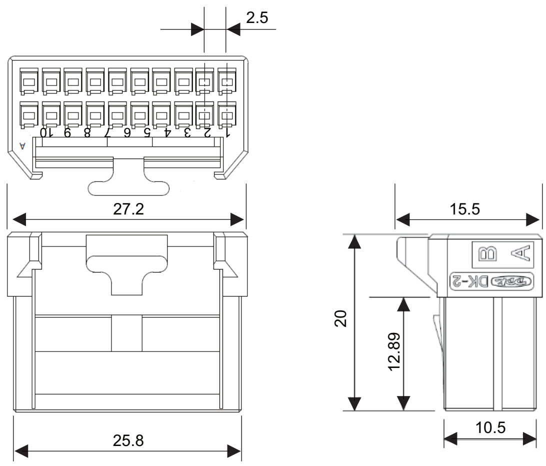
Manufacturer: J.S.T.
< Type >
Connector: J-FAT-OT-EXL



Connector for power backup unit CN43

［Unit : mm］

Manufacturer: DDK
< Type >
Connector: DK-2100D-20R



9

Appx. 2: Restrictions for Lithium Batteries

9.1 Restriction for Packing

When transporting lithium batteries with means such as by air transport, measures corresponding to the United Nations Dangerous Goods Regulations (hereafter called "UN Regulations") must be taken.
The UN Regulations classify the batteries as dangerous goods (Class 9) or not dangerous goods according to the lithium metal content. To ensure safety during transportation, lithium batteries (battery unit) directly exported from Mitsubishi are packaged in a dedicated container (UN package) for which safety has been confirmed.
When the customer is transporting these products with means subject to the UN Regulations, such as air transport, the shipper must follow the details explained in the section "Transportation Restrictions for Lithium Batteries: Handling by User".
The followings are restrictions for transportation. Each restriction is specified based on the recommendation of the United Nations.

Area	Transportation method	Restriction	Special clause
World	Air	ICAO, IATA	-
World	Marine	IMO	188
United States	All (air, marine, land)	DOT	49 CFR 173.185
Europe	land	RID, ADR	-

9.1.1 Target Products

The following Mitsubishi NC products use lithium batteries. If the lithium metal content exceeds 1g for battery cell and 2g for battery, the battery is classified as dangerous good (Class9).
In order to avoid an accidental actuation during the transportation, all lithium battery products incorporated in a machinery or device must be fixed securely and must be shipped with wrapped over the outer package as to prevent damage or short-circuits.

(1) Materials falling under Class 9

Mitsubishi type (Type for arrangement)	Battery type	Lithium metal content	Number of incorporated batteries	Application (Data backup)	Battery class	Outline dimension drawing
CR23500SE-CJ5	CR23500SE-CJ5	1.52g	-	For NC SRAM (M500)	Battery cell	Refer to "Battery Option" in the specification manual for drive unit you are using for the outline dimension drawing for servo.

(2) Materials not falling under Class 9

<table>
<tr><th>Mitsubishi type (Type for arrangement)</th><th>Battery type</th><th>Lithium metal content</th><th>Number of incorporated batteries</th><th>Application (Data backup)</th><th>Battery class</th><th>Outline dimension drawing</th></tr>
<tr><td>CR2032
(for built-in battery)</td><td>CR2032</td><td>0.067g</td><td>-</td><td>For NC SRAM/</td><td rowspan="5">Battery cell</td><td rowspan="7">Refer to "Battery Option" in the specification manual for drive unit you are using for the outline dimension drawing for servo.</td></tr>
<tr><td>CR2450
(for built-in battery)</td><td>CR2450</td><td>0.173g</td><td>-</td><td>For NC SRAM</td></tr>
<tr><td>ER6, ER6V series
(for built-in battery)</td><td>ER6, ER6V</td><td>0.65g</td><td>-</td><td>For NC SRAM/
servo encoder</td></tr>
<tr><td>MR-BAT</td><td>ER17330V</td><td>0.48g</td><td>-</td><td>For servo encoder</td></tr>
<tr><td>Q6BAT</td><td>Q6BAT</td><td>0.57g</td><td>-</td><td>For NC SRAM</td></tr>
<tr><td>MDS-BAT6V1SET</td><td rowspan="2">2CR17335A</td><td rowspan="2">1.2g</td><td rowspan="2">2</td><td rowspan="2">For servo encoder</td><td rowspan="2">Battery</td></tr>
<tr><td>MR-BAT6V1SET</td></tr>
</table>

(Note) If the number of batteries exceeds 24 batteries for the battery cell or 12 batteries for the battery, the dedicated packing (for materials falling under Class 9) is required.

9.1.2 Handling by User

The shipper must confirm the latest IATA Dangerous Goods Regulations, IMDG Codes and laws and orders of the corresponding export country.
These should be checked by the company commissioned for the actual transportation.

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

9.1.3 Reference

Refer to the following materials for details on the regulations and responses.
Guidelines regarding transportation of lithium batteries and lithium ion batteries
Battery Association of Japan
http://www.baj.or.jp/e/

9.2 Products Information Data Sheet (ER Battery)

MSDS system does not cover the product used in enclosed state. The ER battery described in this section applies to that product.
This description is applied to the normal use, and is provided as reference but not as guarantee.
This description is based on the lithium battery's (ER battery) hazardous goods data sheet (Products Information Data Sheet) which MITSUBISHI has researched, and will be applied only to the ER batteries described in "Transportation Restrictions for Lithium Batteries: Restriction for Packing".

(1) Outline of hazard

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

(2) First-aid measure

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

(3) Fire-fighting measure

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

(4) Measure for leakage

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

(5) Handling and storage

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

(6) Physical/chemical properties

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

(7) Stability and reactivity

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

(8) Toxicological information

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

< Lithium metal >

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

< Thionyl chloride >

Acute toxicity	Lc_{50}: 500ppm (inhaled administration to rat)
Local effect	The lungs can be damaged by chronic cough, dyspnea and asthma.

< Aluminum chloride >

Acute toxicity	L_{D50}: 3700ppm (oral administration to rat)
Local effect	Not found.

< Lithium chloride >

Acute toxicity	L_{D50}: 526ppm (oral administration to rat)
Local effect	The central nerves and kidney can be influenced.

< Carbon black >

Acute toxicity	L_{D50}: 2,000mg/kg > (rat)
Carcinogenicity	LARC group 2 (suspected of being carcinogenic)

(9) Ecological information

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

(10) Caution for disposal

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

9.3 Forbiddance of Transporting Lithium Battery by Passenger Aircraft Provided in the Code of Federal Regulation

This regulation became effective from Dec.29, 2004. This law is a domestic law of the United States, however it also applies to the domestic flight and international flight departing from or arriving in the United States. Therefore, when transporting lithium batteries to the United State, or within the United State, the shipper must take measures required to transport lithium batteries. Refer to the Federal Register and the code of Federal Regulation for details.
When transporting primary lithium battery by cargo aircraft, indicate that transportation by passenger aircraft is forbidden on the exterior box.
"Lithium Metal batteries forbidden for transport aboard Passenger aircraft"

9.4 California Code of Regulation "Best Management Practices for Perchlorate Materials"

When any products that contain primary lithium batteries with perchlorate are shipped to or transported through the State of California, they are subject to the above regulation.The following information must be indicated on the package, etc. of the products that contain primary lithium batteries (with a perchlorate content of 6 ppb or higher).
"Perchlorate Meterial-special handling may apply. See http://www.dtsc.ca.gov/hazardouswaste/perchlorate"

9.5 Restriction Related to EU Battery Directive

EU Battery Directive (2006/66/EC) has been enforced since September 26th in 2008. Hereby, battery and machinery incorporating battery marketed in European Union countries must be in compliance with the EU Battery Directive.
Lithium battery provided by MITSUBISHI are subjected to this restriction.

9.5.1 Important Notes

Follow the instruction bellow as shipping products incorporating MITSUBISHI device.

(1) When shipping products incorporating MITSUBISHI device any time later than September 26th, 2008, the symbol mark shown as Figure 1 in section "Information for End-user" is required to be attached on the machinery or on the package. Also, the explanation of the symbol must be added.

(2) Machinery with battery and maintenance battery produced before the EU Battery Directive are also subjected to the restriction. When shipping those products to EU countries later than September 26th, 2008, follow the instruction explained in (1).

9.5.2 Information for End-user

Figure 1

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!

Revision History

Date of revision	Manual No.	Revision details
Feb. 2015	IB(NA)1501226-A	First edition created.
May. 2015	IB(NA)1501226-B	- "Precautions for Safety" was revised. - Resolutions of encoders D48/D51/D74 were changed. - SJ-DG Series spindle motors were added. - "Explanation of Type" was revised. - "Specifications List" in "Servo Motor" was revised. - "Specifications" and "Output Characteristics" in "Spindle Motor" were revised. - "Servo Drive Unit", "Spindle Drive Unit", "Power Supply Unit", and "AC Reactor" in "Drive Unit" were revised. - "Explanation of Each Part" was revised. - "Function Specifications List" was revised. - "Speed Command Synchronous Control" was revised. - The pictures of NC in following chapters were changed to the ones of M800. "OMR-FF Control", "STO (Safe Torque Off) Function", "SBC (Safe Brake Control) Function", "Deceleration and Stop Function at Power Failure", and "Retraction Function at Power Failure". - "Motor Brake Control Function" was revised. - "Dynamic Brake Characteristics" was revised. - "Shaft Characteristics" in "Spindle Motor" was revised. - "Servo Options" was revised. - "Battery Option (MDS-BAT6V1SET, MDSBTBOX-LR2060)" was revised. - "Machine Side Encoder" was revised. - Example of wiring was added to "Serial Output Interface Unit for ABZ Analog Encoder MDS-B-HR". - "Side Protection Cover" was added. - "List of Cables and Connectors" was revised. - "Example of Wires by Unit" was revised. - "Relay" was revised. - "Wire Size for L+ and L- Link Bar" was revised. - "Calculation of Spindle Output" was revised. - "Cable and Connector Specifications" was revised. - "Restrictions for Lithium Batteries" was revised. - "Instruction Manual for Compliance with UL/c-UL Standard" was added. - Miswrite is corrected.
Mar. 2016	IB(NA)1501226-C	- Revisions were made to support MDS-E-V3 Series. - Specification descriptions of servo motor HG75, HG105, HG-H75, and HG-H105 were added. - Servo motor HG46, HG56, HG96, and HG-H1502 were added. - The encoder D47 was added. - The following spindle motors were deleted. SJ-VS7.5-14FZT,SJ-VKS26-09FZT,SJ-VKS30-16FZT,SJ-VLS15-11FZT, SJ-4-V3.7-05ZT,SJ-4-V11-23ZT,SJ-4-V15-18T,SJ-4-V37-04ZT, SJ-4-V11-21T,SJ-4-V18.5-17T - Descriptions for tool spindle motor were added. - "Precautions for Safety" was revised. - "System Configuration" was revised. - "Explanation of Type" was revised.

Date of revision	Manual No.	Revision details
Mar. 2016	IB(NA)1501226-C	- "Tool Spindle Motor Type" was added. - "Specifications List" and "Torque Characteristics" in "Servo Motor" were revised. - "Specifications" and "Output Characteristics" in "Spindle Motor" were revised. - "Tool Spindle Motor" was added. - "Servo Drive Unit", "Spindle Drive Unit", "Power Supply Unit", "Unit Outline Dimension Drawing" and "Explanation of Each Part" were revised. - Function Specifications List was revised. - "Real-time Tuning I" was added. - "Retraction Function at Power Failure" was revised. - "External Emergency Stop Function" was revised. - "Drive Unit Diagnosis Display Function" was added. - "Quakeproof Level" and "Shaft Characteristics" in "Servo Motor" were revised. - "Oil / Water Standards", "Installation of Servo Motor", "Overload Protection Characteristics", "Magnetic Brake", "Dynamic Brake Characteristics" were revised. - "Shaft Characteristics" and "Machine Accuracy" in "Spindle Motor" were revised. - "Installation of Spindle Motor" was revised. - "Heating Value" and "Drive Unit Arrangement" was revised. - "Servo Options" was revised. - "Battery Option (MDS-BAT6V1SET, MDSBTBOX-LR2060)" was revised. - "Ball Screw Side Encoder (OSA405ET2AS, OSA676ET2AS)" was revised. - "Spindle Side PLG Serial Output Encoder (TS5690, MU1606 Series)" was revised. - "Serial Output Interface Unit for ABZ Analog Encoder MDS-B-HR" was revised. - "DC Connection Bar" was revised. - "Cable Connection Diagram", "List of Cables and Connectors" and "Optical Communication Cable Specifications" were revised. - "Example of Wires by Unit" was revised. - "Selection of Contactor" was revised. - "Selection of Earth Leakage Breaker", "Surge Absorber" and "Selection of Link Bar" were revised. - "Selection of the Power Supply Unit" was revised. - "Brake Cable and Connector" was revised. - "Connector for Drive Unit" and "Connector for Servo" were revised. - "Instruction Manual for Compliance with UL/c-UL Standard" was revised. - "Global service network" was revised. - Miswrite is corrected.
Apr. 2017	IB(NA)1501226-D	- "Introduction" was revised. - "System Configuration" was revised. - Description order of servo motors was changed. - "Spindle Motor Type" was revised. - Specifications lists of servo motor and tool spindle motor were revised. - "Continuous rated current" was added in specifications list of spindle motor. - SJ-VL2.2-02ZT was changed to low-inertia specifications. - SJ-4-V11-18ZT was replaced by SJ-4-V11-18T. - SJ-4-V37-04ZT was added.

Date of revision	Manual No.	Revision details
Apr. 2017	IB(NA)1501226-D	- "Output Characteristics" was revised. - "Drive Unit" was revised. - "Function Specifications List" was revised. - "Deceleration and Stop Function at Power Failure" and "Retraction Function at Power Failure"were revised. - "External Emergency Stop Function" was revised. - "Installation of Servo Motor" was revised. - "Servo Options" was revised. - "OSA105ET2A" was replaced by "OSA405ET2AS". - "OSA166ET2NA" was replaced by "OSA676ET2AS". - Descriptions for twin-head magnetic encoder MBA/MBE Series were deleted. - Manufacturer names and the contact information were updated. - "Machine Side Encoder" was revised. - "Serial Output Interface Unit for ABZ Analog Encoder MDS-EX-HR" was added. - "Serial Output Interface Unit for ABZ Analog Encoder MDS-B-HR" was revised. - "Cables and Connectors" was revised. - "Selection of Wire" was revised. - "Cable and Connector Specifications" was revised. - "EC Declaration of Conformity" was revised. - "Instruction Manual for Compliance with UL/c-UL Standard" was revised. - "Global Service Network" was revised. - Miswrite is corrected.
Sep. 2018	IB(NA)1501226-E	- MDS-E-V3-80 and MDS-EH-V3-40 were added. - Tool spindle motor HG-JR series was added. - "Power facility capacity" was deleted from the specifications list of servo motor and spindle motor. -The following spindle motors were added. SJ-D15/80-01, SJ-D18.5/80-01, SJ-D22/80-01, SJ-D26/80-01, SJ-DG11/120-03T, SJ-DL3.7/240-01T, SJ-DL5.5/240-05T -The following spindle motors were deleted. SJ-V7.5-03ZT, SJ-V11-08ZT, SJ-V11-13ZT, SJ-V15-01ZT, SJ-VL18.5-05FZT - "Precautions for Safety" was revised. - "System Configuration" was revised. - "Explanation of Type" was revised. - "Specifications List" and "Torque Characteristics" in "Servo Motor" were revised. - "Specifications" and "Output Characteristics" in "Spindle Motor" were revised. - "Specifications" and "Output Characteristics" in "Tool Spindle Motor" were revised. - "Servo Drive Unit", "Unit Outline Dimension Drawing" and "Explanation of Each Part" in "Drive Unit" were revised. - "Function Specifications List" was revised. - "Position Command Synchronous Control" and "Speed Command Synchronous Control" were revised. - "High-speed Synchronous Tapping Control (OMR-DD Control)" was revised. - "Notch Filter" and "Machine End Compensation Control" were revised.

Date of revision	Manual No.	Revision details
Sep. 2018	IB(NA)1501226-E	- "Lost Motion Compensation Type4" and "SLS (Safely Limited Speed) Function" were deleted. - "Full-closed Torsion Compensation Function" was added. - "STO (Safe Torque Off) Function" was revised. - "Open Loop Control Function" was deleted. - "Dynamic Brake Characteristics" was revised. - "Spindle Motor" was revised. - "Shaft Characteristics" and "Tool Spindle Temperature Characteristics" in "Tool Spindle Motor" were revised. - "Heating Value" was revised. - "Drive Unit Arrangement" was deleted. - "Servo Options" was revised. - "Battery Option (MDS-BAT6V1SET, MDSBTBOX-LR2060)" was revised. - "Ball Screw Side Encoder (OSA405ET2AS, OSA676ET2AS)" was revised. - "Machine Side Encoder" was revised. - "Spindle Options" was revised. - "Machine Side Encoder" in "Spindle Options" was deleted. - "Serial Output Interface Unit for ABZ Analog Encoder MDS-EX-HR" was revised. - "Serial Output Interface Unit for ABZ Analog Encoder MDS-B-HR" was deleted. - ADB-20J71 in "Serial Output Interface Unit for ABZ Analog Encoder ADB-20J Series (Other Manufacturer's Product)" was deleted. - "Serial Output Interface Unit for ABZ Analog Encoder ADB-K70M (Other Manufacturer's Product)" was added. - "DC Connection Bar" was revised. - "Cable Connection Diagram" and "List of Cables and Connectors" were revised. - "Selection of Wire" was revised. - "Selection of Circuit Protector and Contactor" was revised. - "Selection of Earth Leakage Breaker" and "Selection of Link Connection" were revised. - "Selection of the Servo Motor" and "Selection of the Power Supply Unit" were revised. - "Main Circuit Cable Connection Diagram" was revised. - "Restrictions for Lithium Batteries" was revised. - "EC Declaration of Conformity" was deleted. - "Instruction Manual for Compliance with UL/c-UL Standard" was deleted. - Miswrite is corrected.
May. 2019	IB(NA)1501226-F	- "Servo Drive Unit" was revised. - "Spindle Drive Unit" was revised. - "Power Supply Unit" was revised. - "Power Backup Unit (MDS-D/DH-PFU)" was revised.
Sep. 2019	IB(NA)1501226-G	- MDS-EH-V2-160 was added. - SJ-DN Series spindle motors were added. - The following spindle motor was added. SJ-DG15/120-02T-K - "Cooling fan Maximum power consumption 50/60Hz" was deleted from the specifications list of spindle motor.

Date of revision	Manual No.	Revision details
Sep. 2019	IB(NA)1501226-G	- "Precautions for Safety" was revised. - "Servo Drive Unit Type", "Spindle Motor Type", and "Tool Spindle Motor Type" in "Explanation of Type" were revised. - "Specifications" and "Output Characteristics" in "Spindle Motor" were revised. - "Specifications" in "Tool Spindle Motor" was revised. - "Servo Drive Unit", "Spindle Drive Unit", "Power Supply Unit", and "Explanation of Each Part" in "Drive Unit" were revised. - "Function Specifications List" was revised. - "Speed Command Synchronous Control" was revised. - "Shaft Characteritics" and "Machine Accuracy" in "Spindle Motor" were revised. - "Heating Value" was revised. - "Spindle Options" was revised. - "Spindle Side Accuracy Serial Output Encoder (Other Manufacturer's Product)" was revised. - "Serial Output Interface Unit for ABZ Analog Encoder MDS-EX-HR" was revised. - "Serial Output Interface Unit for ABZ Analog Encoder ADB-20J Series (Other Manufacturer's Product)" was deleted. - "Side Protection Cover" was revised. - "List of Cables and Connectors" was revised. - "Example of Wires by Unit" was revised. - "Selection of Earth Leakage Breaker" was revised. - "Connection of L+ and L- Link" was revised. - "Selection of the Power Supply Unit" was revised. - "Cable Wire and Assembly" was revised. - "Spindle Encoder Cable" was revised. - "Connector for Servo" and "Connector for Spindle" were revised. - Miswrite is corrected.
Sep. 2020	IB(NA)1501226-H	- Servo motor HG603, HG702, HG1103, and HG-H224 were added. - "Introduction" was revised. - "Precautions for Safety" was revised. - "Servo Motor Type", "Servo Drive Unit Type", and "Spindle Motor Type" was revised. - "Specifications List" and "Torque Characteristics" in "Servo Motor" was revised. - "Output Characteristics" in "Spindle Motor" was revised. - "Specifications" in "Tool Spindle Motor" was revised. - "Spindle Drive Unit", "Unit Outline Dimension Drawing", and "Explanation of Each Part" in "Drive Unit" were revised. - "Quakeproof Level", "Shaft Characteristics", "Oil/Water Standards", "Overload Protection Characteristics", "Magnetic Brake", and "Dynamic Brake Characteristics"in "Servo Motor" were revised. - "Servo Options" was revised. - "Machine Side Encoder" was revised. - "Power Backup Unit (MDS-D/DH-PFU)" was revised. - "List of Cables and Connectors" was revised. - "Circuit Protector" was revised. - "Connection of L+ and L- Link" was revised. - "Calculation of Servo Motor Output" was revised.

Date of revision	Manual No.	Revision details
Sep. 2020	IB(NA)1501226-H	- Miswrite is corrected.
Sep. 2021	IB(NA)1501226-J	- "System configuration" was revised. - "Torque Characteristics" in "Servo Motor" was revised. - "Output Characteristics" in "Spindle Motor" was revised. - Function Specifications" was revised. - "PWM Control" was added. - "Servo Options" was revised. - "Machine Side Encoder" was revised. - "Servo motor/Tool spindle motor cable and connector" was revised. - "Selection of Circuit Protector and Contactor" was revised. - "Connection of L+ and L- Link" was revised. - "Selection of Servo Motor Capacity" was revised. - "Servo Encoder Cable" was revised. - "Connector for Servo" was revised. - Miswrite is corrected.
Apr. 2022	IB(NA)1501226-K	- The following spindle motors were added. SJ-DG11/120-03T-S, SJ-DG11/120-12T-K, SJ-DG11/120-12T-KS, SJ-DG11/150-06T, SJ-DG11/150-06T-S, SJ-DG11/150-15T-K, SJ-DG11/150-15T-KS, SJ-DG15/120-02T-KS, SJ-DM11/120-01T - "Spindle Motor Type" was revised. - "Spindle Motor" was revised. - Function Specifications List was revised. - "Variable Speed Loop Gain Control" was revised. - "Overload Protection Characteristics" was revised. - "Shaft Characteristics" in "Spindle Motor" was revised. - "Servo Options" was revised. - "Machine Side Encoder" was revised. - "Serial Output Interface Unit for ABZ Analog Encoder ADB-K70M (Other Manufacturer's Product)" was revised. - Miswrite is corrected.
May 2023	IB(NA)1501226-L	- Descriptions of servo motor HK, HK-H Series were added. - "Precautions for Safety" was revised. - "Servo Motor Type", "Servo Drive Unit Type", "Spindle Motor Type", "Spindle Drive Unit Type", and "Power Supply Unit Type" were revised. - "Servo Motor" of "Specifications" was revised. - Function Specifications List was revised. - "Common Encoder Current Command Synchronous Control" was added. - "Servo Motor" of "Characteristics" was revised. - "Servo Options" was revised. - "Machine Side Encoder" was revised. - "Spindle Options" was revised. - "Spindle Side PLG Serial Output Encoder (TS5690, MU1606 Series)" was revised. - "Spindle Side Accuracy Serial Output Encoder (Other Manufacturer's Product)" was revised. - "Serial Output Interface Unit for ABZ Analog Encoder MDS-EX-HR" was revised. - "List of Cables and Connectors" was revised. - "Selection of Contactor" was revised. - "Connection for L+ and L- Link" was revised.

Date of revision	Manual No.	Revision details
May 2023	IB(NA)1501226-L	- "Expressions for Load Inertia Calculation" was revised. - "Calculation of Servo Motor Output" was revised. - "Servo Encoder Cable" was revised. - "Connector for Servo" was revised. - Miswrite is corrected.

Global Service Network

AMERICA

MITSUBISHI ELECTRIC AUTOMATION INC. (AMERICA FA CENTER)
Central Region Service Center (Chicago)
500 CORPORATE WOODS PARKWAY, VERNON HILLS, ILLINOIS 60061, U.S.A.
TEL: +1-847-478-2500 / FAX: +1-847-478-2650
Minneapolis, MN Service Satellite
Detroit, MI Service Satellite
Grand Rapids, MI Service Satellite
Milwaukee, WI Service Satellite
Cleveland, OH Service Satellite
Indianapolis, IN Service Satellite
St. Louis, MO Service Satellite

South/East Region Service Center (Georgia)
1845 SATELLITE BOULEVARD STE. 450, DULUTH, GEORGIA 30097, U.S.A.
TEL +1-678-258-4529 / FAX +1-678-258-4519
Charleston, SC Service Satellite
Charlotte, NC Service Satellite
Raleigh, NC Service Satellite
Dallas, TX Service Satellite
Houston, TX Service Satellite
Hartford, CT Service Satellite
Knoxville, TN Service Satellite
Nashville, TN Service Satellite
Baltimore, MD Service Satellite
Pittsburg, PA Service Satellite
Tampa, FL Service Satellite
Syracuse, NY Service Satellite
Orlando, FL Service Satellite
Lafayette, LA Service Satellite
Philadelphia, PA Service Satellite

Western Region Service Center (California)
5900-B KATELLA AVE. - 5900-A KATELLA AVE. CYPRESS, CALIFORNIA 90630, U.S.A.
TEL: +1-714-699-2625 / FAX: +1-847-478-2650
San Jose, CA Service Satellite
Seattle, WA Service Satellite
Denver, CO Service Satellite

Canada Region Service Center (Toronto)
4299 14TH AVENUE MARKHAM, ONTARIO L3R OJ2, CANADA
TEL: +1-905-475-7728 / FAX: +1-905-475-7935
Edmonton, AB Service Satellite
Montreal, QC Service Satellite

Mexico Region Service Center (Queretaro)
Parque Tecnológico Innovación Querétaro, Lateral Carretera Estatal 431, Km 2+200, Lote 91 Modulos 1 y 2
Hacienda la Machorra, CP 76246, El Marqués, Querétaro, México
TEL: +52-442-153-6050
Monterrey, NL Service Satellite
Mexico City, DF Service Satellite

BRAZIL

MITSUBISHI ELECTRIC DO BRASIL COMÉRCIO E SERVIÇOS LTDA.
Votorantim Office
AV. GISELE CONSTANTINO,1578, PARQUE BELA VISTA, VOTORANTIM-SP, BRAZIL CEP:18.110-650
TEL: +55-15-3023-9000
Blumenau, Santa Catarina Office

EUROPE

MITSUBISHI ELECTRIC EUROPE B.V.
European Service Headquarters (Dusseldorf, GERMANY)
Mitsubishi-Electric-Platz 1 40882 RATINGEN, GERMANY
TEL: +49-2102-486-5000 / FAX: +49-2102-486-5910

South Germany Service Center (Stuttgart)
SCHELMENWASENSTRASSE 16-20, 70567 STUTTGART, GERMANY
TEL: + 49-711-770598-0 / FAX: +49-711-770598-141

France Service Center (Paris)
2 RUE DE L'UNION, 92565 RUEIL-MALMAISON CEDEX, FRANCE
TEL: +33-1-41-02-83-13 / FAX: +33-1-49-01-07-25

France Service Satellite (Lyon)
240, ALLEE JACQUES MONOD 69800 SAINT PRIEST FRANCE
TEL: +33-1-41-02-83-13 / FAX: +33-1-49-01-07-25

Italy Service Center (Milan)
VIA ENERGY PARK 14, VIMERCATE 20871 (MB) ITALY
TEL: +39-039-6053-342 / FAX: +39-039-6053-206

Italy Service Satellite (Padova)
VIA G. SAVELLI, 24 - 35129 PADOVA, ITALY
TEL: +39-039-6053-342 / FAX: +39-039-6053-206

U.K. Service Center
TRAVELLERS LANE, HATFIELD, HERTFORDSHIRE, AL10 8XB, U.K.
TEL: +44-1707-288-780 / FAX: +44-1707-278-695

Spain Service Center
CTRA. RUBI, 76-80 8174 SAINT CUGAT DEL VALLES, BARCELONA, SPAIN
TEL: +34-935-65-2236 / FAX: +34-935-89-1579

Poland Service Center
UL.KRAKOWSKA 50, 32-083 BALICE, POLAND
TEL: +48-12-347-6500 / FAX: +48-12-630-4701

Hungary Service Center
BUDAÖRS OFFICE PARK, SZABADSÁG ÚT 117., 2040 BUDAÖRS, HUNGARY
TEL: +48-12-347-6500 / FAX: +48-12-630-4701

Turkey Service Center
MITSUBISHI ELECTRIC TURKEY ELEKTRİK ÜRÜNLERİ A.Ş
SERIFALI MAHALLESI KALE SOKAK. NO.41 34775
UMRANIYE, ISTANBUL, TURKEY
TEL: +90-216-969-2500 / FAX: +90-216-661-44-47

Czech Republic Service Center
AutoCont Control Systems s.r.o (Service Partner)
KAFKOVA 1853/3, 702 00 OSTRAVA 2, CZECH REPUBLIC
TEL: +420-59-5691-185 / FAX: +420-59-5691-199

Russia Service Center
MITSUBISHI ELECTRIC RUSSIA LLC
LETNIKOVSKAYA STREET 2, BLD.1, 5TH 115114 MOSCOW, RUSSIA
TEL: +7-495-721-2070 / FAX: +7-495-721-2071

Sweden Service Center
HAMMARBACKEN 14, P.O.BOX 750 SE-19127, SOLLENTUNA, SWEDEN
TEL: +46-8-6251200 / FAX: +46-8-6251014

Bulgaria Service Center
AKHNATON Ltd. (Service Partner)
4 ANDREJ LJAPCHEV BLVD. POB 21, BG-1756 SOFIA, BULGARIA
TEL: +359-2-8176009 / FAX: +359-2-9744061

Ukraine Service Center (Kiev)
CSC Automation Ltd. (Service Partner)
4 B, YEVHENA SVERSTYUKA STR., 02002 KIEV, UKRAINE
TEL: +380-44-494-3344 / FAX: +380-44-494-3366

Belarus Service Center
TECHNIKON Ltd. (Service Partner)
NEZAVISIMOSTI PR.177, 220125 MINSK, BELARUS
TEL: +375-17-393-1177 / FAX: +375-17-393-0081

South Africa Service Center
Adroit Technologies (Service Partner)
20 WATERFORD OFFICE PARK, WATERFORD DRIVE, CNR OF WITKOPPEN ROAD,
FOURWAYS JOHANNESBURG SOUTH AFRICA
TEL: +27-11-658-8100 / FAX: +27-11-658-8101

ASEAN

MITSUBISHI ELECTRIC ASIA PTE. LTD. (ASEAN FA CENTER)
Singapore Service Center
307 ALEXANDRA ROAD MITSUBISHI ELECTRIC BUILDING SINGAPORE 159943
TEL: +65-6473-2308 / FAX: +65-6476-7439

PHILIPPINES

MELCO FACTORY AUTOMATION PHILIPPINES INC.
Head Office
128 LOPEZ RIZAL STREET, BRGY., HIGHWAY HILLS, MANDALUYONG CITY , MM PHILIPPINES 1550
TEL: +63-2-8256-8042 / FAX: +632-8637-2294

Philippines Service Center
KM.23 WEST SERVICE ROAD SSH, CUPANG ,MUNTINLUPA CITY, PHILIPPINES
TEL: +63-2-8807-0420 / FAX: +63-2-8842-5202

VIETNAM

MITSUBISHI ELECTRIC VIETNAM CO., LTD.
Vietnam Ho Chi Minh Service Center
11TH & 12TH FLOOR, VIETTEL TOWER B, 285 CACH MANG THANG 8 STREET, WARD 12, DISTRICT 10, HO CHI MINH CITY, VIETNAM
TEL: +84-28-3910-5945 / FAX: +84-28-3910-5947

Vietnam Hanoi Service Center
14TH FLOOR, CAPITAL TOWER, 109 TRAN HUNG DAO STREET, CUA NAM WARD, HOAN KIEM DISTRICT, HA NOI CITY, VIETNAM
TEL: +84-24-3937-8075 / FAX: +84-24-3937-8076

INDONESIA

PT. MITSUBISHI ELECTRIC INDONESIA
Indonesia Service Center (Cikarang)
JL. KENARI RAYA BLOK G2-07A, DELTA SILICON 5, LIPPO CIKARANG - BEKASI 17550, INDONESIA
TEL: +62-21-2961-7797 / FAX: +62-21-2961-7794

MALAYSIA

MITSUBISHI ELECTRIC SALES MALAYSIA SDN. BHD.
Malaysia Service Center (Kuala Lumpur Service Center)
LOT 11, JALAN 219, P.O BOX 1036, 46860 PETALING JAYA, SELANGOR DARUL EHSAN, MALAYSIA
TEL: +60-3-7626-5032
Johor Bahru Service Satellite
Pulau Pinang Service Satellite

THAILAND

MITSUBISHI ELECTRIC FACTORY AUTOMATION (THAILAND) CO., LTD.
Thailand Service Center (Bangkok)
101, TRUE DIGITAL PARK OFFICE, 5TH FLOOR, SUKHUMVIT ROAD, BANGCHAK, PHRA KHANONG, BANGKOK, 10260 THAILAND
TEL: +66-2-092-8600 / FAX: +66-2-043-1231-33

INDIA

MITSUBISHI ELECTRIC INDIA PVT., LTD.
CNC Technical Center (Bangalore)
PLOT NO. 56, 4TH MAIN ROAD, PEENYA PHASE 3,
PEENYA INDUSTRIAL AREA, BANGALORE 560058, KARNATAKA, INDIA
TEL : +91-80-4655-2121
Chennai Service Satellite
Coimbatore Service Satellite
Hyderabad Service Satellite

North India Service Center (Gurgaon)
PLOT 517, GROUND FLOOR, UDYOG VIHAR PHASE-III, GURUGRAM 122008, HARYANA, INDIA
TEL : +91-124-463-0300
Ludhiana Service Satellite
Panthnagar Service Satellite
Delhi Service Satellite
Jamshedpur Service Satellite
Manesar Service Satellite

West India Service Center (Pune)
ICC-Devi GAURAV TECHNOLOGY PARK, UNIT NO.402, FOURTH FLOOR, NORTH WING,
SURVEY NUMBER 191-192 (P), NEXT to INDIAN CARD CLOTHING COMPANY Ltd,
OPP. VALLABH NAGAR, PIMPRI, PUNE- 411 018, MAHARASHTRA, INDIA
TEL : +91-20-6819-2274
Kolhapur Service Satellite
Aurangabad Service Satellite
Mumbai Service Satellite

West India Service Center (Ahmedabad)
204-209, 2ND FLOOR, 31FIVE, CORPORATE ROAD PRAHLADNAGAR,
AHMEDABAD -380015, GUJARAT, INDIA
TEL : + 91-79-6777-7888
Rajkot Service Satellite

CHINA

MITSUBISHI ELECTRIC AUTOMATION (CHINA) LTD. (CHINA FA CENTER)
CNC Call Center
TEL: +86-400-921-5130

Shanghai Service Center
NO.1386 HONG QIAO ROAD, CHANG NING QU, SHANGHAI 200336, CHINA
TEL: +86-21-2322-3030 / FAX: +86-21-2322-3000*8422
Qingdao Service Center
Suzhou Service Center
Wuhan Service Center
Ningbo Service Center
Hefei Service Center
Beijing Service Center
Tianjin Service Center
Xian Service Center
Dalian Service Center
Chengdu Service Center

Shenzhen Service Center
LEVEL8, GALAXY WORLD TOWER B, 1 YABAO ROAD, LONGGANG DISTRICT,
SHENZHEN 518129, CHINA
TEL: +86-755-2399-8272 / FAX: +86-755-8229-3686
Dongguan Service Center
Xiamen Service Center

KOREA

MITSUBISHI ELECTRIC AUTOMATION KOREA CO., LTD. (KOREA FA CENTER)
Korea Service Center
8F GANGSEO HANGANG XI-TOWER A, 401 YANGCHEON-RO, GANGSEO-GU,
SEOUL 07528 KOREA
TEL: +82-2-3660-9631 / FAX: +82-2-3664-8668
Korea Daegu Service Satellite

TAIWAN

MITSUBISHI ELECTRIC TAIWAN CO., LTD. (TAIWAN FA CENTER)
Taiwan Taichung Service Center
NO. 8-1, GONGYEQU 16th RD., XITUN DIST., TAICHUNG CITY 40768 , TAIWAN
TEL: +886-4-2359-0688 / FAX: +886-4-2359-0689

Taiwan Taipei Service Center
11F, NO.88, SEC.6, ZHONGSHAN N. RD., SHILIN DIST., TAIPEI CITY 11155, TAIWAN
TEL: +886-2-2833-5430 / FAX: +886-2-2833-5433

Taiwan Tainan Service Center
11F.-1, NO.30, ZHONGZHENG S. RD., YONGKANG DIST., TAINAN CITY 71067, TAIWAN
TEL: +886-6-252-5030 / FAX: +886-6-252-5031

OCEANIA

MITSUBISHI ELECTRIC AUSTRALIA PTY. LTD.
Oceania Service Center
348 VICTORIA ROAD, RYDALMERE, N.S.W. 2116 AUSTRALIA
TEL: +61-2-9684-7269/ FAX: +61-2-9684-7245

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.

Duplication Prohibited

MITSUBISHI ELECTRIC CORPORATION

HEAD OFFICE : TOKYO BLDG.,2-7-3 MARUNOUCHI,CHIYODA-KU,TOKYO 100-8310,JAPAN

MODEL	MDS-E/EH Series
MODEL CODE	100-450
Manual No.	IB-1501226

IB(NA)1501226(ENG)-L(2305)MEE
Made in JAPAN