MITSUBISHI ELECTRIC

Changes for the Better

MITSUBISHI CNC

Specifications Manual

MDS-DM Series

IB-1500891(ENG)-E

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 manufacturers. The "restrictions" and "available functions" described in the manuals issued by the machine manufacturers have precedence to those in this manual.
(2) This manual describes as many special operations as possible, but it should be kept in mind that items not mentioned in this manual cannot be performed.

Precautions for safety

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

⚠**DANGER**	When there is a potential risk of fatal or serious injuries if handling is mistaken.
⚠**WARNING**	When a dangerous situation, or fatal or serious injuries may occur if handling is mistaken.
⚠**CAUTION**	When a dangerous situation may occur if handling is mistaken leading to medium or minor injuries, or physical damage.

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

The signs indicating prohibited and mandatory matters are explained below.

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

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

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

- Servo drive unit
- Spindle drive unit
- Power supply unit
- Scale interface unit
- Magnetic pole detection unit

POINT

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

⚠ WARNING

1. Electric shock prevention

- ⚠ Do not open the front cover while the power is ON or during operation. Failure to observe this could lead to electric shocks.
- ⚠ Do not operate the unit with the front cover removed. The high voltage terminals and charged sections will be exposed, and can cause electric shocks.
- ⚠ Do not remove the front cover and connector even when the power is OFF unless carrying out wiring work or periodic inspections. The inside of the units is charged, and can cause electric shocks.
- ⚠ Since the high voltage is supplied to the main circuit connector while the power is ON or during operation, do not touch the main circuit connector with an adjustment screwdriver or the pen tip. Failure to observe this could lead to electric shocks.
- ⚠ Wait at least 15 minutes after turning the power OFF, confirm that the CHARGE lamp has gone out, and check the voltage between P and N terminals with a tester, etc., before starting wiring, maintenance or inspections. Failure to observe this could lead to electric shocks.
- ⚠ Ground the unit and motor. For the motor, ground it via the drive unit.
- ⚠ Wiring, maintenance and inspection work must be done by a qualified technician.
- ⚠ Wire the servo drive unit and servo motor after installation. Failure to observe this could lead to electric shocks.
- ⚠ Do not touch the switches with wet hands. Failure to observe this could lead to electric shocks.
- ⚠ Do not damage, apply forcible stress, place heavy items on the cables or get them caught. Failure to observe this could lead to electric shocks.
- ⚠ Always insulate the power terminal connection section. Failure to observe this could lead to electric shocks.
- ⚠ After assembling the built-in IPM spindle motor, if the rotor is rotated by hand etc., voltage occurs between the terminals of lead. Take care not to get electric shocks.

⚠ 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 spindle motor uses permanent magnets in the rotor, so observe the following precautions.

(1)Handling

• The linear servo motor, direct-drive motor and built-in IPM spindle motor could adversely affect medical electronics such as pacemakers, etc., therefore, do not approach the rotor.

• Do not place magnetic materials as iron.

• When a magnetic material as iron is placed, take safety measure not to pinch fingers or hands due to the magnetic attraction force.

• Remove metal items such as watch, piercing jewelry, necklace, etc.

• Do not place portable items that could malfunction or fail due to the influence of the magnetic force.

• When the rotor is not securely fixed to the machine or device, do not leave it unattended but store it in the package properly.

• When installing the motor to the machine, take it out from the package one by one, and then install it.

• It is highly dangerous to lay out the motor or magnetic plates together on the table or pallet, therefore never do so.

(2)Transportation and storage

• Correctly store the rotor in the package to transport and store.

• During transportation and storage, draw people's attention by applying a notice saying "Strong magnet-Handle with care" to the package or storage shelf.

• Do not use a damaged package.

(3)Installation

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

⚠ 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., 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

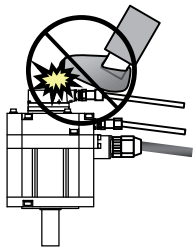
⚠ Correctly transport the product according to its weight.

❗ Use the motor's hanging bolts only when transporting the motor. Do not transport the machine when the motor is installed on the machine.

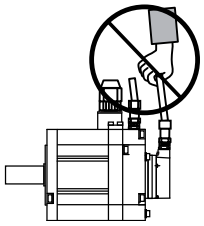
⚠ Do not stack the products above the tolerable number.

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

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



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



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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

⚠ Store the motor in the package box.

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

⚠ Always use a nonmagnetic tool (explosion-proof beryllium copper alloy safety tool: NGK Insulators, etc.) when installing the built-in IPM spindle motor, direct-drive motor and linear servo motor.

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

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

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

⚠ 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.

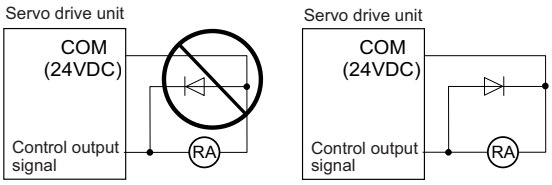
⚠ Always connect the motor to the drive unit's output terminals (U, V, W).

⚠ 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 drive wire and power line.

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

(3) Trial operation and adjustment

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

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

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

⚠ The direct-drive motor and linear servo motor does 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, tolerable sudden power failure time, etc.).

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

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

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

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

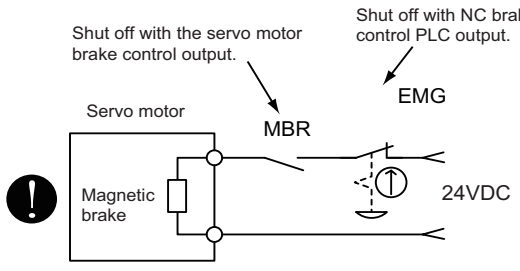
(5) Troubleshooting

⚠ If a hazardous situation is predicted during power failure or product trouble, use a servo motor with magnetic brakes or install an external brake mechanism.

⚠ Use a double circuit configuration that allows the operation circuit for the magnetic brakes to be operated even by the external emergency stop signal.

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

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



⚠ 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 delayer for repairs or part replacement.

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

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

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

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

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

(7) Disposal

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

⚠ Do not disassemble the unit or motor.

⚠ Dispose of the battery according to local laws.

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

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

(8) Transportation

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

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

(9) General precautions

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

Treatment of waste

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

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

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

Disposal

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

Your MITSUBISHI ELECTRIC product is designed and manufactured with high quality materials and components which can be recycled and/or reused.
This symbol means that batteries and accumulators, at their end-of-life, should be disposed of separately from your household waste.
If a chemical symbol is printed beneath the symbol shown above, this chemical symbol means that the battery or accumulator contains a heavy metal at a certain concentration. This will be indicated as follows:
Hg: mercury (0,0005%), Cd: cadmium (0,002%), Pb: lead (0,004%)
In the European Union there are separate collection systems for used batteries and accumulators.
Please, dispose of batteries and accumulators correctly at your local community waste collection/ recycling centre.

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

Trademarks

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

Other company and product names that appear in this manual are trademarks or registered trademarks of the respective companies.

本製品の取扱いについて

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

Handling of our product

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

본 제품의 취급에 대해서

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

WARRANTY

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

1. Warranty Period and Coverage

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

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

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

2. Service in Overseas Countries

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

3. Exclusion of Loss in Opportunity and Secondary Loss from Warranty Liability

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

4. Changes in Product Specifications

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

5. Product Application

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

Contents

Outline for MDS-DM Series Instruction Manual (IB-1500893-D)

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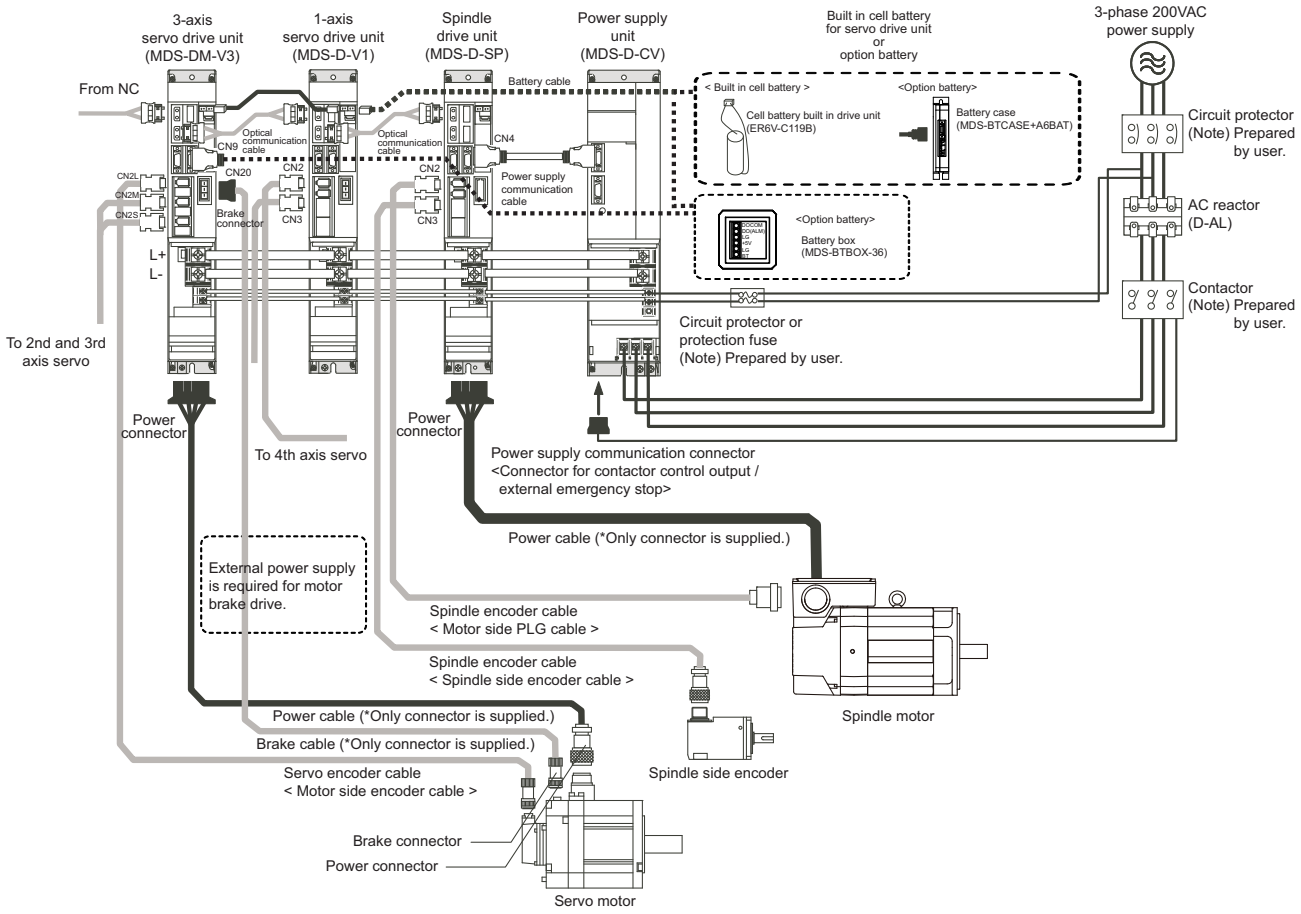
Introduction

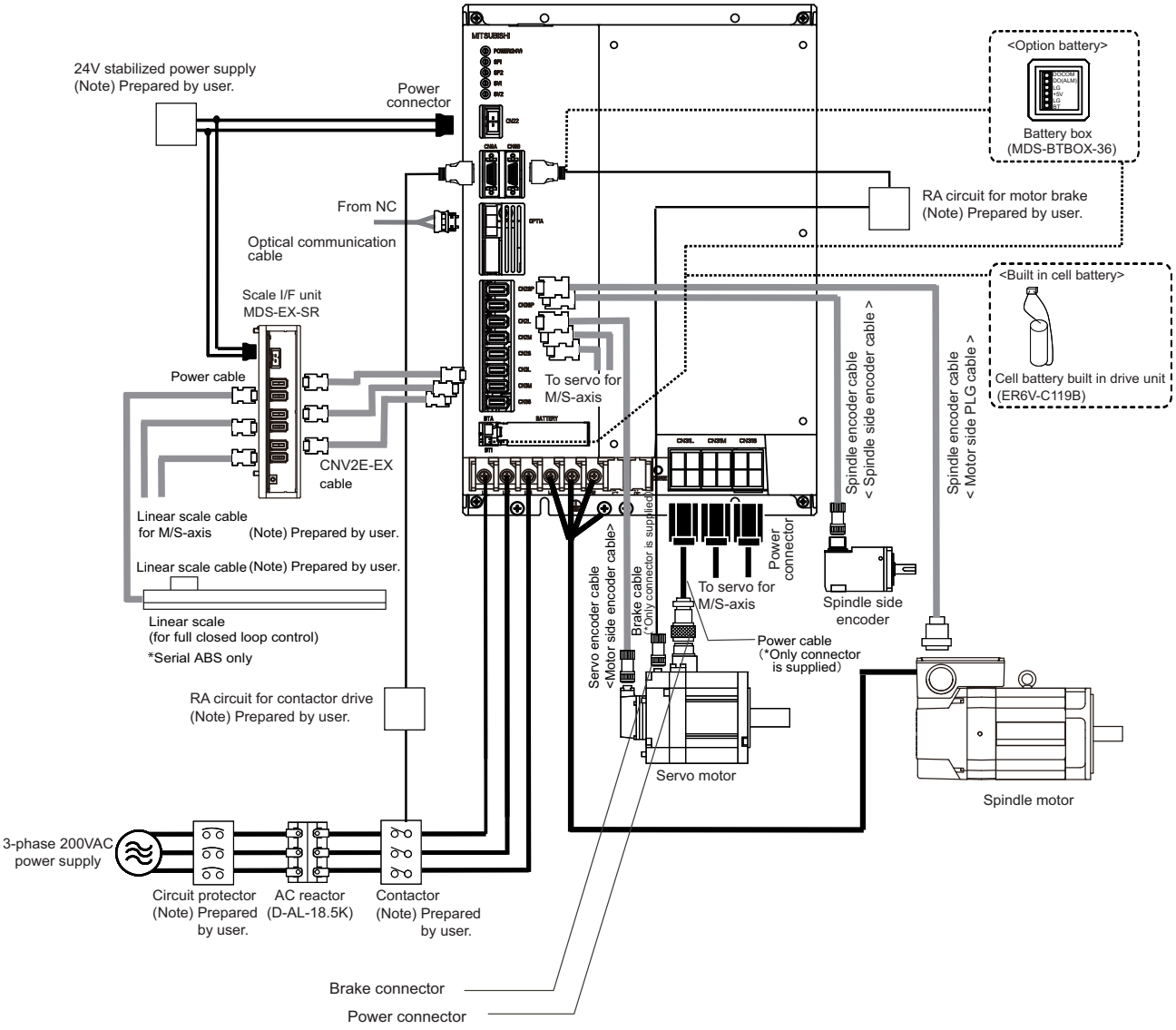
1-1 Servo/spindle drive system configuration

1-1-1 System configuration

<MDS-DM-V3 Series>

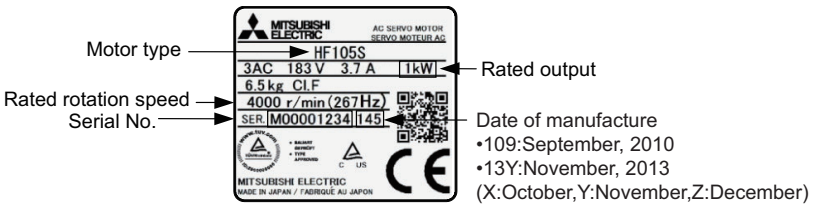


<MDS-DM-SPV2F/SPV3F Series>



1-2 Explanation of type

1-2-1 Servo motor type



Motor rating nameplate

Encoder rating nameplate

< HF Series >

HF (1) (2) (3) - (4)

(1) Rated output · Maximum rotation speed

Symbol	Rated output	Maximum rotation speed	Flange size (mm)
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.
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
S	Straight
T	Taper

(Note) "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
A48	OSA18-100	Absolute position	260,000 p/rev
A51	OSA105S5A		1,000,000 p/rev

< HF-KP Series >

HF-KP (1) (2) JW04-S6

(1) Rated output · Maximum rotation speed

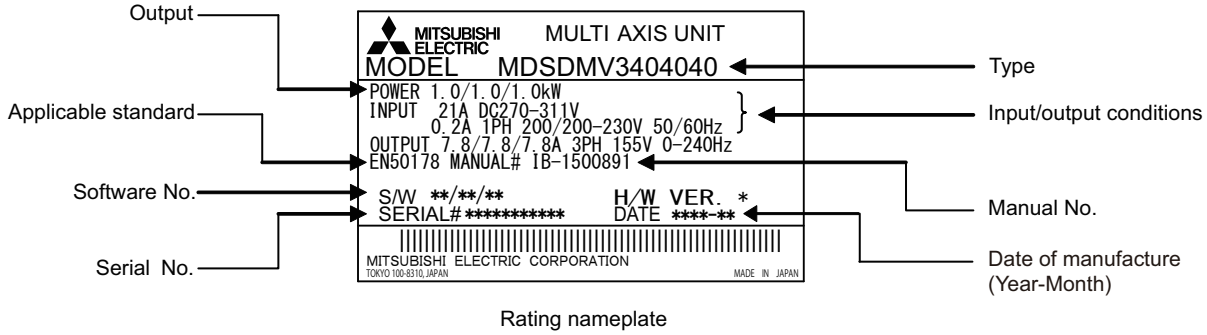
Symbol	Rated output	Maximum rotation speed	Flange size (mm)
23	0.2 kW	6000 r/min	60 SQ.
43	0.4 kW	6000 r/min	60 SQ.
73	0.75 kW	6000 r/min	80 SQ.

(2) Magnetic brake

Symbol	Magnetic brake
None	None
B	With magnetic brake

1-2-2 Servo drive unit type

(1) 3-axis integrated servo drive unit



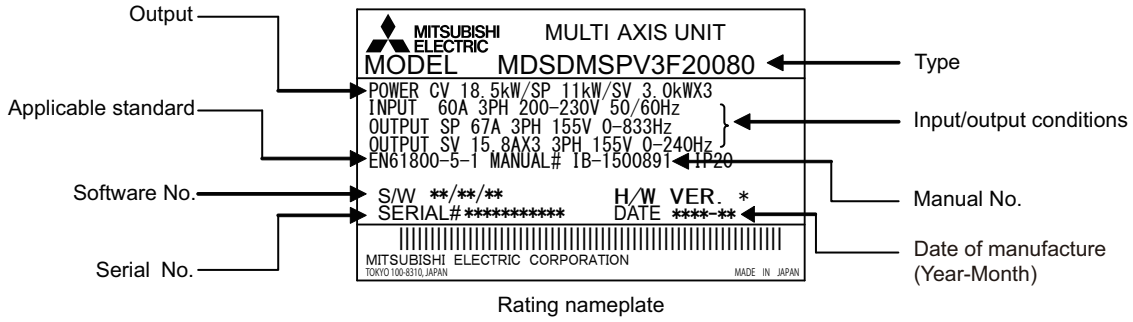
Rating nameplate

MDS-DM- **(1)**

(1) Unit Type MDS-DM-			Compatible motor type	HF□									HF-KP□		
				75	105	54	104	154	123	223	142	302	23	43	73
	Unit width	Unit nominal maximum current	Stall torque (N·m) / Axis	2.0	3.0	2.9	5.9	7.0	7.0	12 (10.0)	11.0	20 (15.6)	0.64	1.3	5.1
V3-202020	60mm	20+20+20A	L	●	●				●		●		●	●	●
			M	●	●				●		●		●	●	●
			S	●	●				●		●		●	●	●
V3-404040		40+40+40A	L	●	●	●	●	□	●	●	●	●			
			M	●	●	●	●	□	●	○	●	○			
			S	●	●	●	●	□	●	○	●	○			

● Indicates the compatible motor for each servo drive unit.
○ Indicates the motor that can be combine with the drive unit although the stall torque is limited.
□ Indicates the motor that can be combine with the drive unit although the stall torque and maximum torque are limited.
(Note) The values in the parentheses are specifications when connecting with the M/S-axis of the MDS-DM-V3-404040.

(2) Multi axis integrated servo drive unit



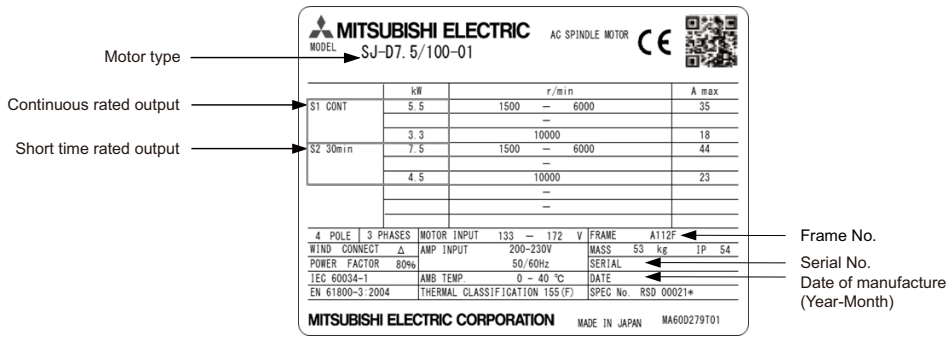
Rating nameplate

MDS-DM- **(1)**

(1) Unit Type MDS-DM-			Compatible motor type	HF□									
				54	104	154	224	204	354	223	303	453	302
	Unit width	Unit nominal maximum current	Stall torque (N·m) / Axis	2.9	5.9	9.0	12.0	13.7	22.5	12.0	22.5	37.2	20.0
SPV3F-10080	260mm	80+80+80A	LMS	●	●	●	●	●		●	●		●
SPV3F-16080		80+80+80A	LMS	●	●	●	●	●		●	●		●
SPV3F-20080		80+80+80A	LMS	●	●	●	●	●		●	●		●
SPV3F-200120		120+120+120A	LMS			●	●	●	●		●	●	
SPV2F-10080		80+80A	LM	●	●	●	●	●		●	●		●
SPV2F-16080		80+80A	LM	●	●	●	●	●		●	●		●
SPV2F-20080		80+80A	LM	●	●	●	●	●		●	●		●

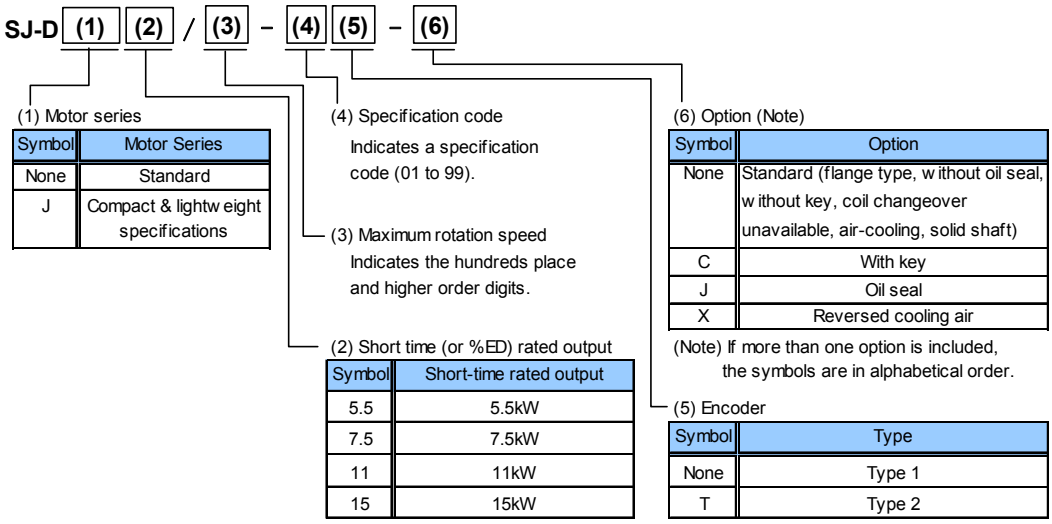
● Indicates the compatible motor for each servo drive unit.

1-2-3 Spindle motor type



Rating nameplate

< SJ-D Series >



Symbol	Motor Series
None	Standard
J	Compact & lightw eight specifications

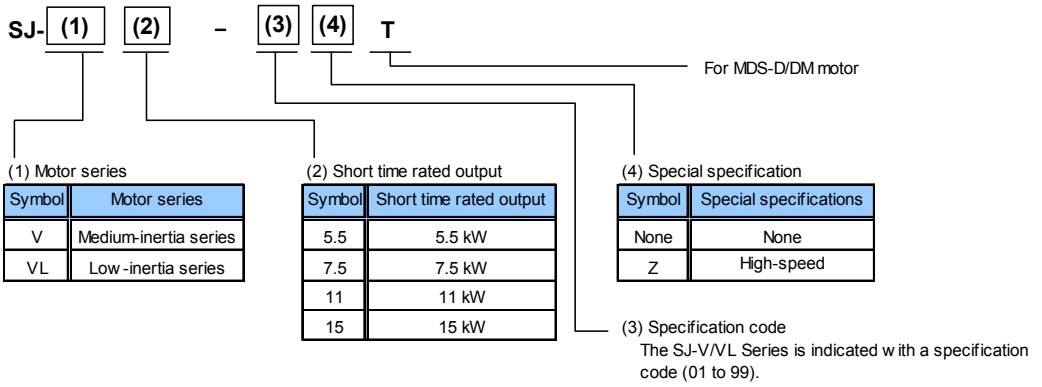
Symbol	Short-time rated output
5.5	5.5kW
7.5	7.5kW
11	11kW
15	15kW

Symbol	Option
None	Standard (flange type, w ithout oil seal, w ithout key, coil changeover unavailable, air-cooling, solid shaft)
C	With key
J	Oil seal
X	Reversed cooling air

Symbol	Type
None	Type 1
T	Type 2

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

< SJ-V/VL Series >



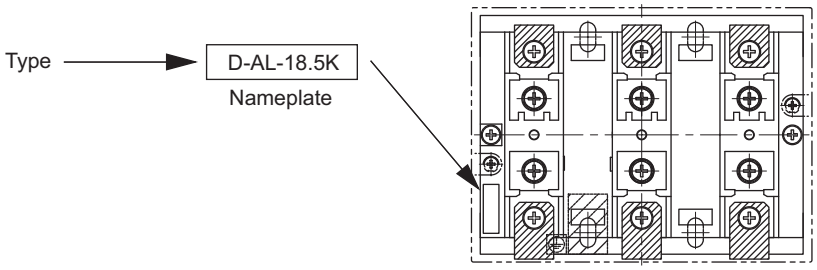
Symbol	Motor series
V	Medium-inertia series
VL	Low -inertia series

Symbol	Short time rated output
5.5	5.5 kW
7.5	7.5 kW
11	11 kW
15	15 kW

Symbol	Special specifications
None	None
Z	High-speed

(Note 1) For the short time rated output of the w ide range constant output and hollow shaft series refer to the specifications od each spindle motor.
(Note 2) This explains the model name system of spindle motors, but does not mean all the combinations are available.

1-2-4 AC reactor type



Top surface of AC reactor

Type	Capacity	Compatible pow er supply unit
D-AL-18.5K	18.5kW	MDS-DM-SPV Series

2

Specifications

2-1 Servo motor

2-1-1 Specifications list

< HF Series >

Servo motor type		HF Series							
		ABS specifications: HF ☐ -A51 / -A48							
		HF75	HF105	HF54	HF104	HF154		HF224	HF204
Compatible drive unit type	MDS-DM-V3-	202020 404040	202020 404040	404040	404040	404040	-	-	-
	MDS-DM-SPV3F-	-	-	xxx80	xxx80	-	xxx80 200120	xxx80 200120	xxx80 200120
	MDS-DM-SPV2F-	-	-	xxx80	xxx80	-	xxx80	xxx80	xxx80
Continuous characteristics	Rated output [kW]	0.75	1.0	0.5	1.0	1.5	1.5	2.2	2.0
	Rated current [A]	3.1	3.7	2.0	3.9	5.6	5.6	8.6	6.8
	Rated torque [N•m]	1.8	2.4	1.6	3.2	4.8	4.8	7.0	6.4
	Stall current [A]	3.2	4.6	3.2	6.6	8.5	11	15	15
	Stall torque [N•m]	2.0	3.0	2.9	5.9	7.0	9.0	12.0	13.7
Power facility capacity [kVA]		1.5	2.0	1.1	2.0	2.8	2.8	4.1	3.7
Rated rotation speed [r/min]		4000		3000					
Maximum rotation speed [r/min]		5000		4000					
Maximum current [A]		14.0	15.5	16.8	29.0	29.0	52.0	57.0	57.0
Maximum torque [N•m]		8.0	11.0	13.0	23.3	23.7	42.0	46.5	47.0
Power rate at continuous rated torque [kW/s]		12.3	11.2	4.1	8.4	12.7	12.7	20.7	10.6
Motor inertia [$\times 10^{-4}$kg•m^2]		2.6	5.1	6.1	11.9	17.8	17.8	23.7	38.3
Motor inertia with brake [$\times 10^{-4}$kg•m^2]		2.8	5.3	8.3	14.1	20.0	20.0	25.9	48.0
Maximum motor shaft conversion load inertia ratio		High-speed, high-accuracy machine: 3 times or less of motor inertia General machine tool (interpolation axis): 5 times or less of motor inertia General machine (non-interpolation axis): 7 times or less of motor inertia							
Motor side encoder		Resolution per motor revolution A51: 1,000,000 pulse/rev, A48: 260,000 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°Cto 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 (3G)
Flange size [mm]		90 SQ.	90 SQ.	130 SQ.	130 SQ.	130 SQ.		130 SQ.	176 SQ.
Total length (excluding shaft) [mm] (Note 3)		126.5	162.5	118.5	140.5	162.5		184.5	143.5
Flange fitting diameter [mm]		Φ80	Φ80	Φ110	Φ110	Φ110		Φ110	Φ114.3
Shaft diameter [mm]		Φ14	Φ14	Φ24	Φ24	Φ24		Φ24	Φ35
Mass Without / with brake [kg]		2.5/ 3.9	4.3/ 5.7	4.8/ 6.7	6.5/ 8.5	8.3/ 10.3		10.0/ 12.0	12.0/ 18.0
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) Use the HF motor in combination with the MDS-DM Series drive unit compatible with the 200VAC input.

(Note 3) The total length will be 3.5mm longer when using an A51 encoder.

(Note 4) The values in the parentheses are specifications when connecting with the M/S-axis of the MDS-DM-V3-404040.

(Note 5) 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-1500273(ENG)).

< HF Series >

Servo motor type		HF Series						
		ABS specifications: HF ☐ -A51 / -A48						
		HF354	HF123	HF223	HF303	HF453	HF142	HF302
Compatible drive unit type	MDS-DM-V3-	-	202020 404040	404040	-	-	202020 404040	404040
	MDS-DM-SPV3F-	200120	-	xxx80	xxx80 200120	200120	-	xxx80
	MDS-DM-SPV2F-	-	-	xxx80	xxx80	-	-	xxx80
Continuous characteristics	Rated output [kW]	3.5	1.2	2.2 (2.1)	3.0	4.5	1.4	3.0 (2.2)
	Rated current [A]	12	5.2	9.0 (8.5)	11	19	5.2	11 (8.5)
	Rated torque [N•m]	11.1	5.7	10.5 (10.0)	14.3	14.3	6.7	14.3 (10.6)
	Stall current [A]	22	6.4	11 (8.5)	16	28	6.4	11 (8.5)
	Stall torque [N•m]	22.5	7.0	12.0 (10.0)	22.5	37.2	11.0	20.0 (15.6)
Power facility capacity [kVA]		6.4	2.3	4.1 (3.9)	5.5	8.1	2.7	5.5 (4.1)
Rated rotation speed [r/min]		3000	2000			3000	2000	
Maximum rotation speed [r/min]		4000	3000			3500	2000	
Maximum current [A]		79.6	15.5	29.0	48.0	79.6	15.5	29.0
Maximum torque [N•m]		75.0	17.0	32.0	64.0	90.0	26.5	50.0
Power rate at continuous rated torque [kW/s]		16.5	27.3	46.5	27.3	18.3	25.2	27.3
Motor inertia [$\times 10^{-4}$kg•m^2]		75.0	11.9	23.7	75.0	112.0	17.8	75.0
Motor inertia with brake [$\times 10^{-4}$kg•m^2]		84.7	14.1	25.9	84.7	121.7	20.0	84.7
Maximum motor shaft conversion load inertia ratio		High-speed, high-accuracy machine: 3 times or less of motor inertia General machine tool (interpolation axis): 5 times or less of motor inertia General machine (non-interpolation axis): 7 times or less of motor inertia						
Motor side encoder		Resolution per motor revolution A51: 1,000,000 pulse/rev, A48: 260,000 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°Cto 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:24.5m/s^2 (2.5G) Y:29.4m/s^2 (3G)	X,Y:24.5m/s^2 (2.5G)		X:24.5m/s^2 (2.5G) Y:29.4m/s^2 (3G)		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.	130 SQ.	130 SQ.	176 SQ.	176 SQ.	130 SQ.	176 SQ.
Total length (excluding shaft) [mm] (Note 3)		183.5	140.5	184.5	183.5	223.5	162.5	183.5
Flange fitting diameter [mm]		Φ114.3	Φ110	Φ110	Φ114.3	Φ114.3	Φ110	Φ114.3
Shaft diameter [mm]		Φ35	Φ24	Φ24	Φ35	Φ35	Φ24	Φ35
Mass Without / with brake [kg]		19.0/ 25.0	6.5/ 8.5	10.0/ 12.0	19.0/ 25.0	25/ 31	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) Use the HF motor in combination with the MDS-DM Series drive unit compatible with the 200VAC input.

(Note 3) The total length will be 3.5mm longer when using an A51 encoder.

(Note 4) The values in the parentheses are specifications when connecting with the M/S-axis of the MDS-DM-V3-404040.

(Note 5) 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-1500273(ENG)).

< HF-KP Series >

Servo motor type		HF-KP Series		
		Absolute position standard		
		HF-KP23JW04-S6	HF-KP43JW04-S6	HF-KP73JW04-S6
Compatible drive unit type	MDS-DM-V3-	202020	202020	202020
	MDS-DM-SPV2F/SPV3F-	-	-	-
Continuous characteristics	Rated output [kW]	0.2	0.4	0.75
	Rated current [A]	1.4	2.9	5.2
	Rated torque [N•m]	0.64	1.3	2.4
	Stall current [A]	1.4	2.9	5.2
	Stall torque [N•m]	0.64	1.3	2.4
Power facility capacity [kVA]		0.6	0.9	1.5
Rated rotation speed [r/min]		3000		
Maximum rotation speed [r/min]		6000		
Maximum current [A]		4.3	8.5	15.5
Maximum torque [N•m]		1.9	3.8	7.2
Power rate at continuous rated torque [kW/s]		16.9	38.6	39.9
Motor inertia [$\times 10^{-4}$kg•m^2]		0.23	0.42	1.43
Motor inertia with brake [$\times 10^{-4}$kg•m^2]		0.31	0.50	1.63
Maximum motor shaft conversion load inertia ratio		General machine (non-interpolation axis): 15 times or less of motor inertia		
Motor side encoder		Resolution per motor revolution: 260,000 pulse/rev		
Degree of protection		IP65 (The shaft-through portion is excluded.)		
Environment	Ambient temperature	Operation: 0 to 40°C(with no freezing), Storage: -15°Cto 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]		98	119.9	134.2
Flange fitting diameter [mm]		Φ50	Φ50	Φ70
Shaft diameter [mm]		Φ14	Φ14	Φ19
Mass Without / with brake [kg]		1.2/1.8	1.7/2.3	2.9/4.1
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) Use the HF-KP motor in combination with the MDS-D Series or MDS-DM Series drive unit compatible with the 200VAC input.

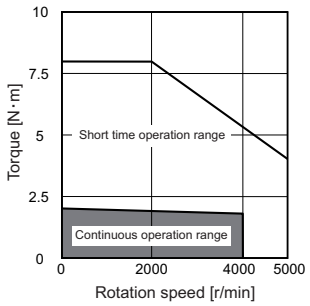
(Note 3) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1500273(ENG)).

2-1-2 Torque characteristics

< HF Series >

[HF75]



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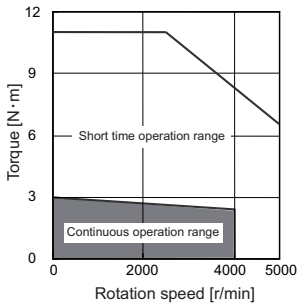

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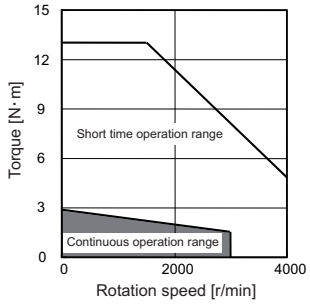

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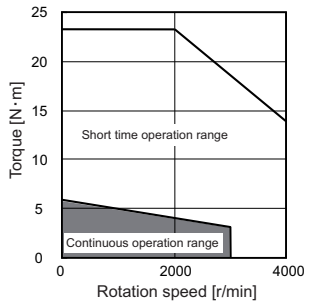

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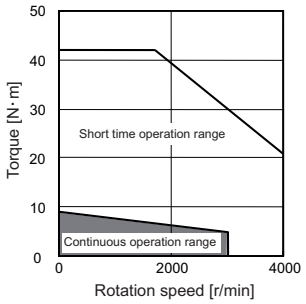

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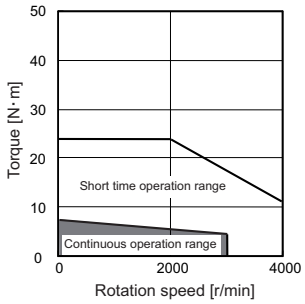

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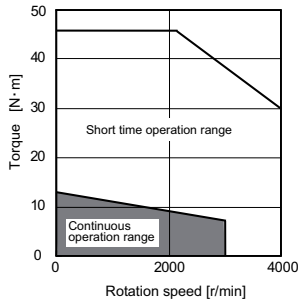

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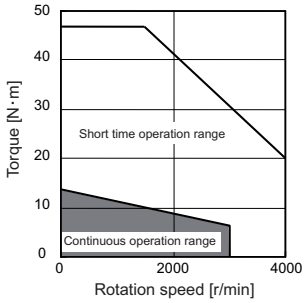
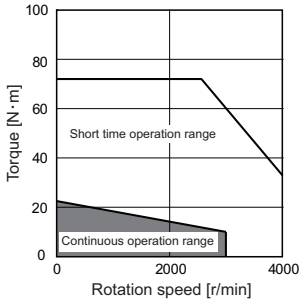


[HF354]

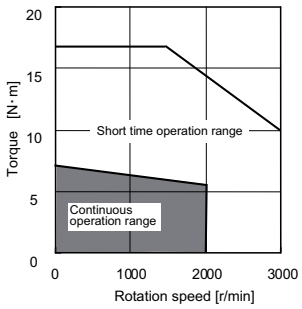


(Note1) The above graphs show the data when applied the input voltage of 200VAC. When the input voltage is 200VAC or less, the short time operation range is limited.

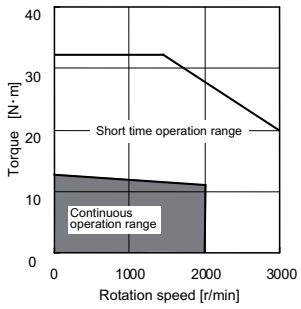
(Note2) Each line indicates the case in connecting the following drive unit or axis.
HF154: MDS-DM-V3-404040
HF223, HF302: M/S-axis of MDS-DM-V3-404040

< HF Series >

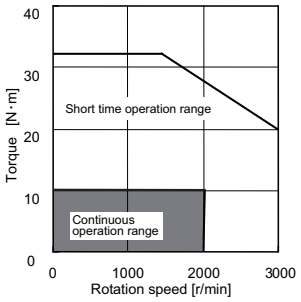
[HF123]



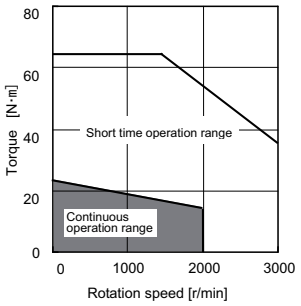
[HF223]



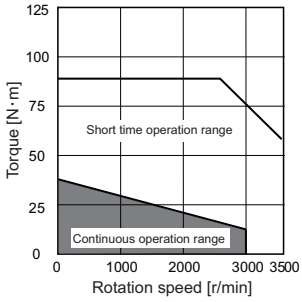
[HF223] (Note2)



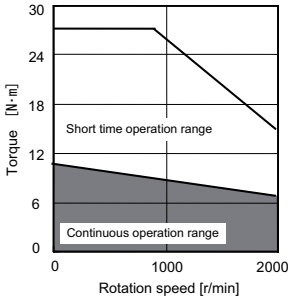
[HF303]



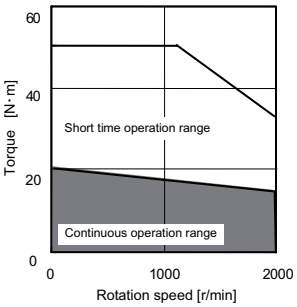
[HF453]



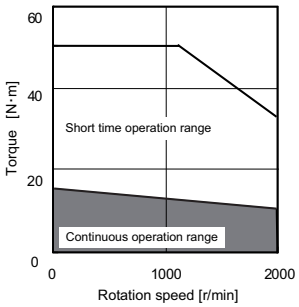
[HF142]



[HF302]



[HF302] (Note2)

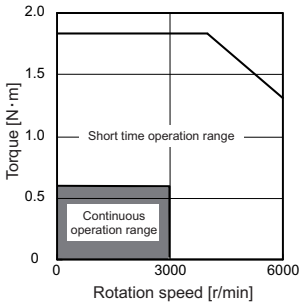


(Note1) The above graphs show the data when applied the input voltage of 200VAC. When the input voltage is 200VAC or less, the short time operation range is limited.

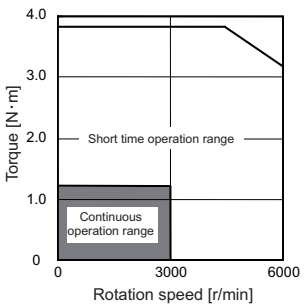
(Note2) Each line indicates the case in connecting the following drive unit or axis.
HF154: MDS-DM-V3-404040
HF223, HF302: M/S-axis of MDS-DM-V3-404040

< HF-KP Series >

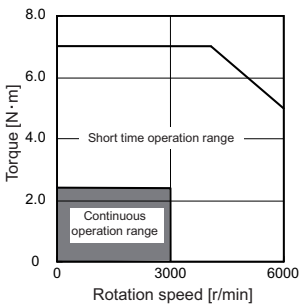
[HF-KP23JW04-S6]



[HF-KP43JW04-S6]



[HF-KP73JW04-S6]



(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.

2-2 Spindle motor

2-2-1 Specifications

< SJ-D Series (Normal specifications) >

Spindle motor type		SJ-D5.5/100-01	SJ-D7.5/100-01	SJ-D11/80-01
Compatible drive unit MDS-DM-SPV2F/SPV3F-		10080	10080	16080
Output capacity [kW]	Continuous rating	3.7	5.5	7.5
	Short time rating	5.5 (30-minute rating)	7.5 (30-minute rating)	11 (30-minute rating)
	Standard output during acceleration/deceleration	5.5	7.5	11
	Actual acceleration/ deceleration output (Note 3)	6.6	9	13.2
Power facility capacity [kVA]		9.9	13.4	19.6
Base rotation speed [r/min]		1500	1500	1500
Maximum rotation speed [r/min]		10000	10000	8000
Frame No.		D90	A112	B112
Continuous rated torque [N•m]		23.6	35.0	47.7
GD^2[kg•m^2]		0.053	0.094	0.122
Motor inertia [kg•m^2]		0.013	0.023	0.031
Tolerable radial load [N]		1470	1960	1960
Cooling fan	Input voltage	3-phase 200V		
	Maximum power consumption	38W	50W	50W
Environ ment	Ambient temperature	Operation: 0 to 40°C(with no freezing), Storage: -20°Cto 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.	204 SQ.	204 SQ.
Total length (excluding shaft) [mm]		417	439	489
Flange fitting diameter [mm]		Φ150	Φ180	Φ180
Shaft diameter [mm]		Φ28	Φ32	Φ48
Mass [kg]		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".

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1500273(ENG)).

< SJ-DJ Series (Compact & lightweight specifications) >

Spindle motor type		SJ-DJ5.5/100-01	SJ-DJ7.5/100-01	SJ-DJ11/100-01	SJ-DJ15/80-01
Compatible drive unit MDS-DM-SPV2F/SPV3F-		10080	10080	16080	20080
Output capacity [kW]	Continuous rating	3.7	5.5	7.5	11
	Short time rating	5.5 (25%ED rating)	7.5 (15-minute rating)	11 (15-minute rating)	15 (15-minute rating) (15%ED rating)
	Standard output during acceleration/deceleration	5.5	7.5	11	15
	Actual acceleration/ deceleration output (Note 3)	6.6	9	13.2	18
Power facility capacity [kVA]		9.9	13.4	19.6	26.7
Base rotation speed [r/min]		1500	1500	1500	1500
Maximum rotation speed [r/min]		10000	10000	10000	8000
Frame No.		B90	D90	A112	B112
Continuous rated torque [N•m]		17.7	26.3	35.8	52.5
GD^2[kg•m^2]		0.030	0.053	0.094	0.122
Motor inertia [kg•m^2]		0.0074	0.013	0.023	0.031
Tolerable radial load [N]		980	1470	1960	1960
Cooling fan	Input voltage	3-phase 200V			
	Maximum power consumption	38W	38W	50W	50W
Environment	Ambient temperature	Operation: 0 to 40°C(with no freezing), Storage: -20°Cto 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.	204 SQ.	204 SQ.
Total length (excluding shaft) [mm]		327	417	439	489
Flange fitting diameter [mm]		Φ150	Φ150	Φ180	Φ180
Shaft diameter [mm]		Φ28	Φ28	Φ32	Φ48
Mass [kg]		26	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".

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1500273(ENG)).

< SJ-V Series (Normal specifications) >

Spindle motor type		SJ-V5.5-01ZT	SJ-V7.5-01ZT	SJ-V7.5-03ZT	SJ-V11-01ZT	SJ-V11-06ZT	SJ-V11-13ZT	SJ-V15-01ZT
Compatible drive unit type MDS-DM-SPV2F/SPV3F-		10080	10080	16080	16080	20080	20080	20080
Output capacity [kW]	Continuous rating	3.7	5.5	5.5	7.5	5.5	7.5	11
	Short time rating	5.5 (30-minute rating)	7.5 (30-minute rating)	7.5 (30-minute rating)	11 (30-minute rating)	7.5 (30-minute rating)	11 (30-minute rating)	15 (30-minute rating)
	Standard output during acceleration/deceleration	5.5	7.5	7.5	11	7.5	11	15
	Actual acceleration/ deceleration output (Note 3)	6.6	9	9	13.2	9	13.2	18
Power facility capacity [kVA]		9.9	13.4	13.4	19.6	13.4	19.6	26.7
Base rotation speed [r/min]		1500	1500	1500	1500	3000	1500	1500
Maximum rotation speed [r/min]		12000	12000	12000	8000	12000	8000	8000
Frame No.		D90	A112	A112	B112	A112	B112	A160
Continuous rated torque [N•m]		23.6	35	35	47.7	35.0	47.7	70
GD^2[kg•m^2]		0.059	0.098	0.098	0.12	0.098	0.12	0.23
Inertia [kg•m^2]		0.0148	0.0245	0.0245	0.03	0.025	0.03	0.0575
Tolerable radial load [N]		980	980	980	1960	980	1960	2940
Cooling fan	Input voltage	Single-phase 200V	3-phase 200V	3-phase 200V	3-phase 200V	3-phase 200V	3-phase 200V	3-phase 200V
	Maximum power consumption	36W	70W	70W	40W	40W	70W	80W
Environment	Ambient temperature	Operation: 0 to 40°C(with no freezing), Storage: -20°Cto 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.	204 SQ.	204 SQ.	204 SQ.	204 SQ.	204 SQ.	250 SQ.
Total length (excluding shaft) [mm]		425	440	440	490	440	490	469.5
Flange fitting diameter [mm]		Φ150	Φ180	Φ180	Φ180	Φ180	Φ180	Φ230
Shaft diameter [mm]		Φ28	Φ32	Φ32	Φ48	Φ32	Φ48	Φ48
Mass [kg]		49	60	60	70	60	70	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".

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1500273(ENG)).

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

Spindle motor type		SJ-V11-01T	SJ-V11-09T
Compatible drive unit type MDS-DM-SPV2F/SPV3F-		16080	16080
Output capacity [kW]	Continuous rating	3.7	5.5
	Short time rating	5.5 (30-minute rating)	7.5 (30-minute rating)
	Standard output during acceleration/deceleration	5.5	7.5
	Actual acceleration/ deceleration output (Note 3)	6.6	9
Power facility capacity [kVA]		9.9	13.4
Base rotation speed [r/min]		750	750
Maximum rotation speed [r/min]		6000	6000
Frame No.		B112	A160
Continuous rated torque [N•m]		47.1	70.0
GD^2 [kg•m^2]		0.12	0.23
Inertia [kg•m^2]		0.03	0.0575
Tolerable radial load [N]		1960	2940
Cooling fan	Input voltage	3-phase 200V	
	Maximum power consumption	40W	63W
Environment	Ambient temperature	Operation: 0 to 40°C(with no freezing), Storage: -20°Cto 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.
Total length (excluding shaft) [mm]		490	469.5
Flange fitting diameter [mm]		Φ180	Φ230
Shaft diameter [mm]		Φ48	Φ48
Mass [kg]		70	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".

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1500273(ENG)).

< SJ-VL Series (Low-inertia) >

Spindle motor type		SJ-VL11-05FZT-S01	SJ-VL11-10FZT	SJ-VL11-10FZT	SJ-VL11-07ZT	SJ-VL11-07ZT
Compatible drive unit type MDS-DM-SPV2F/SPV3F-		16080	16080	16080	16080	16080
Output capacity [kW]	Continuous rating	1.5	2.2	3.7	5.5	7.5
	Short time rating	3 (10-minute rating)	3.7 (15-minute rating)	5.5 (15-minute rating)	7.5 (30-minute rating)	11 (15-minute rating)
	Standard output during acceleration/deceleration	11	11	11	11	11
	Actual acceleration/ deceleration output (Note 3)	13.2	13.2	13.2	13.2	13.2
Power facility capacity [kVA]		5.5	6.7	9.9	13.4	19.6
Base rotation speed [r/min]		5000	1700	3000 (10-minute rating: 2500)	1500	2200
Maximum rotation speed [r/min]		15000	15000	15000	12000	12000
Frame No.		B71	D90	D90	B112	B112
Continuous rated torque [N•m]		2.8	12.4	11.8	35	32.6
GD^2 [kg•m^2]		0.0096	0.021	0.021	0.072	0.072
Inertia [kg•m^2]		0.0024	0.00525	0.00525	0.018	0.018
Tolerable radial load [N]		98	245	245	980	980
Cooling fan	Input voltage	Single-phase 200V	Single-phase 200V	Single-phase 200V	3-phase 200V	3-phase 200V
	Maximum power consumption	14W	41W	41W	70W	70W
Environment	Ambient temperature	Operation: 0 to 40°C(with no freezing), Storage: -20°Cto 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.	174 SQ.	204 SQ.	204 SQ.
Total length (excluding shaft) [mm]		335	441	441	490	490
Flange fitting diameter [mm]		Φ110	Φ150	Φ150	Φ180	Φ180
Shaft diameter [mm]		Φ22	Φ28	Φ28	Φ32	φ32
Mass [kg]		20	40	40	70	70
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.

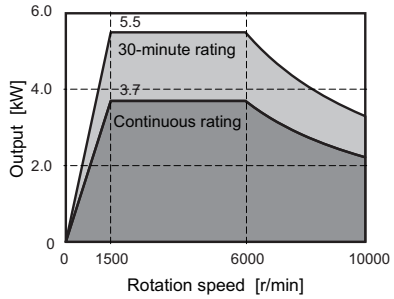
(Note 3) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1500273(ENG)).

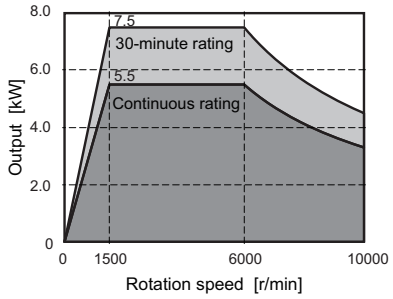
2-2-2 Output characteristics

< SJ-D Series (Normal specifications) >

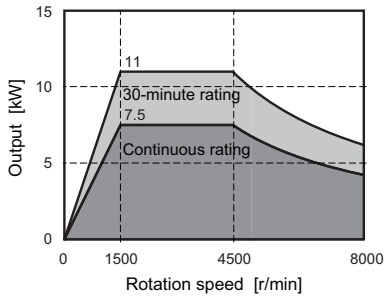
[SJ-D5.5/100-01]



[SJ-D7.5/100-01]

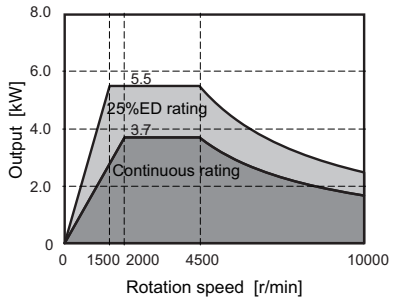


[SJ-D11/80-01]

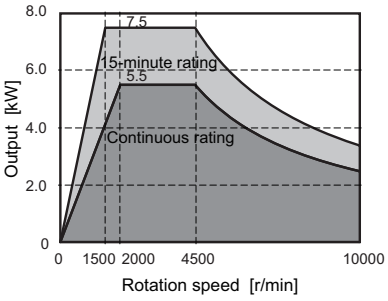


< SJ-DJ Series (Compact & lightweight specifications) >

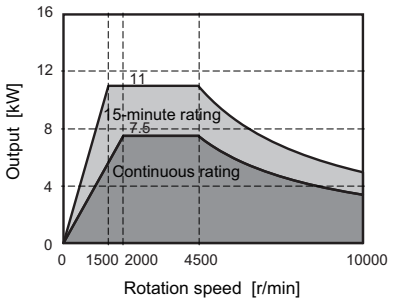
[SJ-DJ5.5/100-01]



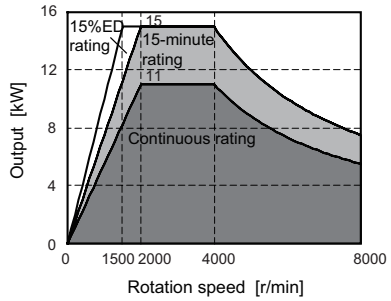
[SJ-DJ7.5/100-01]



[SJ-DJ11/100-01]



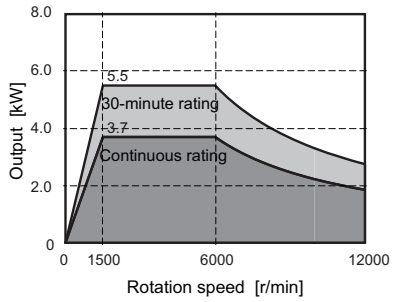
[SJ-DJ15/80-01]



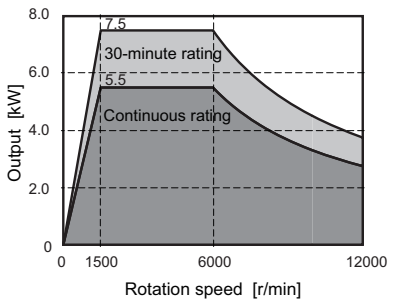
(Note) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

< SJ-V Series (Normal specifications) >

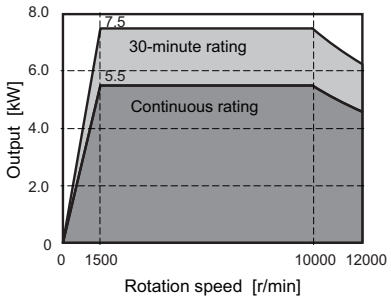
[SJ-V5.5-01ZT]



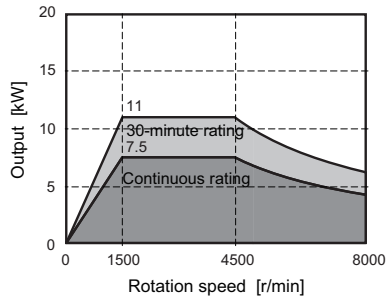
[SJ-V7.5-01ZT]



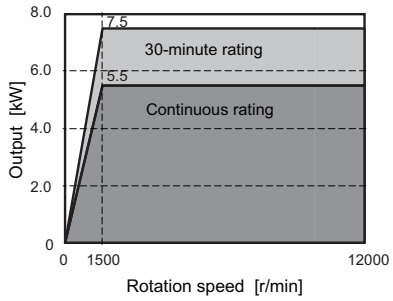
[SJ-V7.5-03ZT]



[SJ-V11-01ZT]



[SJ-V11-06ZT]



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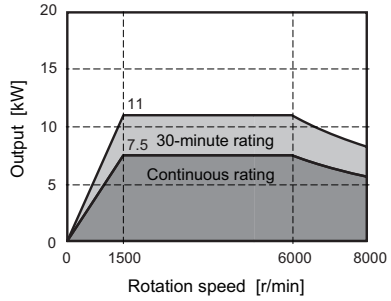
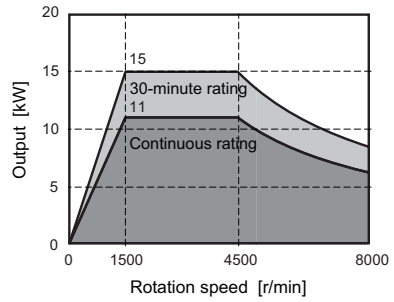
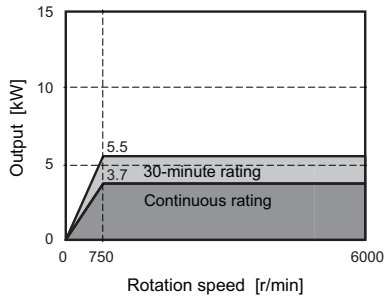


[SJ-V15-01ZT]



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

[SJ-V11-01T]



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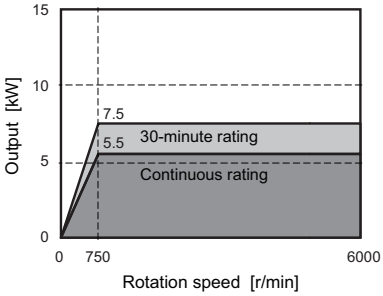
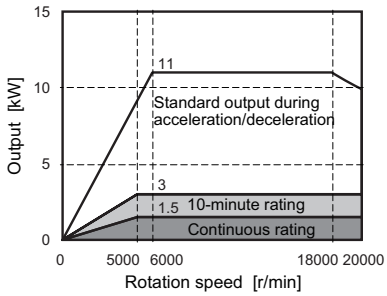


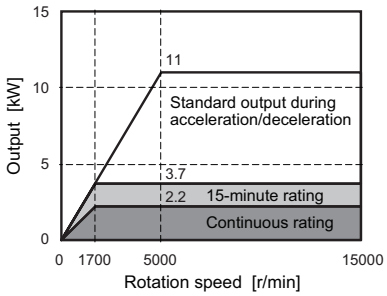
(Note) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

< SJ-VL Series (Low-inertia) >

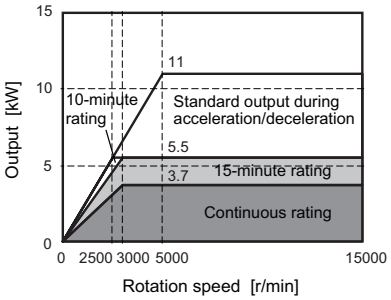
[SJ-VL11-05FZT-S01]



[SJ-VL11-10FZT]



[SJ-VL11-10FZT]



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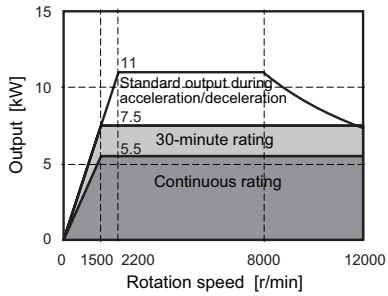
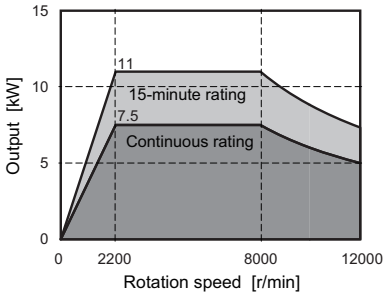


[SJ-VL11-07ZT]



(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 Drive unit

2-3-1 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°Cto 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)

2-3-2 Multi axis drive unit

(1) 3-axis integrated servo drive unit

		3-axis integrated servo drive unit MDS-DM-V3 Series	
Servo drive unit type MDS-DM-V3-		202020	404040
Nominal maximum current (peak) [A]		20/20/20	40/40/40
Output	Rated voltage [V]	AC155	
	Rated current [A]	6.4/6.4/6.4	11/11/11
Input	Rated voltage [V]	DC270 to 311	
	Rated current [A]	21	21
Control power	Voltage [V]	200AC (50Hz) / 200 to 230AC (60Hz) Tolerable fluctuation between +10% and -15%	
	Frequency [Hz]	50/60 Tolerable fluctuation between +3% and -3%	
	Maximum current [A]	0.2	
	Maximum rush current [A]	30	
	Maximum rush conductivity time [ms]	6	
Earth leakage current [mA]		1 (Max. 2)	
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 [over all]	
Cooling method		Forced air cooling	
Mass [kg]		3.8	
Heat radiated at rated output [W]		89	159
Noise		Less than 55dB	
Unit outline dimension drawing		A0	

(2) Multi axis integrated drive unit

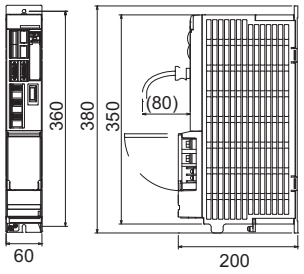
		Multi axis integrated drive unit MDS-DM-SPV2/SPV3 Series						
Drive unit type MDS-DM-		SPV2F-			SPV3F-			
		10080	16080	20080	10080	16080	20080	200120
Nominal maximum current (at peak of spindle section) [A]		100	160	200	100	160	200	200
Nominal maximum current (at peak of servo section) [A]		80×2			80×3			120×3
Power facility capacity [kVA]		17.1	21.7	27.0	28.2	14.7	19.3	24.6
Output	Rated voltage [V]	AC155						
	Rated current (spindle axis) [A]	26	37	67	26	37	67	67
	Rated current (servo) [A]	15.8×2			15.8×3			28×3
Input	Rated voltage [V]	AC200 (50Hz) /AC200 to 230 (60Hz) Tolerable fluctuation between +10% and -15%						
	Rated current [A]	33	43	55	38	48	60	65
Control power	Voltage [V]	DC24±10%						
	Maximum current [A]	4.0						
	Maximum rush current [A]	10						
	Maximum rush conductivity time [ms]	100						
Earth leakage current [mA]		9/ Max.21 (Details: Spindle 6/Max.15, Servo per one axis 1/Max.2)						
Control method		Sine wave PWM control method						
Braking		Regenerative braking and dynamic brakes (only regenerative braking for spindle)						
	Dynamic brakes	Built-in						
External analog output		0 to +5V,2ch (data for various adjustments)						
Degree of protection		IP20 [over all] (IP00 [Terminal block TE1])						
Cooling method		Forced air cooling						
Mass [kg]		14.5			15			
Heat radiated at rated output [W]		630	700	895	730	800	990	1260
Noise		Less than 55dB						
Unit outline dimension drawing		F0						

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1500273(ENG)).

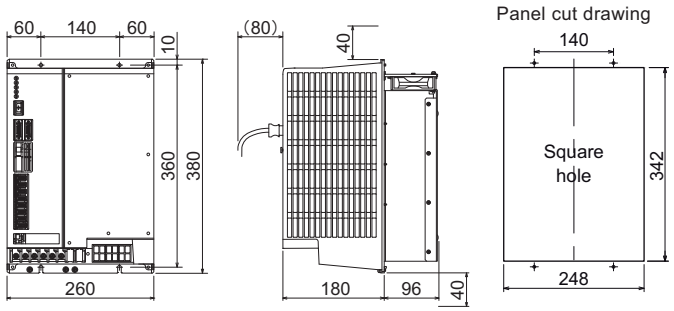
2-3-3 Unit outline dimension drawing

Unit:[mm]

A0



F0

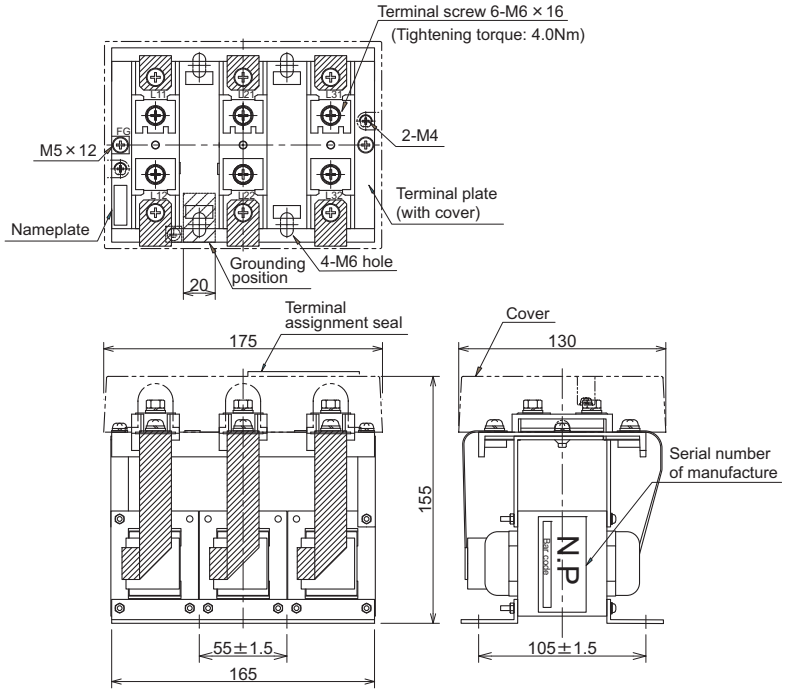


2-3-4 AC reactor

		AC reactor
AC reactor model D-AL-		**18.5K**
Compatible unit type MDS-DM-SPV2F/SPV3F-		10080, 16080, 20080
Rated capacity [kW]		18.5
Rated voltage [V]		200 to 240AC Tolerable fluctuation : between +10% and -15%
Rated current [A]		66
Frequency [Hz]		50/60 Tolerable fluctuation between +3% and -3%
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]		5.3

Outline dimension drawing

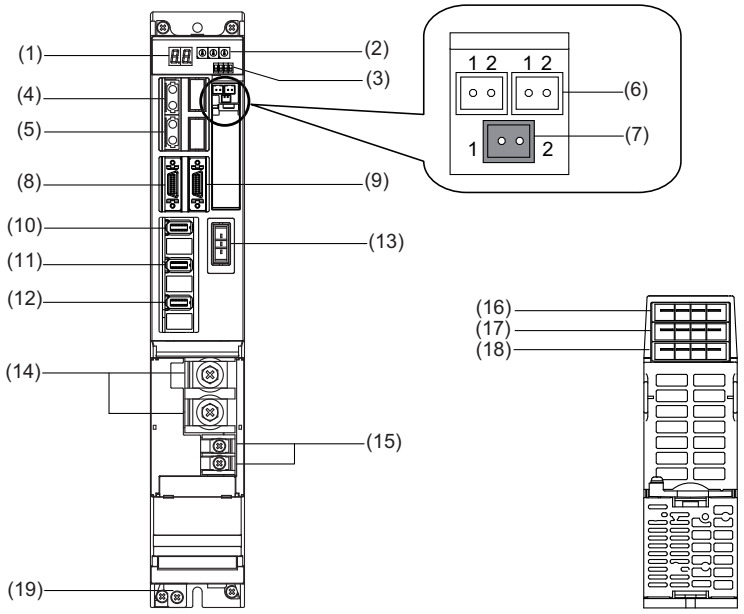
Unit:[mm]



D-AL-18.5K

2-3-5 Explanation of each part

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



MDS-DM-V3 Bottom view

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

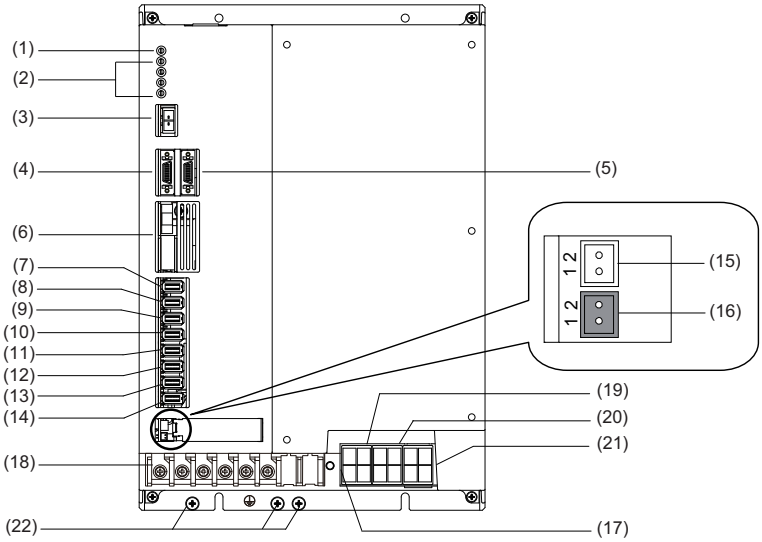
<Each part name>

		Name		Description
(1)	Control circuit	LED	---	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	---	For connecting converged battery unit Both BTA and BTB are the same function, and they are internally connected each other.
(7)		BT1	---	For connecting battery built-in drive unit ER6V-C119B
(8)		CN9	---	Maintenance connector (usually not used)
(9)		CN4	---	Power supply communication connector
(10)		CN2L	---	Motor side encoder connection connector (L-axis) 5V power supply capacity:0.35A
(11)		CN2M	---	Motor side encoder connection connector (M-axis) 5V power supply capacity:0.35A
(12)		CN2S	---	Motor side encoder connection connector (S-axis) 5V power supply capacity:0.35A
(13)		CN20	---	Motor brake/dynamic brake control connector (Key way: X type)
(14)	Main circuit	TE2	L+ L-	Converter voltage input terminal (DC input)
(15)		TE3	L11 L21	Control power input terminal (single-phase AC input)
(16)		TE1	SU, SV, SW, ⏚	Motor power supply output connector (3-phase AC output)
(17)			MU, MV, MW, ⏚	
(18)			LU, LV, LW, ⏚	
(19)		PE	⏚	Grounding terminal Note that TE1 connector is used for the motor grounding.

<Screw size>

	3-axis servo drive unit MDS-DM-V3-	
Type	202020	404040
Unit width (mm)	60	
(14) TE2	M6x 16	
(15) TE3	M4x 12	
(19) ⏚	M4x 12	

(2) Explanation of each multi axis integrated servo drive unit part



MDS-DM-SPV2F/SPV3F

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	POWER	---	24V power supply status indication LED
(2)		SP1, SP2,SV1,SV2	---	Unit status indication LED
(3)		CN22	---	Control power input terminal (DC24V) input connector
(4)		CN9A	---	Connector for DIO/analog output (spindle)
(5)		CN9B	---	Connector for DIO/analog output (servo)
(6)		OPT1A	---	NC optical communication connector
(7)		CN2SP	---	Spindle motor side encoder connection connector 5V power supply capacity:0.35A
(8)		CN3SP	---	Spindle side encoder connection connector 5V power supply capacity:0.35A
(9)		CN2L	---	Servo motor side encoder connection connector (L-axis) 5V power supply capacity:0.35A
(10)		CN2M	---	Servo motor side encoder connection connector (M-axis) 5V power supply capacity:0.35A
(11)		CN2S	---	Servo motor side encoder connection connector (S-axis) 5V power supply capacity:0.35A
(12)		CN3L	---	MDS-EX-SR connection connector (L axis:LA)
(13)		CN3M	---	MDS-EX-SR connection connector (M axis:MA)
(14)		CN3S	---	MDS-EX-SR connection connector (S axis:SA)
(15)		BTA	---	For connecting converged battery unit
(16)		BT1	---	For connecting battery built-in drive unit ER6V-C119B
(17)		CHARGE LAMP	---	Converter voltage output charge-discharge status indication LED
(18)	Main circuit	TE1	L1, L2, L3	Power supply input terminal (3-phase AC output)
			U, V, W	Motor power output terminal (spindle, 3-phase AC output)
			P+, N-	DC output for unit stopped caused by power failure *Do not wiring during unused state.
(19)		CN31L	U, V, W, ⏚	Motor power supply output connector (L-axis, 3-phase AC output)
(20)		CN31M	U, V, W, ⏚	Motor power supply output connector (M-axis, 3-phase AC output)
(21)		CN31S	U, V, W, ⏚	Motor power supply output connector (S-axis, 3-phase AC output)
(22)		PE	⏚	Grounding terminal (also including grounding of the spindle motor)

<Screw size>

Type	Multi axis integrated drive unit MDS-DM-						
	SPV3F-				SPV2F-		
	10080	16080	20080	200120	10080	16080	20080
Unit width (mm)	260						
(18)TE1	M5 x 12						
(22) ⏚	M5 x 8						

3

Function Specifications

Function specifications list

<Power supply specification>

Item		MDS-D-CV	MDS-DH-CV	MDS-DM-SPV built-in converter	MDS-D-SVJ3NA MDS-D-SVJ3 built-in converter	MDS-D-SPJ3NA MDS-D-SPJ3 built-in converter
1 Base control functions	1-14 Power regeneration control	●	●	●	-	-
	1-15 Resistor regeneration control	-	-	-	●	●
4 Protection function	4-6 Fan stop detection	●	●	●	●	●
	4-7 Open-phase detection	●	●	●	-	-
	4-8 Contactor weld detection	●	●	●	●	●
5 Sequence function	5-1 Contactor control function	●	●	●	●	●
	5-3 External emergency stop function	●	●	●	●	●
	5-5 High-speed READY ON sequence	●	●	●	-	-
6 Diagnosis function	6-7 Power supply voltage display function	●	●	-	-	-

<Servo specification>

Item		MDS-D-V1/V2	MDS-DH-V1/V2	MDS-DM-V3	MDS-DM-SPV2F/3F MDS-DM-SPV2/3	MDS-D-SVJ3NA MDS-D-SVJ3
1 Base control functions	1-1 Full closed loop control	●	●	-	● (Note2)	●
	1-2 Position command synchronous control	●	●	●	●	●
	1-3 Speed command synchronous control	●	●	-	-	-
	1-4 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)	●	●	● (Only for 1-axis)	● (Only for 1-axis)	-
	2-8 Dual feedback control	●	●	-	● (Note2)	●
	2-9 HAS 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	●	●	●	●	●
	3-8 Lost motion compensation type 4	●	●	-	-	-
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 Safety observation function	●	●	●	●	●
	4-6 Fan stop detection	●	●	●	●	●
5 Sequence function	5-2 Motor brake control function (Note 1)	●	●	●	●	●
	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	●	●	●	●	●
	6-4 Motor temperature display function (Only for linear or direct-drive motor)	●	●	-	-	●

(Note 1) For the multiaxis drive unit, a control by each axis is not available.
It is required to turn the servo of all axes OFF in the drive unit in order to enable a motor brake output.

(Note 2) For the drive unit MDS-DM-SPV2/3, this function is not available.

<Spindle specifications>

Item		MDS-D-SP	MDS-DH-SP	MDS-D-SP2	MDS-DM-SPV2F/3F MDS-DM-SPV2/3	MDS-D-SPJ3NA MDS-D-SPJ3
1 Base control functions	1-5 Spindle's continuous position loop control	●	●	●	●	●
	1-6 Coil changeover control	●	●	-	●	-
	1-7 Gear changeover control	●	●	●	●	●
	1-8 Orientation control	●	●	●	●	●
	1-9 Indexing control	●	●	●	●	●
	1-10 Synchronous tapping control	●	●	●	●	●
	1-11 Spindle synchronous control	●	●	●	●	●
	1-12 Spindle/C axis control	●	●	●	●	●
	1-13 Proximity switch orientation control	●	●	-	●	●
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 Control loop gain changeover	●	●	●	●	●
	2-11 Spindle output stabilizing control	●	●	●	●	●
	2-12 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
	3-4 Overshooting compensation	●	●	●	●	●
	3-6 Lost motion compensation type 2	●	●	●	●	●
	3-9 Spindle motor temperature compensation function	●	●	●	●	-
4 Protection function	4-1 Deceleration control at emergency stop	●	●	●	●	●
	4-3 Earth fault detection	●	●	●	●	●
	4-5 Safety observation function	●	●	●	●	●
	4-6 Fan stop detection	●	●	●	●	●
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)
	6-6 Open loop control function	●	●	●	●	●

(Note) The motor output effective value cannot be displayed.

3-1 Base control functions

3-1-1 Full closed loop control

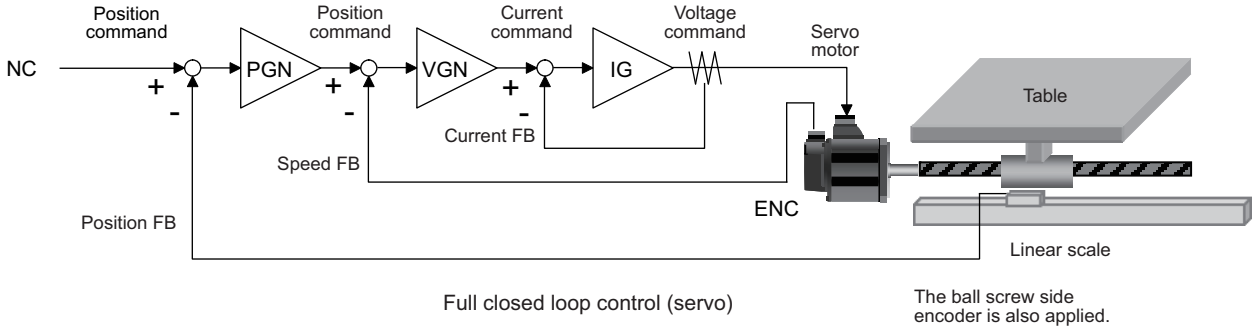
The servo control is all closed loop control using the encoder's feedback. "Full closed loop control" is the system that directly detects the machine position using a linear scale, whereas the general "semi-closed loop" is the one that detects the motor position.

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

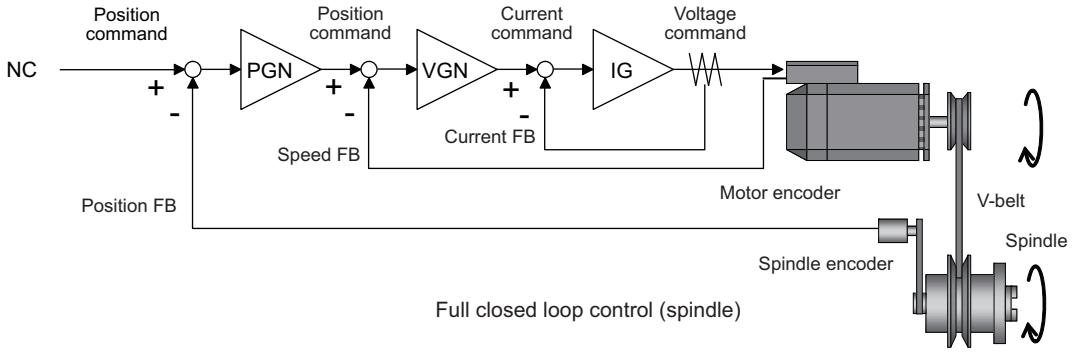
(2) Ball screw pitch error

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)

The ball screw side encoder is also applied.



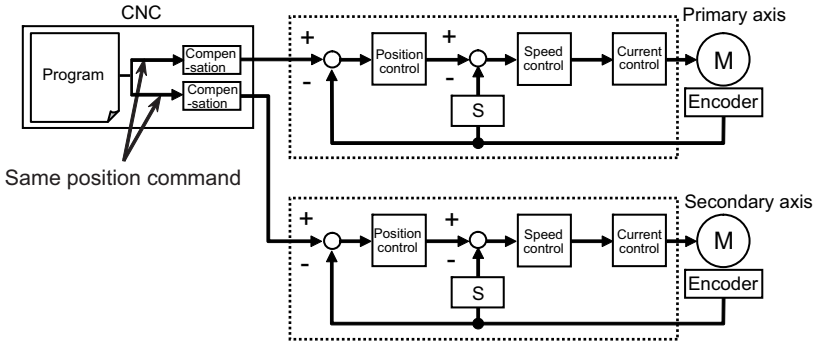
Full closed loop control (spindle)

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.

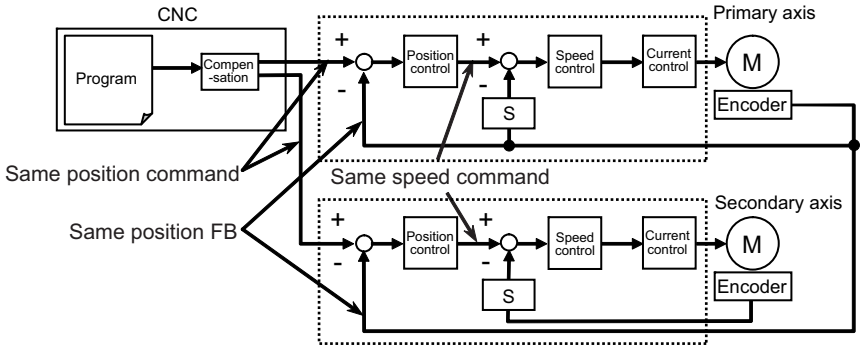


3-1-3 Speed command synchronous control

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) 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

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).

2. Disturbance observer cannot be used during the speed command synchronous control.

POINT

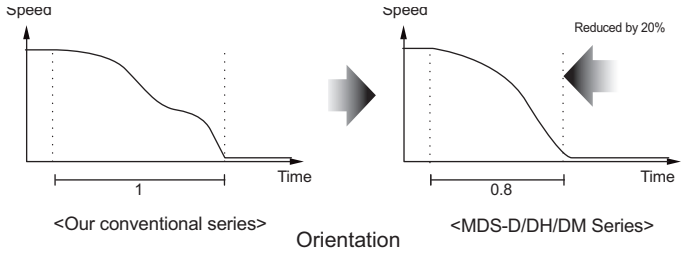
When using a motor with brake for rigid synchronization control axes, the brake circuits of the two motors can be connected to the motor brake control connector.

3-1-4 Distance-coded reference position control

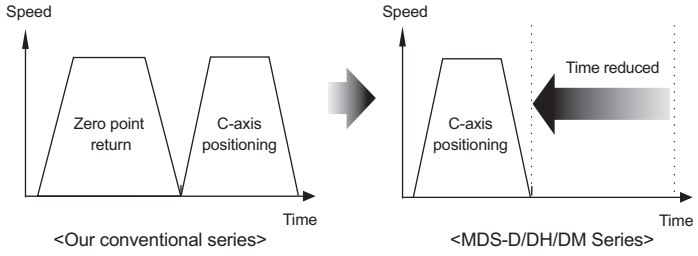
This is the function to establish the reference point from axis movements of the reference points using a scale with distance-coded reference mark.
Since it is not necessary to move the axis to the reference point, the axis movement amount to establish the reference point can be reduced.
No dog is used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

3-1-5 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

3-1-6 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.

3-1-7 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.

3-1-8 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.

3-1-9 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.

3-1-10 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.

3-1-11 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.

3-1-12 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.

3-1-13 Proximity switch orientation control

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

3-1-14 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.

3-1-15 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.

3-2 Servo/Spindle control functions

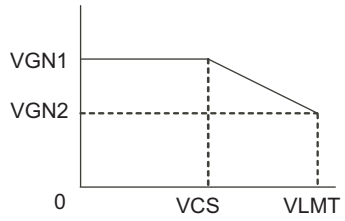
3-2-1 Torque limit function

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.

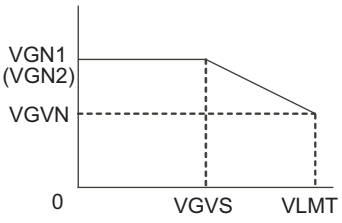


(VLMT=Max. speed x 1.15)

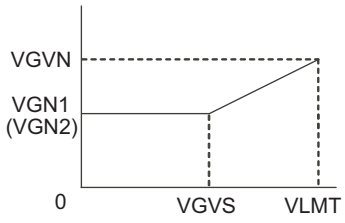
VGN1:SV005
VGN2:SV006
VCS:SV029
VLMT: Servo motor maximum speed x 1.15

< 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.



(VLMT=Max. speed x 1.15)

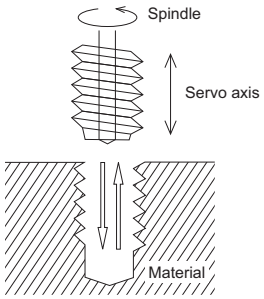


(VLMT=Max. speed x 1.15)

VGN1:SP005
VGN2:SP008
VGVN:SP073
VGVS:SP074
VLMT: Spindle maximum speed x 1.15

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

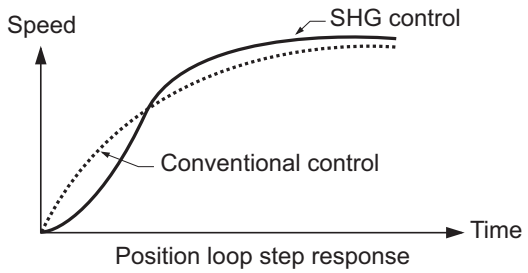
This function is used under full-closed loop control. Normally, machine-end position tracking delays compared with the motor-end position.
Under full-closed position loop control, machine-end position is used for position feedback. Therefore, the motor-end position tends to advance too much, which may 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.

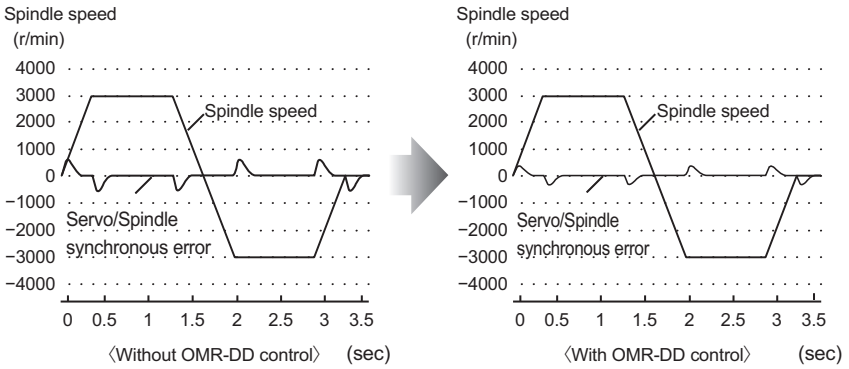


Position loop step response

3-2-7 High-speed synchronous tapping control (OMR-DD control)

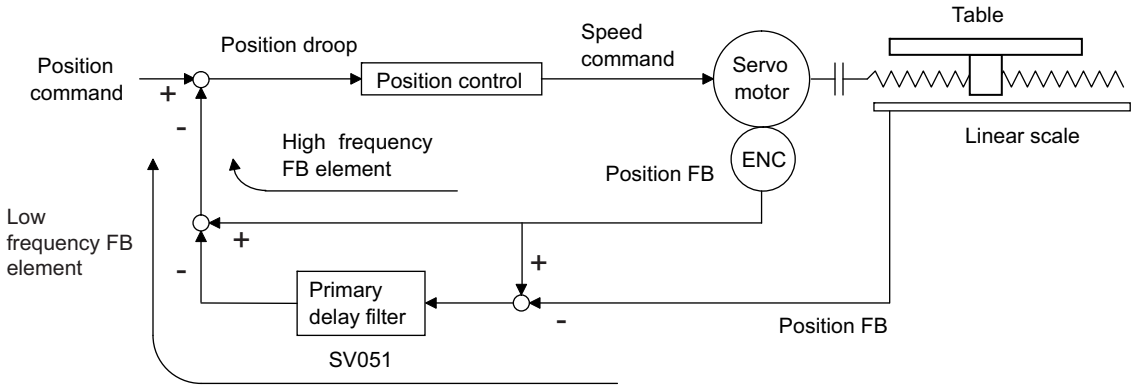
Servo drive unit detects the spindle position, and compensates the synchronization errors. This control enables more accurate tapping than the previous.

(Note) A spindle drive unit that controls the high-speed synchronous tapping (OMR-DD control) has to be connected on the farther side from the NC than the servo drive unit that is subject to the synchronous tapping control.



3-2-8 Dual feedback control

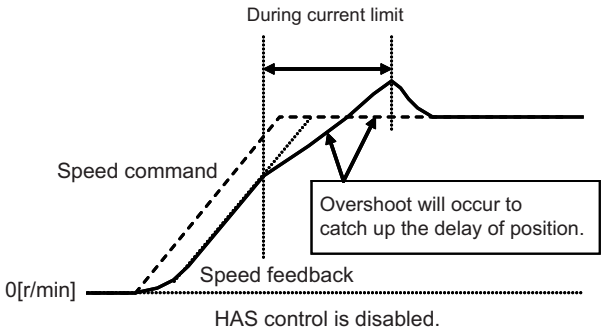
This function is used under full-closed loop control.
When a linear scale is used, the machine-end position, such as a table, is directly detected, which may render the position loop control unstable.
With this control, however, high-frequency components are eliminated from the machine-end feedback signals,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

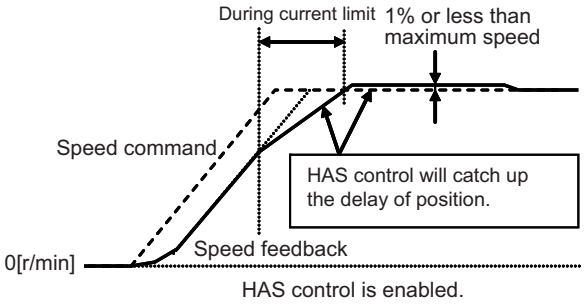


Dual feedback control

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 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.

3-2-11 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.

3-2-12 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

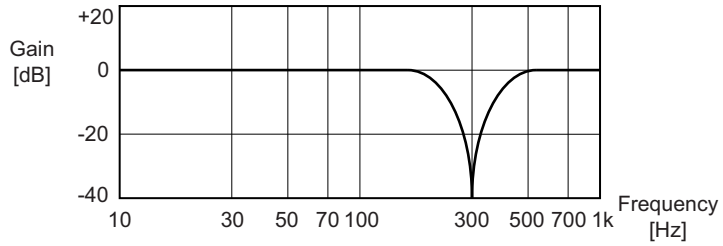
The load inertia becomes much smaller than usual if the motor position enters the machine backlash when the motor is stopped.
Because this means that an extremely large VGN1 is set for the load inertia, vibration may occur.
Jitter compensation can suppress the vibration that occurs at the motor stop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

3-3-2 Notch filter

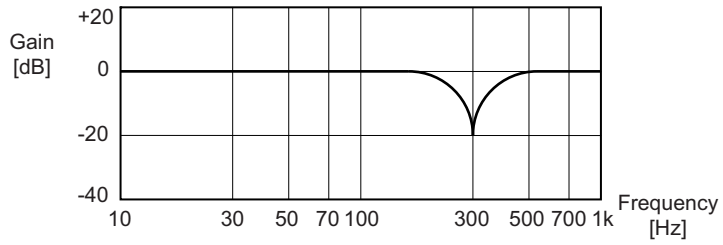
This filter can damp vibrations of servo torque commands at a specified frequency.
Machine vibrations can be suppressed by adjusting the notch filter frequency to the machine's resonance frequency.
Filter depth adjustment is also available that allows stable control even when the filter is set to an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

<Specifications>

Notch filter	Frequency	Depth compensation
Notch filter 1	50Hz to 2250Hz	Enabled
Notch filter 2	50Hz to 2250Hz	Enabled
Notch filter 3	Fixed at 1125Hz	Disabled
Notch filter 4	50Hz to 2250Hz	Enabled
Notch filter 5	50Hz to 2250Hz	Enabled



Example of filter characteristic set to 300Hz



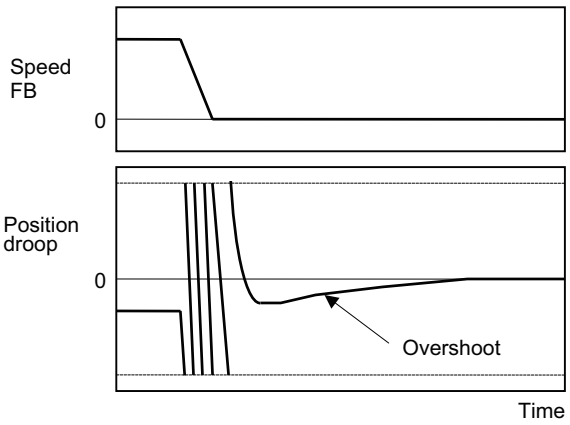
For shallow setting by additionally using the depth compensation at 300Hz

3-3-3 Adaptive tracking-type notch filter

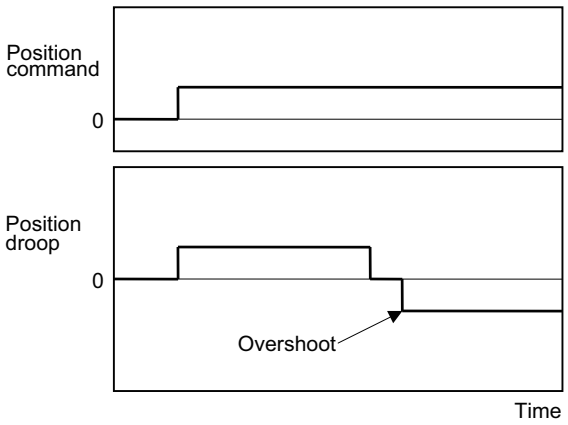
Machine's specific resonance frequency tends to change due to aged deterioration or according to machine's operation conditions. Therefore, the frequency may be deviated from the filter frequency set at the initial adjustment. With adaptive tracking-type notch filter, resonance point fluctuation due 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.



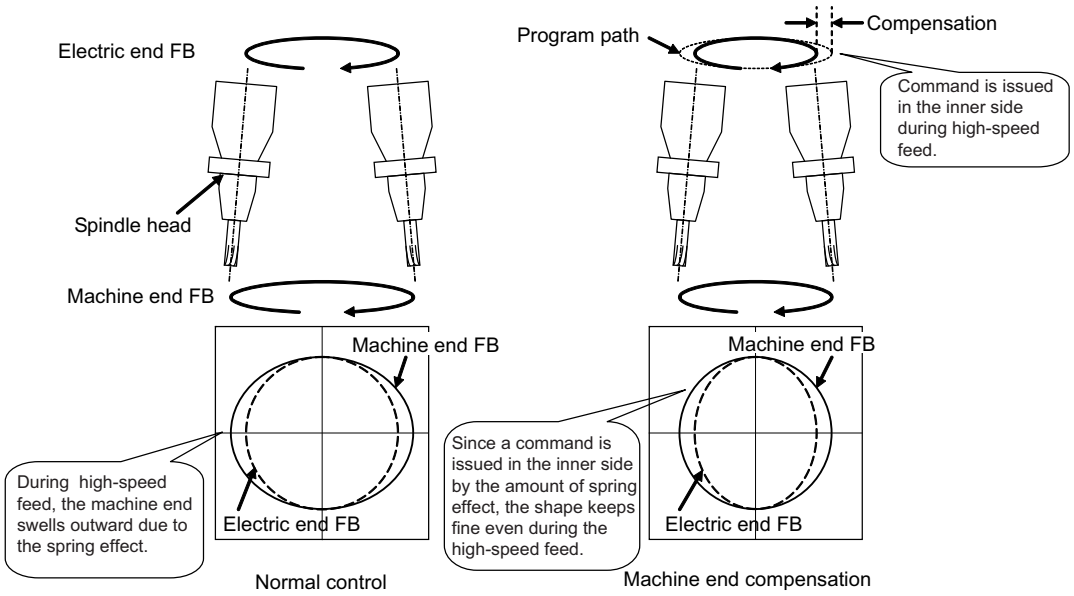
[1] Overshooting during rapid traverse settling



[2] Overshooting during pulse feed

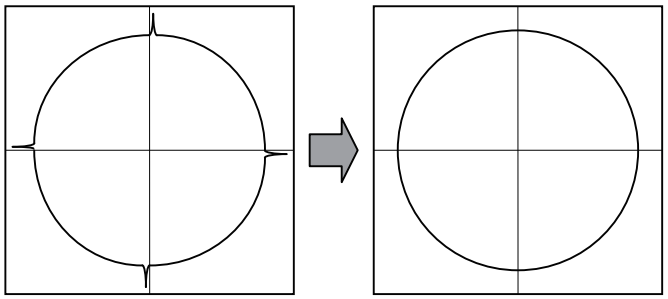
3-3-5 Machine end compensation control

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

Servo motor always drives the machine opposing to the frictional force, and the torque which is required to oppose the friction during the axis movement is outputted by I control (Integral 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.
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.
With the this lost motion compensation function improves the accuracy worsened by the stick motion.



No compensation　　With compensation

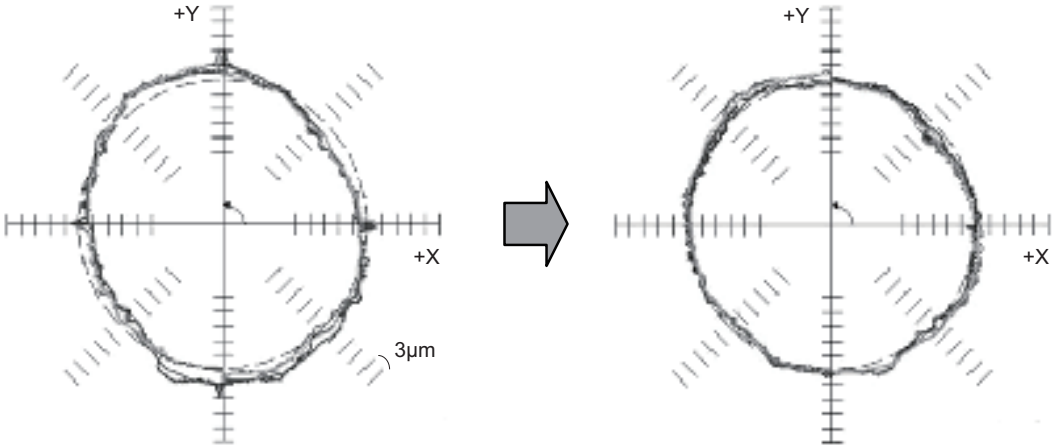
3-3-7 Lost motion compensation type 3

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.

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

Conventional control can't perform enough compensation.



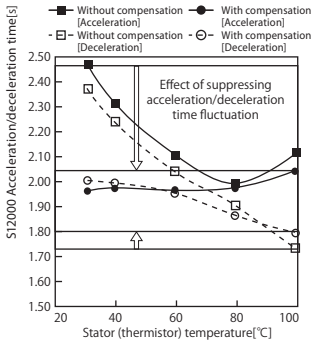
Conventional compensation control　　Lost motion compensation control type 3

3-3-8 Lost motion compensation type 4

When the difference between static and dynamic friction is large, the friction torque changes sharply at the inversion of the travel direction. When the lost motion type 4 is used together with the type 2 or type 3, the acute change of the friction torque is compensated so that the path accuracy at the travel direction inversion can be enhanced.

3-3-9 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.



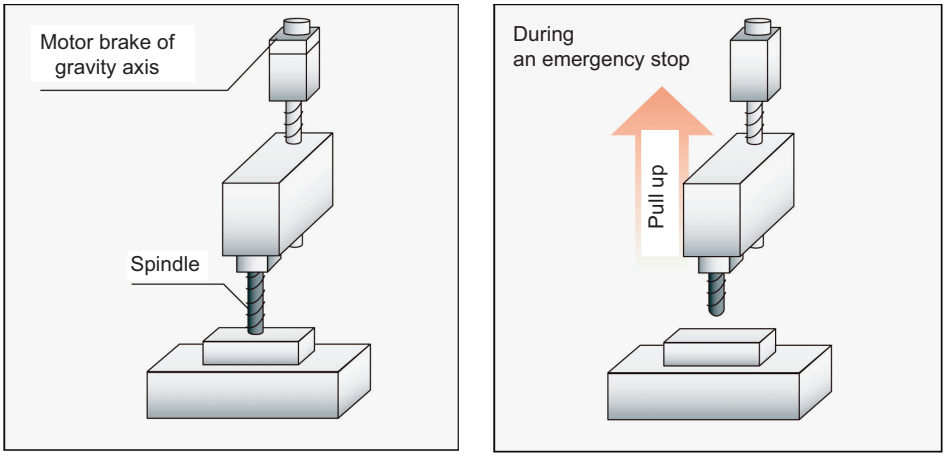
3-4 Protection function

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.



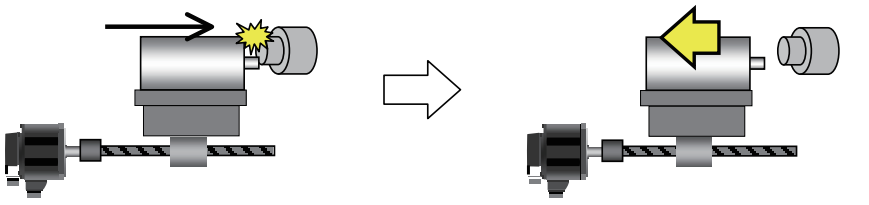
3-4-3 Earth fault detection

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

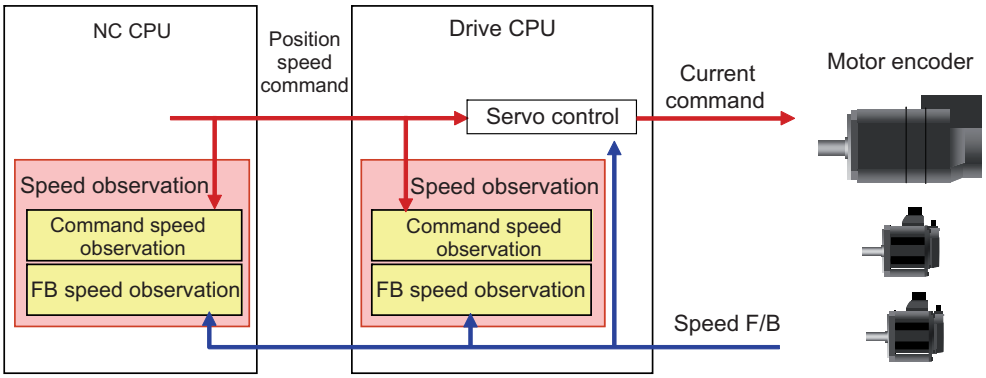


(a) A collision of machine is detected.

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

3-4-5 Safety observation function

This function is aimed at allowing a safety access to the machine's working part by opening the protection door, etc. without shutting the power for saving the setup time.
Both the NC control system and drive system (servo and spindle drive units) doubly observe the axis feed rate so that it will not exceed the safety speed. If it exceeds the set safety speed, emergency stop occurs and the power is shut OFF.



3-4-6 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.

3-4-7 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.

3-4-8 Contactor weld detection

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

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.

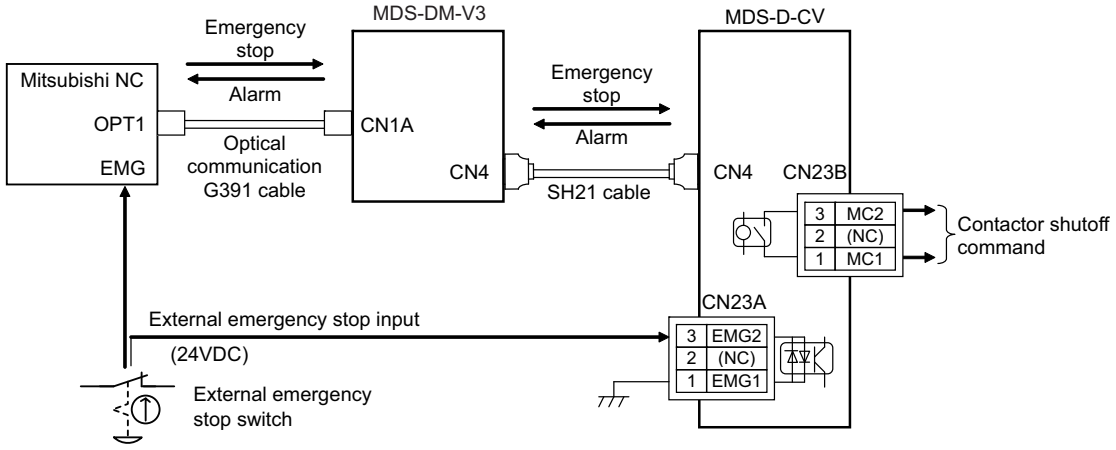
3-5-2 Motor brake control function

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.
When a multiaxis drive unit is connected, all the axes are simultaneously controlled.

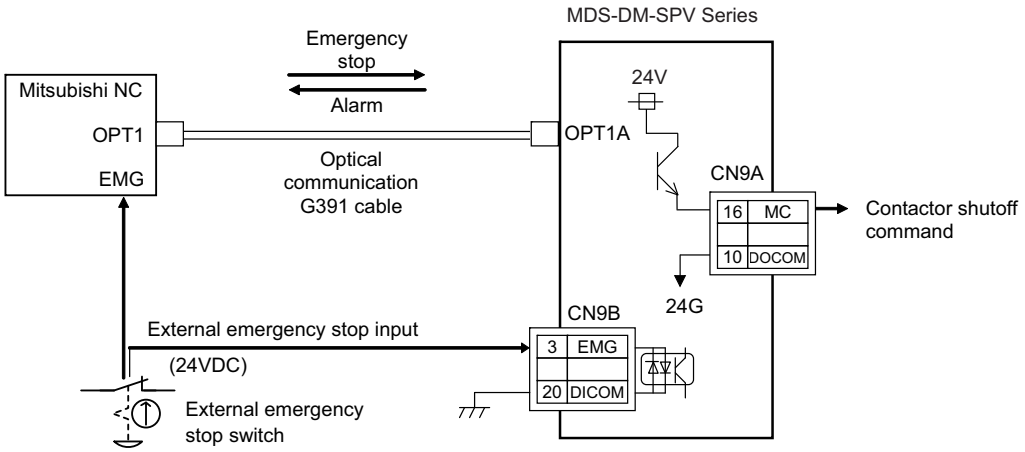
3-5-3 External emergency stop function

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.

<MDS-DM-V3>



<MDS-DM-SPV Series>



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 protection 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.

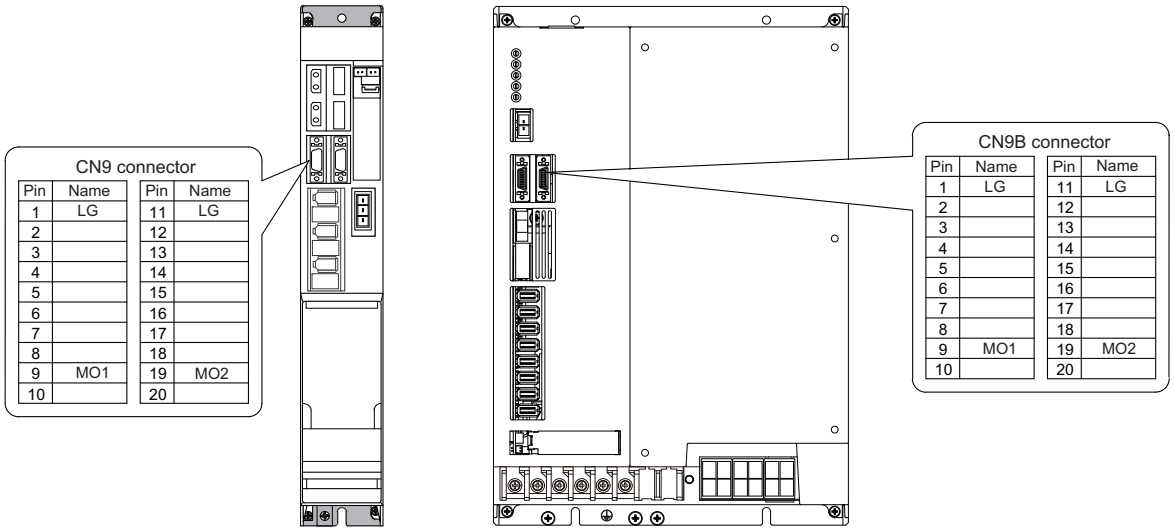
3-6 Diagnosis function

3-6-1 Monitor output function

<Servo drive unit>

Drive unit has a function to D/A output the various control data. The servo adjustment data required for setting the servo parameters to match the machine can be D/A output. Measure using a high-speed waveform recorder, oscilloscope, etc.

(1) D/A output specifications



CN9 connector

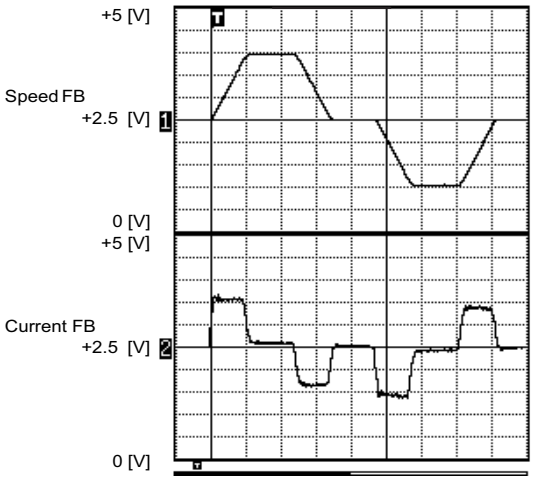
Pin	Name	Pin	Name
1	LG	11	LG
2		12	
3		13	
4		14	
5		15	
6		16	
7		17	
8		18	
9	MO1	19	MO2
10		20	

CN9B connector

Pin	Name	Pin	Name
1	LG	11	LG
2		12	
3		13	
4		14	
5		15	
6		16	
7		17	
8		18	
9	MO1	19	MO2
10		20	

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,CN9B connector)	MO1 = Pin 9, MO2 = Pin 19, LG = Pin 1,11
Others	The D/A output for the 2nd axis or the 3rd axis is also 2ch. When using the 2nd axis or the 3rd axis, set "-1" for the output data (SV061, SV062) 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

(2) Output data settings
(Standard output)

【#2261】 SV061 DA1NO D/A output ch1 data No.

Input the data number you wish to output to the D/A output channel 1.
When using the 2-axis drive unit, set "-1" to the axis that the data will not be output.

---Setting range---
-1 to 127

【#2262】 SV062 DA2NO D/A output ch2 data No.

Input the data number you wish to output to the D/A output channel 2.
When using the 2-axis drive unit, set "-1" to the axis that the data will not be output.

---Setting range---
-1 to 127

No.	Output data	Standard output unit		Output cycle
		Linear axis	Rotary axis	
-1	D/A output not selected	For 2nd axis or 3rd axis drive unit.Set the parameters to the other axes in the drive unit that is not D/A output.		
0	Commanded rotation speed	1000(r/min)/V		0.8ms
1	Motor rotation speed	1000(r/min)/V		0.8ms
2	Torque command	Motor stall rated ratio 100%/V		0.8ms
3	Torque feedback	Motor stall rated ratio 100%/V		0.8ms
6	Effective current command	100%/V		0.8ms
7	Effective current feedback	100%/V		0.8ms
8	Machine vibration frequency	500Hz/V		0.8ms
9	HAS control droop cancel amount	1mm/V	1°/V	0.8ms
30	Collision detection estimated torque	100%/V		0.8ms
31	Collision detection disturbance estimated torque	100%/V		0.8ms
32	Estimated load inertia ratio	100%/V		0.8ms
35	Disturbance observer estimated disturbance torque	100%/V		0.8ms
50	Position droop	1μm/V	1/1000°/V	0.8ms
51	Position command	1μm/V	1/1000°/V	0.8ms
52	Position feedback	1μm/V	1/1000°/V	0.8ms
53	Position FΔT	1μm/s/V	1/1000°/s/V	0.8ms
54	Deviation from ideal position (considering servo tracking delay)	1μm/V	1/1000°/V	0.8ms
60	Position droop	1mm/V	1°/V	0.8ms
61	Position command	1mm/V	1°/V	0.8ms
62	Position feedback	1mm/V	1°/V	0.8ms
63	Position FΔT	1mm/s/V	1°/s/V	0.8ms
64	Deviation from ideal position (considering servo tracking delay)	1mm/V	1°/V	0.8ms
70	Position droop	1m/V	1000°/V	0.8ms
71	Position command	1m/V	1000°/V	0.8ms
72	Position feedback	1m/V	1000°/V	0.8ms
73	Position FΔT	1m/s/V	1000°/s/V	0.8ms
74	Deviation from ideal position (considering servo tracking delay)	1m/V	1000°/V	0.8ms
126	Saw tooth wave	0V to 5V		0.8ms
127	2.5V test data	2.5V		0.8ms

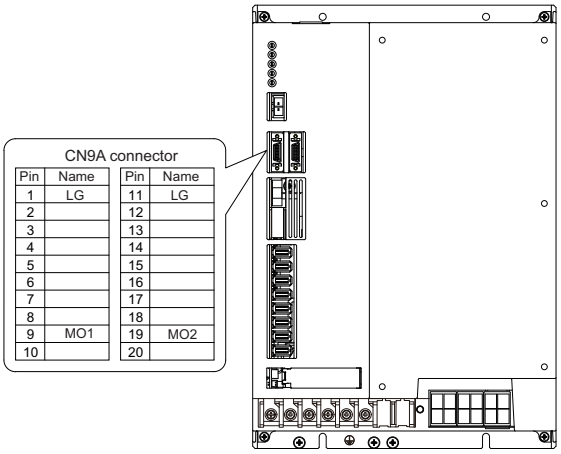
(Servo control signal)

Servo control input (NC to Servo)			Servo control output (Servo to NC)		
No.	Details		No.	Details	
16384	Servo control input 1-0	READY ON command	**16480**	Servo control output 1-0	In READY ON
16385	Servo control input 1-1	Servo ON command	**16481**	Servo control output 1-1	In servo ON
16388	Servo control input 1-4	Position loop gain changeover command	**16484**	Servo control output 1-4	In position loop gain changeover
16390	Servo control input 1-6	Excessive error detection width changeover command	**16486**	Servo control output 1-6	In excessive error detection width changeover
16391	Servo control input 1-7	Alarm reset command	**16487**	Servo control output 1-7	In alarm
16392	Servo control input 1-8	Current limit selection command	**16488**	Servo control output 1-8	In current limit selection
			16492	Servo control output 1-C	In in-position
			16493	Servo control output 1-D	In current limit
			16494	Servo control output 1-E	In absolute position data loss
			16495	Servo control output 1-F	In warning
			16496	Servo control output 2-0	Z phase passed
			16499	Servo control output 2-3	In zero speed
			16503	Servo control output 2-7	In external emergency stop
16409	Servo control input 2-9	Speed monitor command valid	**16505**	Servo control output 2-9	In speed monitor
16410	Servo control input 2-A	In door closed (controller)	**16506**	Servo control output 2-A	In door closed (controller)
16411	Servo control input 2-B	In door closed (all drive units)	**16507**	Servo control output 2-B	In door closed (self drive unit)
16416	Servo control input 3-0	Control axis detachment command	**16512**	Servo control output 3-0	In control axis detachment

< Spindle drive unit >

Drive unit has a function to D/A output each control data. The spindle adjustment data required to set the spindle parameters matching the machine can be D/A output. The data can be measured with a high-speed waveform recorder or oscilloscope, etc.

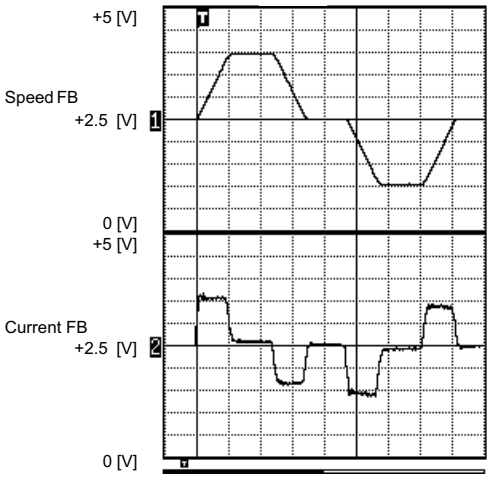
(1) D/A output specifications



MDS-DM-SPV2F/SPV3F

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 (CN9A connector)	MO1 = Pin 9, MO2 = Pin 19, LG = Pin 1,11

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

(2) Output data settings
(Standard output)

【#13125】 SP125 DA1NO D/A output ch1 data No.

Input the desired data number to D/A output channel.

---Setting range---
-32768 to 32767

【#13126】 SP126 DA2NO D/A output ch2 data No.

Input the desired data number to D/A output channel.

---Setting range---
-32768 to 32767

No.	Output data	Output unit for standard setting	Output cycle
-1	D/A output stop	-	
0	Commanded motor rotation speed	1000(r/min)/V	0.8ms(min)
1	Motor rotation speed	1000(r/min)/V	0.8ms(min)
2	Torque current command	Short time rated ratio 100%/V	0.8ms(min)
3	Torque current feedback	Short time rated ratio 100%/V	0.8ms(min)
35	Disturbance observer estimated disturbance torque	Short time rated torque current value ratio 100%/V	0.8ms(min)
50	Position droop	1/1000°/V	0.8ms(min)
51	Position command	1/1000°/V	0.8ms(min)
52	Position feedback	1/1000°/V	0.8ms(min)
53	Position FΔT	1/1000°/s/V	0.8ms(min)
54	Deviation from ideal position (considering spindle tracking delay)	1/1000°/V	0.8ms(min)
60	Position droop	1°/V	0.8ms(min)
61	Position command	1°/V	0.8ms(min)
62	Position feedback	1°/V	0.8ms(min)
63	Position FΔT	1°/s/V	0.8ms(min)
64	Deviation from ideal position (considering spindle tracking delay)	1°/V	0.8ms(min)
70	Position droop	1000°/V	0.8ms(min)
71	Position command	1000°/V	0.8ms(min)
72	Position feedback	1000°/V	0.8ms(min)
73	Position FΔT	1000°/s/V	0.8ms(min)
74	Deviation from ideal position (considering spindle tracking delay)	1000°/V	0.8ms(min)
110	3.0V output load meter (Note)	40%/V, 120%/3V	0.8ms(min)
126	Saw tooth wave	0V to 5V	0.8ms(min)
127	2.5V test data output	2.5V	0.8ms(min)

(Note) Load meter displays "100%(=2.5V)" when the control power turns ON and the NC is starting. After the NC has been run, it displays "0%(=0V%)".

(Special output)

The result of PLG(TS5690) installation accuracy diagnosis is output to D/A output. D/A output magnification:SP127(DA1MPY) and SP128(DA2MPY) is 0.

PLG installation diagnosis function can be enabled during the rotation, when open loop control is enabled:SP018(SPEC2)/bit1=1.

D/A output No.	Details	Description
120	Motor end PLG installation Gap diagnosis	Motor end PLG installation gap is diagnosed. When the gap is good, 2.5V is output. When the gap is excessive, 2.5V+1V is output. When the gap is too small, 2.5V-1V is output.
121	Motor end PLG installation All errors diagnosis	Motor end PLG installation error (including the gap) is diagnosed. When the installation is good, 2.5V is output. When the installation is incorrect, 2.5V+1V is output.
122	Spindle end PLG installation Gap diagnosis	Spindle end PLG installation gap is diagnosed. Diagnostic procedure is the same as that of motor end PLG.
123	Spindle end PLG installation All errors diagnosis	Spindle end PLG installation error (including the gap) is diagnosed. Diagnostic procedure is the same as that of motor end PLG.

(Spindle control signal)

Spindle control input (NC to Spindle)			Spindle control output (Spindle to NC)		
No.	Details		No.	Details	
16384	Spindle control input 1-0	READY ON command	16480	Spindle control output 1-0	In ready ON
16385	Spindle control input 1-1	Servo ON command	16481	Spindle control output 1-1	In servo ON
16391	Spindle control input 1-7	Alarm reset command	16487	Spindle control output 1-7	In alarm
16392	Spindle control input 1-8	Torque limit 1 selection command	16488	Spindle control output 1-8	In torque limit 1 selection
16393	Spindle control input 1-9	Torque limit 2 selection command	16489	Spindle control output 1-9	In torque limit 2 selection
16394	Spindle control input 1-A	Torque limit 3 selection command	16490	Spindle control output 1-A	In torque limit 3 selection
			16492	Spindle control output 1-C	In in-position
			16495	Spindle control output 1-F	In warning
			16496	Spindle control output 2-0	Z phase passed
			16499	Spindle control output 2-3	In zero speed
			16503	Spindle control output 2-7	In external emergency stop
16409	Spindle control input 2-9	Speed monitor command valid	16505	Spindle control output 2-9	In speed monitor
16410	Spindle control input 2-A	In door closed (controller)	16506	Spindle control output 2-A	In door closed (controller)
16411	Spindle control input 2-B	In door closed (all drive units)	16507	Spindle control output 2-B	In door closed (self drive unit)
16432	Spindle control input 4-0	Spindle control mode selection command 1	16528	Spindle control output 4-0	In spindle control mode selection 1
16433	Spindle control input 4-1	Spindle control mode selection command 2	16529	Spindle control output 4-1	In spindle control mode selection 2
16434	Spindle control input 4-2	Spindle control mode selection command 3	16530	Spindle control output 4-2	In spindle control mode selection 3
16436	Spindle control input 4-4	Gear changeover command	16532	Spindle control output 4-4	In gear changeover command
16437	Spindle control input 4-5	Gear selection command 1	16533	Spindle control output 4-5	In gear selection 1
16438	Spindle control input 4-6	Gear selection command 2	16534	Spindle control output 4-6	In gear selection 2
16445	Spindle control input 4-D	L coil selection command	16541	Spindle control output 4-D	In L coil selection
			16545	Spindle control output 5-1	Speed detection
			16550	Spindle control output 5-6	In coil changeover
16458	Spindle control input 5-A	Phase synchronization suppression command	16554	Spindle control output 5-A	In phase synchronization suppression
16459	Spindle control input 5-B	Minimum excitation rate 2 changeover request	16555	Spindle control output 5-B	In minimum excitation rate 2 selection
16460	Spindle control input 5-C	Speed gain set 2 changeover request	16556	Spindle control output 5-C	In speed gain set 2 selection
16461	Spindle control input 5-D	Zero point re-detection request	16557	Spindle control output 5-D	Zero point re-detection complete
16462	Spindle control input 5-E	Spindle holding force up	16558	Spindle control output 5-E	Spindle holding force up completed
			16559	Spindle control output 5-F	In 2nd in-position

(Note 1) Control signal is bit output. Setting the No. of the table above to the data output(SP125, SP126), and when the scale (SP127, SP128) is set to "0", the output is "0V" for bit 0, and "2.5V" for bit 1.

(Note 2) Refer to the section "Spindle control signal" in Instruction Manual for details on the spindle control signal.

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 Open loop control function

This function is to run a spindle motor for operation check before or during the adjustment of the spindle motor's encoder. This allows the operation in which no encoder feedback signals are used.

3-6-7 Power supply voltage display function

The converter bus voltage in main circuit power is displayed on the NC monitor screen.

4

Characteristics

4-1 Servo motor

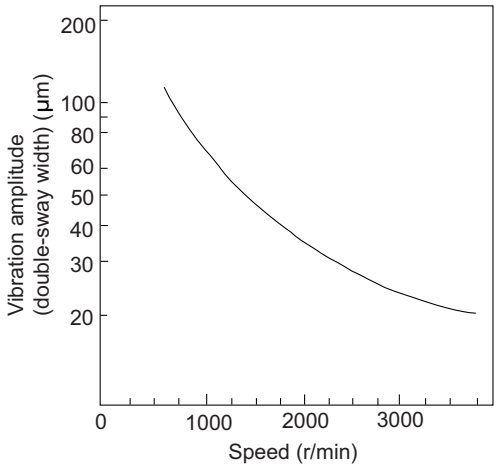
4-1-1 Environmental conditions

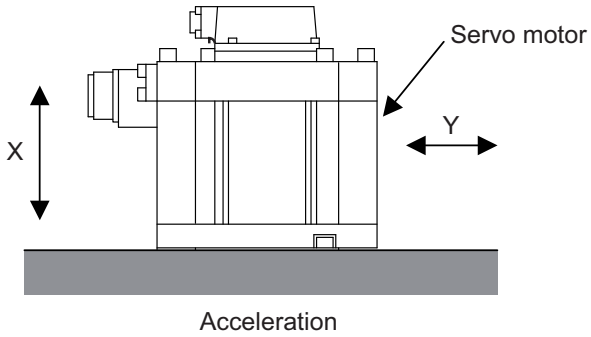
Environment	Conditions
Ambient temperature	0°C to +40°C (with no freezing)
Ambient humidity	80% RH or less (with no dew condensation)
Storage temperature	-15°C to +70°C (with no freezing)
Storage humidity	90% RH or less (with no dew condensation)
Atmosphere	Indoors (no direct sunlight) No corrosive gas,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

4-1-2 Quakeproof level

Motor type	Acceleration direction	
	Axis direction (X)	Direction at right angle to axis (Y)
HF75, 105 **HF54, 104, 154, 224, 123, 223, 142**	24.5m/s^2 (2.5G) or less	24.5m/s^2 (2.5G) or less
HF204, 303, 302, 354, 453	24.5m/s^2 (2.5G) or less	29.4m/s^2 (3G) or less
HF-KP23, 43, 73	49m/s^2 (5G) or less	49m/s^2 (5G) or less

The vibration conditions are as shown below.





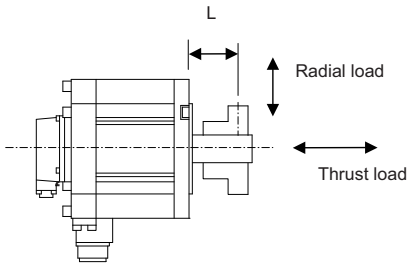
4-1-3 Shaft characteristics

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.

Servo motor	Tolerable radial load	Tolerable thrust load
HF75T, 105T (Taper shaft)	245N (L=33)	147N
HF75S, 105S (Straight shaft)	245N (L=33)	147N
HF54T, 104T, 154T, 224T, 123T, 223T, 142T (Taper shaft)	392N (L=58)	490N
HF54S, 104S, 154S, 224S, 123S, 223S, 142S (Straight shaft)	980N (L=55)	490N
HF204S, 303S, 302S, 354S, 453S (Straight shaft)	2058N (L=79)	980N
HF-KP23, 43 (Straight shaft)	245N (L=30)	98N
HF-KP73 (Straight shaft)	392N (L=40)	147N

(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]

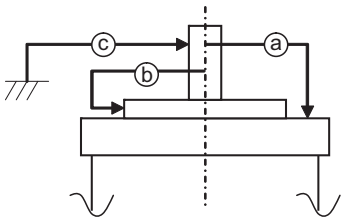
CAUTION !

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

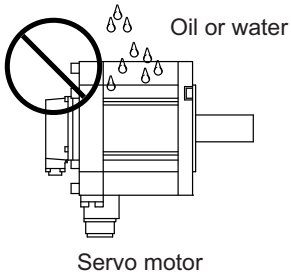
Machine accuracy of the servo motor's output shaft and around the installation part is as below.
(Excluding special products)

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



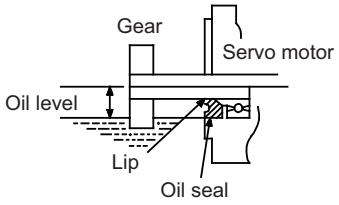
4-1-5 Oil / water standards

(1) The motor protective format uses the IP type, which complies with IEC Standard. (Refer to the section "2-1-1 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.

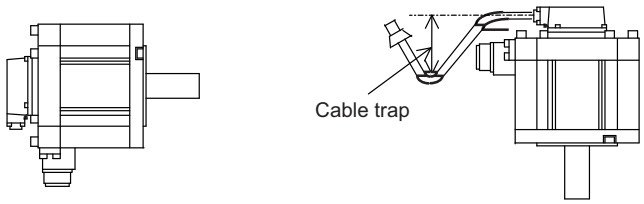


(2) When a gear box is installed on the servo motor, make sure that the oil level height from the center of the shaft is higher than the values given below. Open a breathing hole on the gear box so that the inner pressure does not rise.

Servo motor	Oil level (mm)
HF75, 105	15
HF54, 104, 154, 224, 123, 223, 142	22.5
HF204, 303, 302, 354, 453	30
HF-KP23, 43	12.5
HF-KP73	15



(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
150x150x6	100W
250x250x6	200 to 400W
250x250x12	0.5 to 1.5kW
300x300x20	2.0 to 7.0kW
800x800x35	9.0 to 11.0kW

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

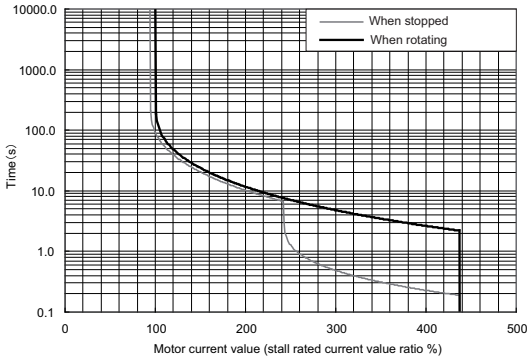
(Note 2) If enough flange size cannot be ensured, ensure the cooling performance by a cooling fan or operate the motor in the state that the motor overheat alarm does not occur.

4-1-7 Overload protection characteristics

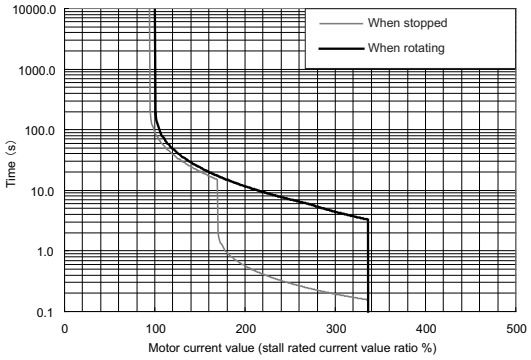
The servo drive unit has an electronic thermal relay to protect the servo motor and servo drive unit from overloads. The operation characteristics of the electronic thermal relay are shown below when standard parameters (SV021=60, SV022=150) are set. If overload operation over the electronic thermal 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.

<MDS-DM-V3-202020>

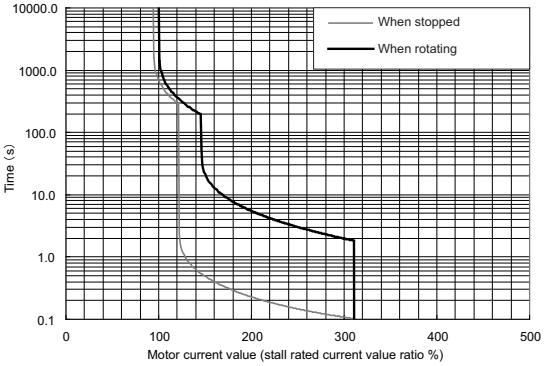
HF75



HF105



HF123



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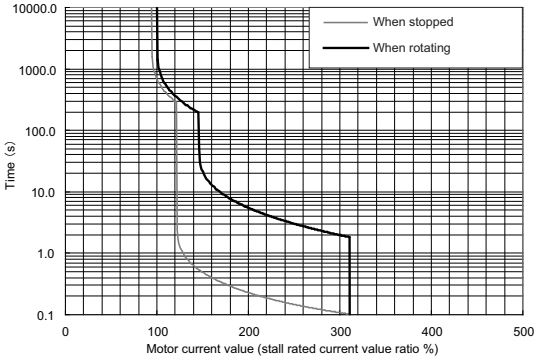
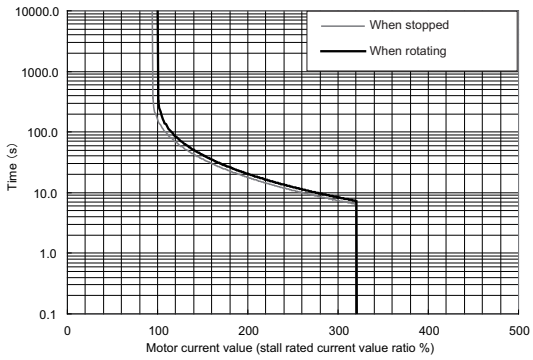


HF-KP23



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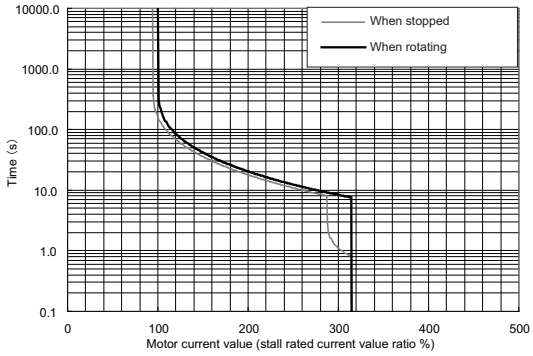
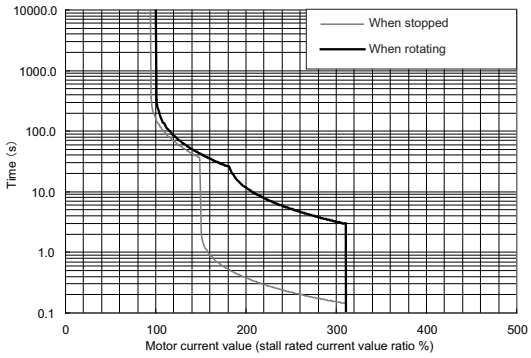


HF-KP73



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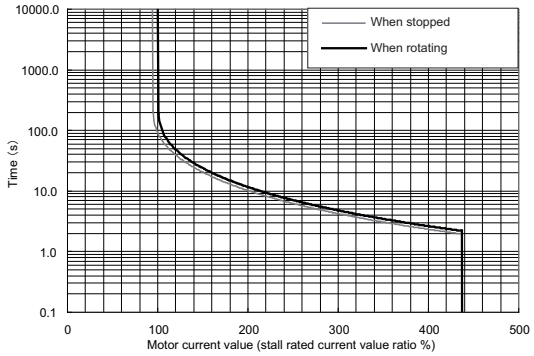
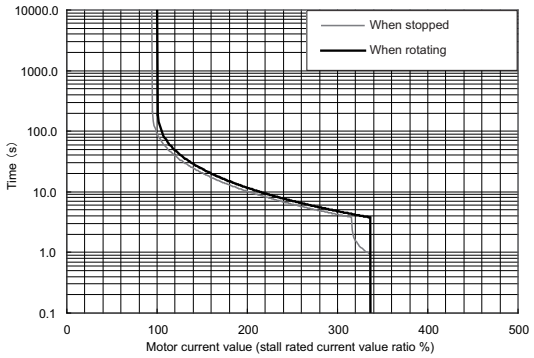
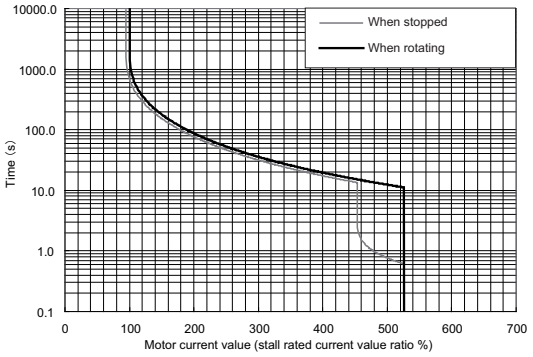
HF75



HF105



HF54



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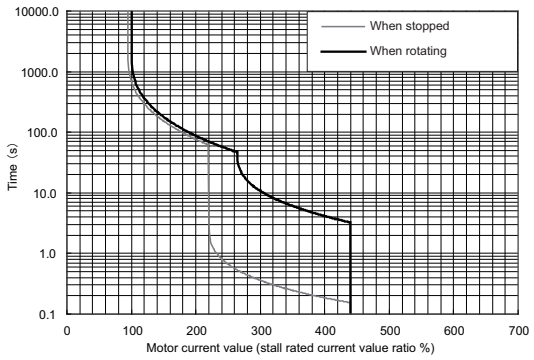

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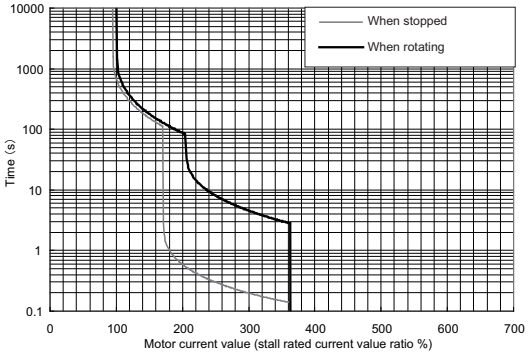

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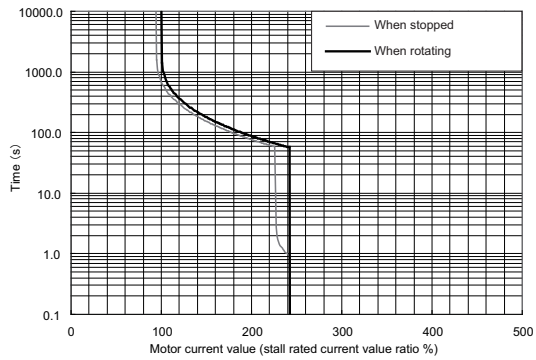

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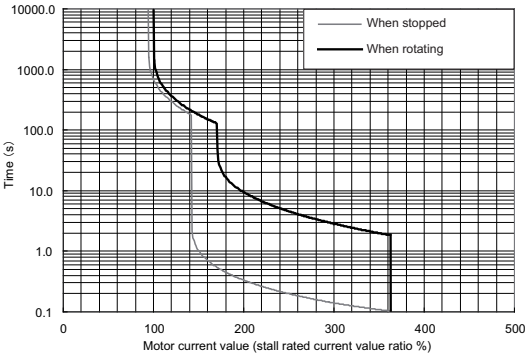

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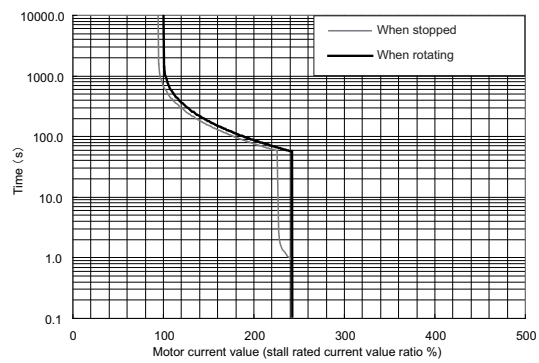

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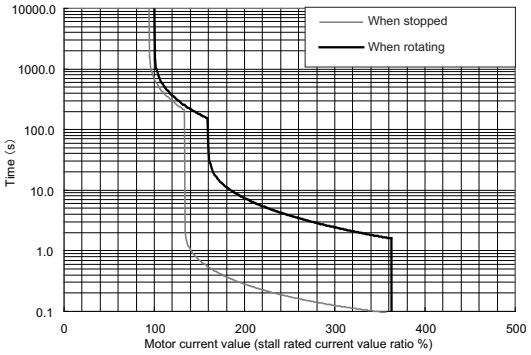
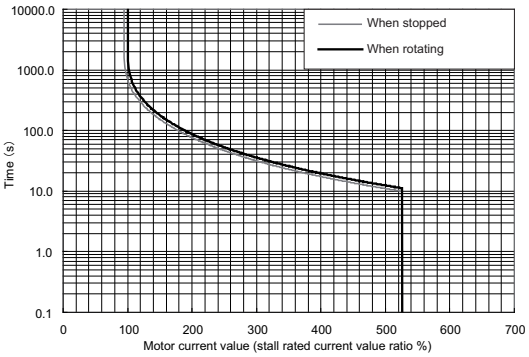


<MDS-DM-SPV Series>

HF54



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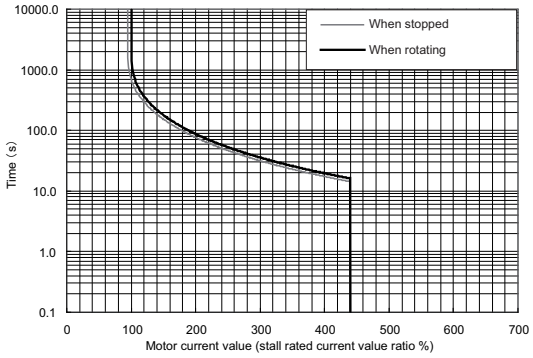

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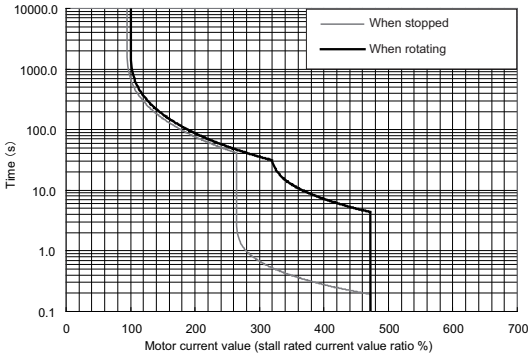
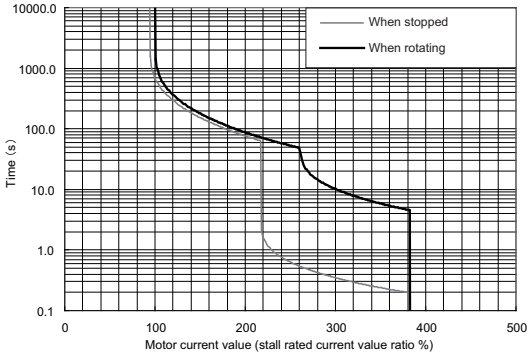
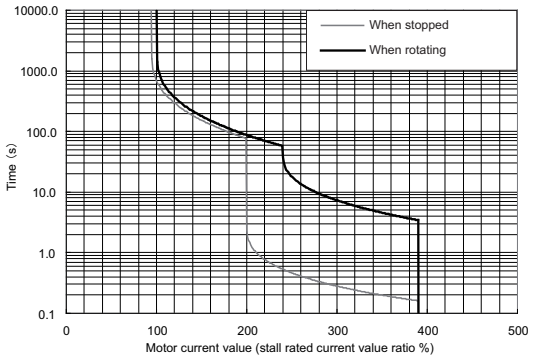


HF224

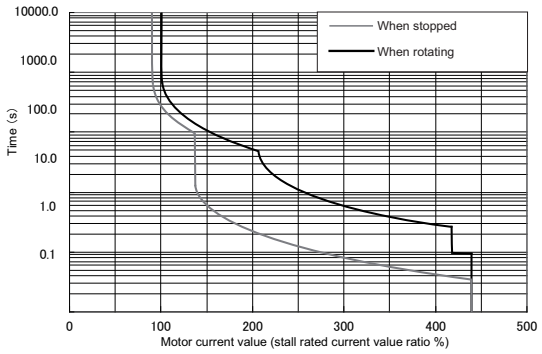


<MDS-DM-SPV Series>

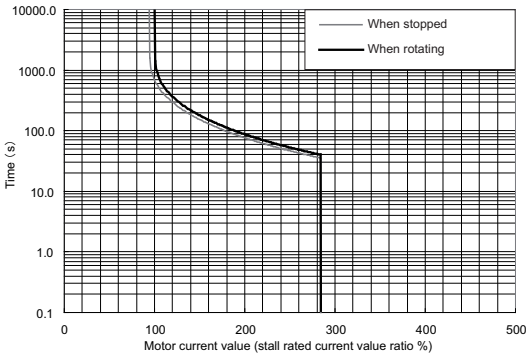
HF204



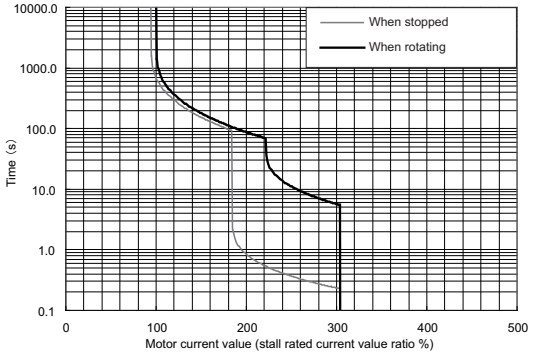
HF354



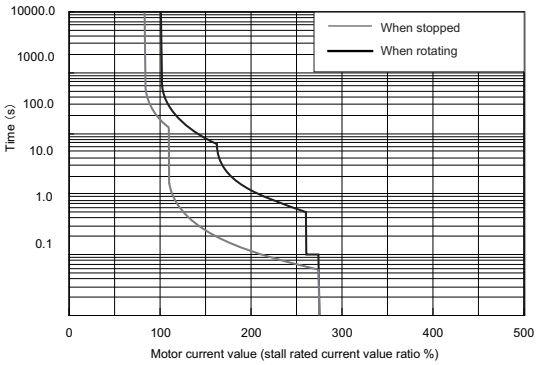
HF223



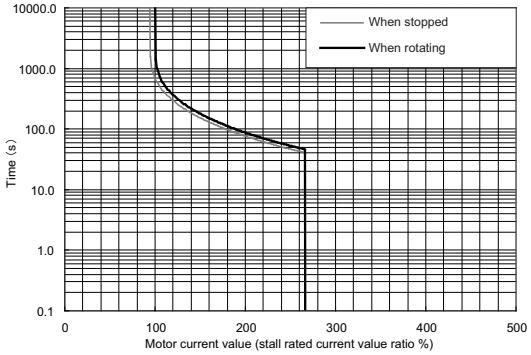
HF303



HF453



HF302



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.)

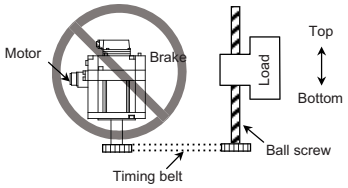
(c) Features

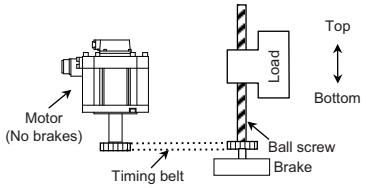
[1] The magnetic brakes use a DC excitation method, thus:
- The brake mechanism is simple and the reliability is high.
- There is no need to change the brake tap between 50Hz and 60Hz.
- There is no rush current when the excitation occurs, and shock does not occur.
- The brake section is not larger than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

< HF Series >

Item		Motor type		
		HF75B, HF105B	HF54B, HF104B HF154B,HF224B HF123B, HF223B HF142B	HF204B, HF354B HF303B, HF453B HF302B
Type (Note 1)		Spring closed non-exciting operation magnetic brakes (for maintenance and emergency braking)		
Rated voltage		24VDC		
Rated current at 20°C (A)		0.38	0.8	1.4
Capacity (W)		9	19	34
Static friction torque (N•m)		2.4	8.3	43.1
Inertia (Note 2) ($\times 10^{-4}$kg•m^2)		0.2	2.2	9.7
Release delay time (Note 3) (s)		0.03	0.04	0.1
Braking delay time (DC OFF) (Note 3) (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 4)	No. of braking operations (times)	20,000	20,000	20,000
	Work amount per braking (J)	32	200	1,000

< HF-KP Series >

Item		Motor type	
		HF-KP23B, HF-KP43B	HF-KP73B
Type (Note 1)		Spring closed non-exciting operation magnetic brakes (for maintenance and emergency braking)	
Rated voltage		24VDC	
Rated current at 20°C(A)		0.33	0.42
Capacity (W)		7.9	10
Static friction torque (N•m)		1.3	2.4
Inertia (Note 2) ($\times 10^{-4}$kg•m^2)		0.08	0.2
Release delay time (Note3) (s)		0.03	0.04
Braking delay time (DC OFF) (Note3) (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 (Note4)	No. of braking operations (times)	20,000	20,000
	Work amount per braking (J)	22	64

(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) These are the values added to the servo motor without a brake.

(Note 3) This is the representative value for the initial attraction gap at 20°C.

(Note 4) 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 5) A leakage flux will be generated at the shaft end of the servo motor with a magnetic brake.

(Note 6) 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. Always install a surge absorber on the brake terminal when using DC OFF.

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.

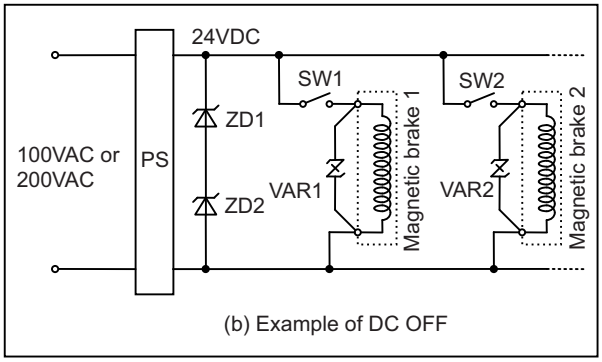
(b) Bake excitation circuit

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.



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

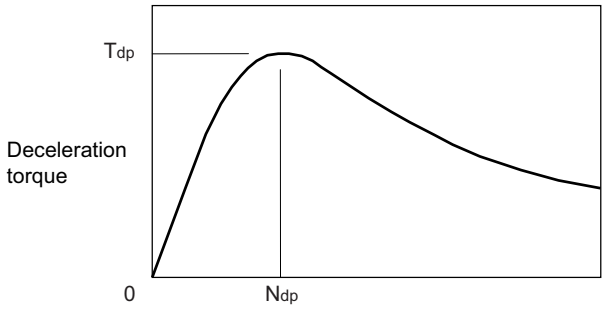
Magnetic brake circuits

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

MDS-DM-V3 Series

Motor type	Stall torque (N•m)	Tdp (N•m)	Ndp (r/min)	Motor type	Stall torque (N•m)	Tdp (N•m)	Ndp (r/min)
HF75	2.0	5.43	1538	**HF-KP23**	0.64	1.04	1167
HF105	3.0	10.21	1520	**HF-KP43**	1.27	2.6	1099
HF54	2.9	3.96	617	**HF-KP73**	2.39	2.96	651
HF104	5.9	10.02	735				
HF154	7.0	15.65	850				
HF123	7.0	9.79	561				
HF223	12.0 (10.0)	19.95	686				
HF142	11.0	14.43	427				
HF302	20.0 (15.6)	29.42	396				

(Note) The values in the parentheses are specifications when connecting with the M/S-axis of the MDS-DM-V3-404040.

MDS-DM-SPV Series

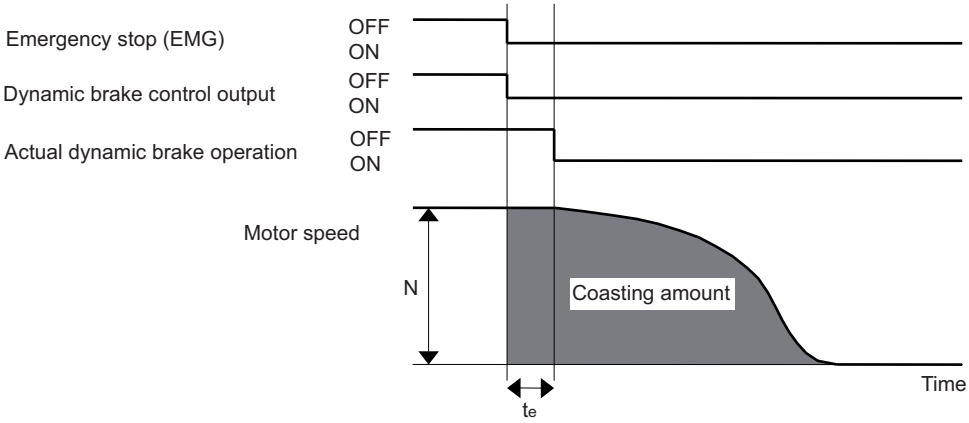
Motor type	Drive unit type	L/M-axis			S-axis		
		Stall torque (N•m)	Tdp (N•m)	Ndp (r/min)	Stall torque (N•m)	Tdp (N•m)	Ndp (r/min)
HF54	**SPVxF-xxx80**	2.9	3.97	758	2.9	3.96	533
HF104	**SPVxF-xxx80**	5.9	10.02	1060	5.9	10.02	540
HF154	**SPVxF-xxx80**	9.0	15.64	1356	9.0	15.65	546
	SPV3F-2000120			850			
HF224	**SPVxF-xxx80**	12.0	20.07	1765	12.0	20.06	608
	SPV3F-2000120			1042			
HF204	**SPVxF-xxx80**	13.7	15.95	1029	13.7	15.97	370
	SPV3F-2000120			617			
HF354	**SPV3F-2000120**	22.5	35.25	908	22.5	35.25	469
HF223	**SPVxF-xxx80**	12.0	19.95	1059	12.0	19.95	463
HF303	**SPVxF-xxx80**	22.5	30.40	955	22.5	30.43	308
	SPV3F-2000120			550			
HF453	**SPV3F-2000120**	37.2	52.94	1080	37.2	52.94	529
HF302	**SPVxF-xxx80**	20.0	29.42	635	20.0	29.42	253

(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.

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

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 next page)	
B	: Coefficient B (Refer to the next page)	



Dynamic brake braking diagram

Coasting amount calculation coefficients table

MDS-DM-V3 Series

Motor type	J_M ($\times 10^{-4}$kg•m^2)	A	B	Motor type	J_M ($\times 10^{-4}$kg•m^2)	A	B
HF75	2.6	0.54×10^{-9}	3.86×10^{-3}	**HF-KP23**	24.0	0.19×10^{-9}	1.36×10^{-3}
HF105	5.1	0.57×10^{-9}	3.98×10^{-3}	**HF-KP43**	42.0	0.14×10^{-9}	0.93×10^{-3}
HF54	6.1	4.35×10^{-9}	4.97×10^{-3}	**HF-KP73**	143.0	0.73×10^{-9}	1.65×10^{-3}
HF104	11.9	2.82×10^{-9}	4.57×10^{-3}				
HF154	17.8	2.34×10^{-9}	5.06×10^{-3}				
HF123	11.9	3.78×10^{-9}	3.57×10^{-3}				
HF223	23.7	3.02×10^{-9}	4.27×10^{-3}				
HF142	17.8	5.04×10^{-9}	2.76×10^{-3}				
HF302	75.0	11.23×10^{-9}	5.29×10^{-3}				

MDS-DM-SPV Series

Motor type	Drive unit type	L/M-axis			S-axis		
		J_M ($\times10^{-4}$kg•m^2)	A	B	J_M ($\times10^{-4}$kg•m^2)	A	B
HF54	SPVxF-xxx80	6.1	3.54×10^{-9}	6.10×10^{-3}	6.1	5.04×10^{-9}	4.29×10^{-3}
HF104	SPVxF-xxx80	11.9	1.95×10^{-9}	6.59×10^{-3}	11.9	3.84×10^{-9}	3.36×10^{-3}
HF154	SPVxF-xxx80	17.8	1.47×10^{-9}	8.08×10^{-3}	17.8	3.64×10^{-9}	3.25×10^{-3}
	SPV3F-2000120		2.34×10^{-9}	5.06×10^{-3}			
HF224	SPVxF-xxx80	23.7	1.17×10^{-9}	10.91×10^{-3}	23.7	3.39×10^{-9}	3.76×10^{-3}
	SPV3F-2000120		1.98×10^{-9}	6.44×10^{-3}			
HF204	SPVxF-xxx80	38.3	4.07×10^{-9}	12.94×10^{-3}	38.3	11.31×10^{-9}	4.66×10^{-3}
	SPV3F-2000120		6.79×10^{-9}	7.76×10^{-3}			
HF354	SPV3F-2000120	75.0	4.09×10^{-9}	10.12×10^{-3}	75	7.92×10^{-9}	5.22×10^{-3}
HF223	SPVxF-xxx80	23.7	1.96×10^{-9}	6.60×10^{-3}	23.7	4.49×10^{-9}	2.88×10^{-3}
HF303	SPVxF-xxx80	75.0	4.51×10^{-9}	12.33×10^{-3}	75.0	14.00×10^{-9}	3.97×10^{-3}
	SPV3F-2000120		7.82×10^{-9}	7.11×10^{-3}			
HF453	SPV3F-2000120	112	3.42×10^{-9}	11.96×10^{-3}	112	6.98×10^{-9}	5.86×10^{-3}
HF302	SPVxF-xxx80	75.0	7.01×10^{-9}	8.48×10^{-3}	75.0	17.58×10^{-9}	3.38×10^{-3}

4-2 Spindle motor

4-2-1 Environmental conditions

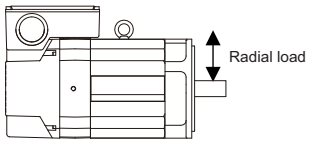
Environment	Conditions
Ambient temperature	0°C to +40°C (with no freezing)
Ambient humidity	90%RH or less (with no dew condensation)
Storage temperature	-20°C to +65°C (with no freezing)
Storage humidity	90%RH or less (with no dew condensation)
Atmosphere	Indoors (Where unit is not subject to direct 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)

(Note) Refer to each spindle motor specifications for details on the spindle motor vibration class.

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.

Spindle motor	Tolerable radial load
SJ-VL11-10FZT	245N
SJ-V5.5-01ZT, SJ-V7.5-01ZT, SJ-V7.5-03ZT, SJ-V11-06ZT SJ-VL11-05FZT-S01, SJ-VL11-07ZT, SJ-DJ5.5/100-01	980N
SJ-D5.5/100-01, SJ-DJ7.5/100-01	1470N
SJ-V11-01ZT, SJ-V11-13ZT, SJ-V11-01T, SJ-D7.5/100-01, SJ-D11/80-01, SJ-DJ11/100-01, SJ-DJ15/80-01	1960N
SJ-V15-01ZT, SJ-V11-09T	2940N



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

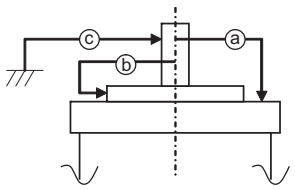
⚠ CAUTION **Consider on the machine side so that the thrust loads are not applied to the spindle motor.**

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)

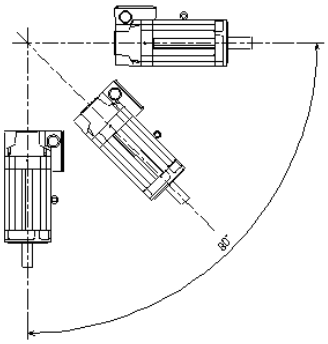
Accuracy	Measurement point	Frame No.	
		A71, B71, A90, B90, D90, A112, B112	A160, B160, C160, A180, B180, A225
Amplitude of the flange surface to the output shaft	a	0.03mm	0.05mm
Amplitude of the flange surface's fitting outer diameter	b	0.02mm	0.04mm
Amplitude of the output shaft end	c	0.01mm	0.02mm

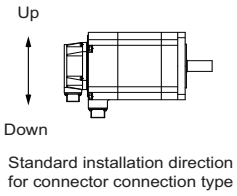
(Note) Refer to Specifications Manual for the frame number of each spindle motor.



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.





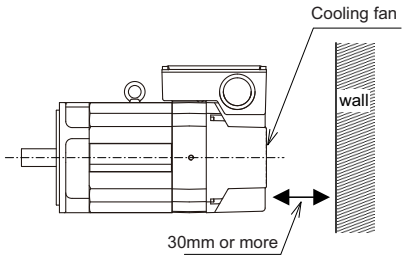
Standard installation direction
for connector connection type

The spindle motor whose motor power line and detection lead wires are connected with connectors, as a standard, should be installed with the connectors facing down. Installation in the standard direction is effective against dripping. Measure to prevent oil and water must be taken when not installing in the standard direction.

⚠ CAUTION

1. **Rubber packing for waterproof is attached on the inner surface of the top cover of terminal block. After checking that the packing is installed, install the top cover.**
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 Drive unit

4-3-1 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.

4-3-2 Heating value

The values for the servo drive unit apply at 50% of the stall output. The values for the spindle drive unit apply for the continuous rated output. The values for the multiple axes integrated drive unit include the AC reactor's heating value.

3-axis integrated servo drive unit			Multiple axes integrated drive unit		
Type MDS-DM-	Heating value [W]		Type MDS-DM-	Heating value [W]	
	Inside panel	Outside panel		Inside panel	Outside panel
V3-202020	89	0	SPV3/SPV3F-10080	140	590
V3-404040	159	0	SPV3/SPV3F-16080	150	650
			SPV3/SPV3F-20080	175	815
			SPV3F-200120	235	1025
			SPV2/SPV2F-10080	120	510
			SPV2/SPV2F-16080	130	570
			SPV2/SPV2F-20080	155	740

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%

5

Dedicated Options

5-1 Servo options

The option units are required depending on the servo system configuration. Check the option units to be required referring the following items.

(1) System establishment in the full closed loop control (only MDS-DM-SPV2F/SPV3F)

Refer to the table below to confirm the interface unit (I/F) and battery option required for the full closed loop control.

(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
Absolute position encoder	Mitsubishi serial signal output	OSA105ET2A (MITSUBISHI)	Mitsubishi serial signal	-	Mitsubishi serial signal	Required	
		SR77, SR87 (MAGNESCALE)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	
		LC191M, LC491M (HEIDENHAIN)	Mitsubishi serial signal		Mitsubishi serial signal	Not required	
		LC193M, LC493M (HEIDENHAIN)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	
		AT343, AT543, AT545 (Mitutoyo)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	
		SAM Series (FAGOR)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	
		SVAM Series (FAGOR)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	
		GAM Series (FAGOR)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	
		LAM Series (FAGOR)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	
	SIN wave signal output	MPS Series (Mitsubishi Heavy Industries Machine Tool)	SIN wave signal	ADB-20J60 (Mitsubishi Heavy Industries Machine Tool)	Mitsubishi serial signal	Required	

(b) Full closed loop control for rotary axis

Machine side encoder to be used			Encoder signal output	Interface unit	Output signal	Battery option	Remarks
Absolute position encoder	Mitsubishi serial signal output	RU77 (MAGNESCALE)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	
		RCN223M, RCN227M (HEIDENHAIN)	Mitsubishi serial signal		Mitsubishi serial signal	Not required	
		RCN727M, RCN827M (HEIDENHAIN)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	
		MPRZ Series (Mitsubishi Heavy Industries Machine Tool)	Mitsubishi serial signal	ADB-20J71 (Mitsubishi Heavy Industries Machine Tool)	Mitsubishi serial signal	Not required	

⚠ CAUTION **MDS-EX-SR unit is required for the full closed loop control.**

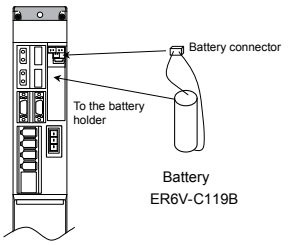
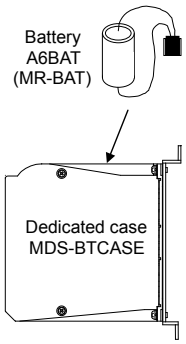
<Contact information about machine side encoder>

- Magnescale Co., Ltd.: http://www.mgscale.com/mgs/language/english/
- HEIDENHAIN CORPORATION: http://www.heidenhain.com/
- Mitutoyo Corporation: http://www.mitutoyo.co.jp/eng/
- Mitsubishi Heavy Industries Machine Tool: http://www.mhi-machinetool.com/en/index.html
- FAGOR Automation: http://www.fagorautomation.com/

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

5-1-1 Battery option (ER6V-C119B, A6BAT, MDS-BTBOX-36)

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	EER6V-C119B	A6BAT(MR-BAT)	MDS-BTBOX-36
Installation type	Drive unit with battery holder type	Dedicated case type	Unit and battery integration type
Hazard class	Not applicable	Not applicable (24 or less)	Not applicable
Number of connectable axes	Up to 3 axes	Up to 8 axes (When using dedicated case)	Up to 8 axes
Battery change	Possible	Possible	Possible
Appearance	(1) 	(2) 	(3) 

(Note) When using the converged battery option, refer to this section "(4) Converged battery option".

⚠ 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. **Contact the Service Center when replacing the cell battery.**
5. **The battery life (backup time) is greatly affected by the working ambient temperature. The above data is the theoretical value for when the battery is used 8 hours a day/240 days a year at an ambient temperature of 25°C. Generally, if the ambient temperature increases, the backup time and useful life will both decrease.**

POINT

A6BAT is a battery with same specifications as MR-BAT.

(1) Cell battery (ER6V-C119B)

(a) Specifications

Battery option type		Cell battery
		ER6V-C119B (Note 1)
Battery model name		ER6V
Nominal voltage		3.6V
Nominal capacity		2000mAh
Battery safety	Hazard class	-
	Battery shape	Single battery
	Number of batteries used	ER6V x 1
	Lithium alloy content	0.7g
	Mercury content	1g or less
Number of connectable axes		Up to 3 axes (Note 3)
Battery continuous backup time		Up to 2 axes: Approx. 10000 hours 3 axes connected: Approx. 6600 hours
Battery useful life (From date of unit manufacture)		7 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		20g

(Note 1) ER6V-C119B is a battery built in a servo drive unit. Install this battery only in the servo drive unit that executes absolute position control.

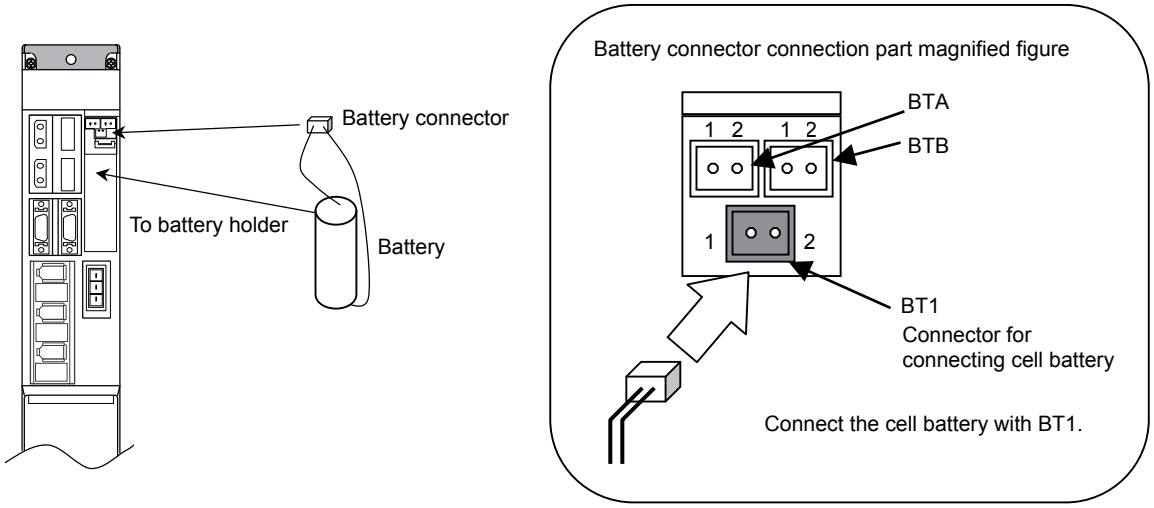
(Note 2) This time is a guideline, so does not guarantee the back up time. Replace the battery with a new battery as soon as a battery warning occurs.

(Note 3) 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 number of load shaft should be two.

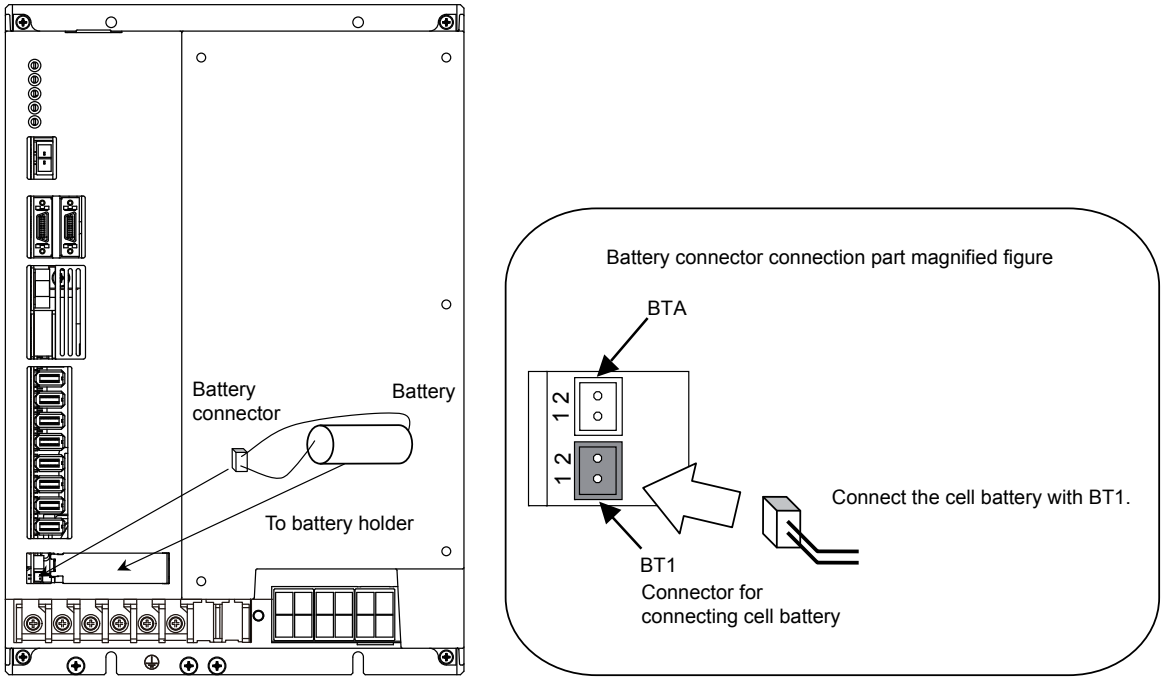
(b) Installing the cell battery

Open the upper front cover of the servo drive unit.
Connect the battery connector and then put the battery inside.

<MDS-DM-V3 Series>



<MDS-DM-SPV Series>



(Note) When using a cell battery, do not connect the battery unit, MDS-BTBOX-36.

POINT

When using a cell battery built-in drive unit, the wiring between units is not required. The cell battery can be changed in each drive unit.

(2) Cell battery (A6BAT)

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

(a) Specifications

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

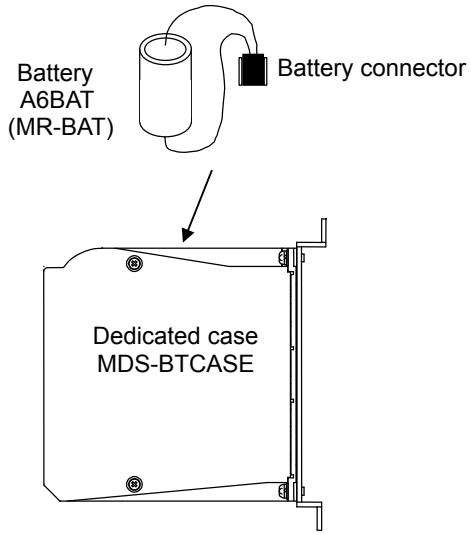
(Note) This time is a guideline, so does not guarantee the back up time. Replace the battery with a new battery as soon as a battery warning occurs.

(b) Specifications of the dedicated case MDS-BTCASE

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

(c) Installing the cell battery

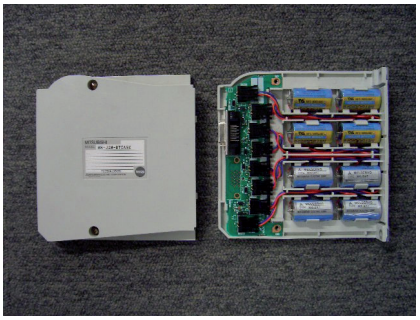
Open the cover of the dedicated case. Connect the battery connector and then put the battery inside.



(d) Installing A6BAT (MR-BAT) to battery case

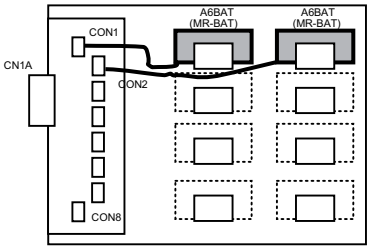
Open the cover of the dedicated case. Connect the battery connector and then put the battery inside.

[1] Incorporate batteries in order, from the connector CON1 on the top of the case.
In the same way, install batteries to holders in order, from the holder on the top.

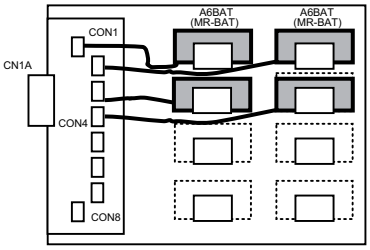


Example of incorporated batteries
(Photo: 8 batteries incorporated)

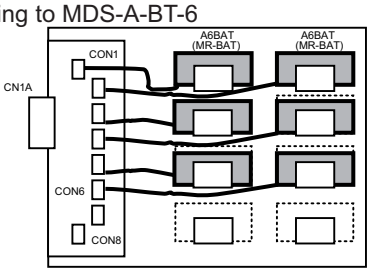
Corresponding to MDS-A-BT-2



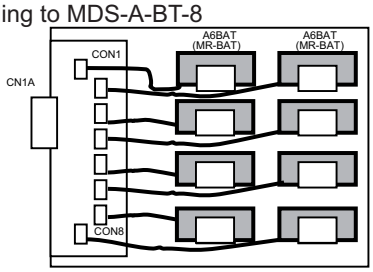
Corresponding to MDS-A-BT-4



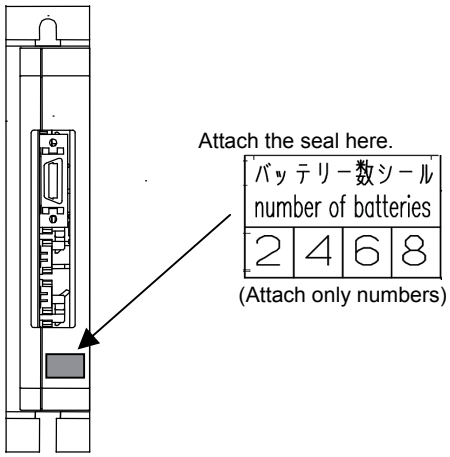
Corresponding to MDS-A-BT-6



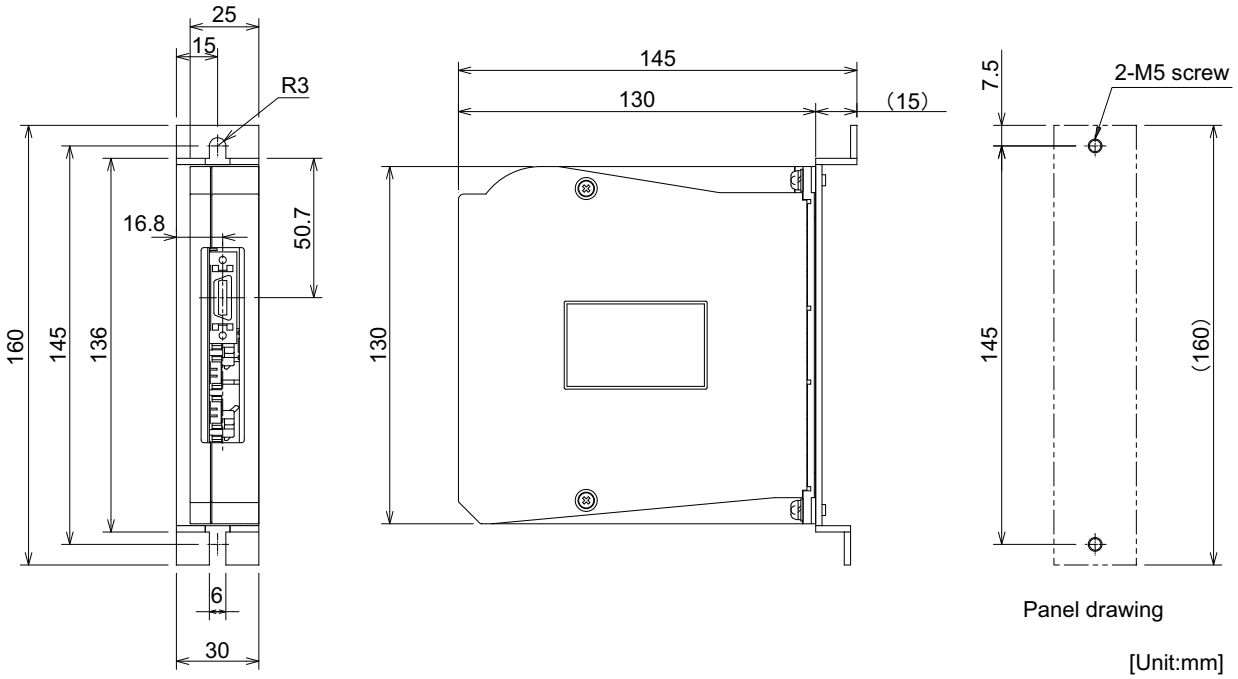
Corresponding to MDS-A-BT-8



[2] Attach a seal indicating the number of incorporated batteries to the part shown below.



(e) Outline dimension drawing of the dedicated case MDS-BTCASE



Panel drawing

[Unit:mm]

(3) Battery box (MDS-BTBOX-36)

(a) Specifications

Battery option type	Battery box
	MDS-BTBOX-36
Battery model name (Note 1)	size-D alkaline batteries LR20 x 4 pieces
Nominal voltage	3.6V (Unit output), 1.5V (Isolated battery)
Number of connectable axes	Up to 8 axes
Battery continuous backup time (Note 2)	Approx. 10000 hours (when 8 axes are connected, cumulative time in non-energized state)
Back up time from battery warning to alarm occurrence (Note 2)	Approx. 336 hours (when 8 axes are connected)

(Note 1) Install commercially-available alkaline dry batteries into MDS-BTBOX-36. 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.

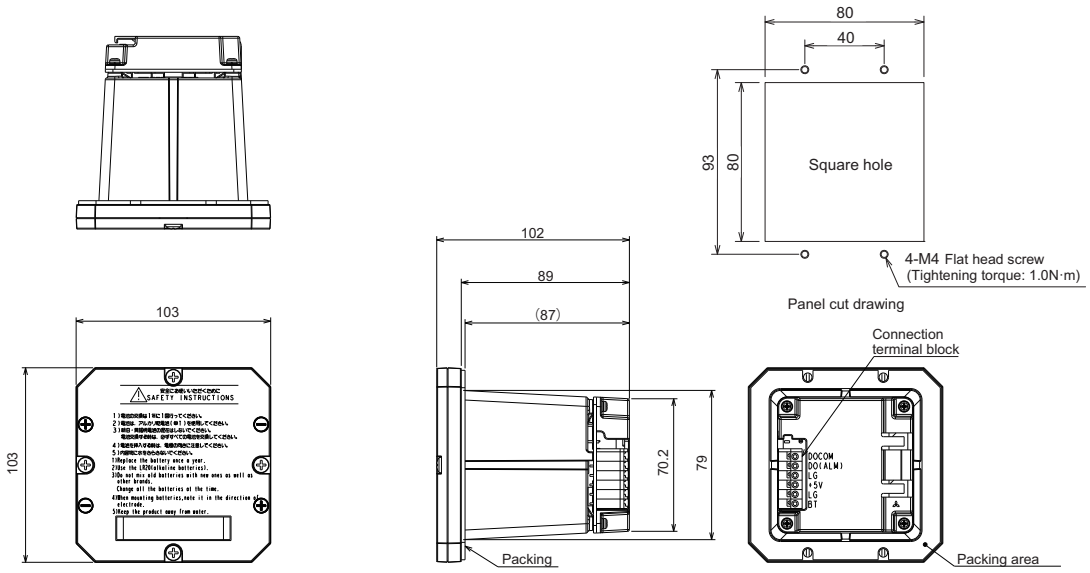
(Note 2) This time is a guideline, so does not guarantee the back up time. Replace the battery with a new battery as soon as a battery warning (9F) occurs.

(b) Explanation of terminals

		Name	Description
(1)	Power supply output for absolute position encoder backup	BT	3.6V output for absolute position encoder backup
(2)		LG	Ground
(3)	Power supply input for battery voltage drop detection circuit	+5V	5V power supply input for battery voltage drop detection circuit
(4)		LG	Ground
(5)	Battery voltage drop warning signal output	DO(ALM)	Battery voltage drop warning output
(6)		DOCOM	DO output common

(c) Outline dimension drawings

[Unit: mm]



POINT

As soon as the battery warning 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

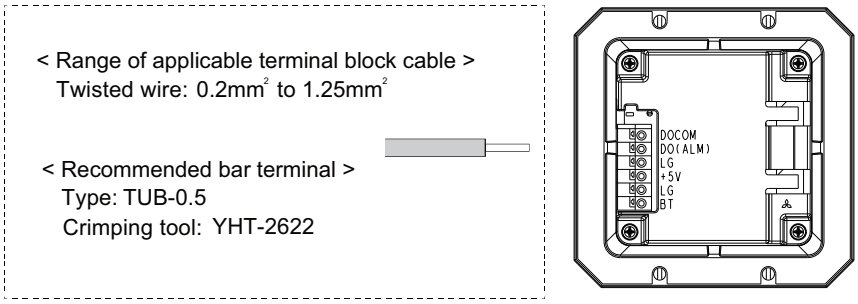
When installing the battery box on the panel, it may be damaged if the screw is tightened too much. Make sure the tightening torque of the screw.

(d) Cable connection procedure

When connecting the terminal block, select a cable for the terminal block referring to the applicable size as a guide. Connect the cable by crimping the bare conductor or bar terminal. Do not pre-solder the wire.

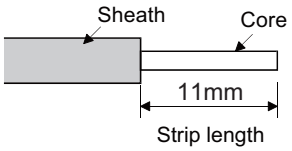
< Range of applicable terminal block cable >
Twisted wire: 0.2mm^2 to 1.25mm^2

< Recommended bar terminal >
Type: TUB-0.5
Crimping tool: YHT-2622



- Processing of power insulator

The strip length of the wire insulator should be 11mm.



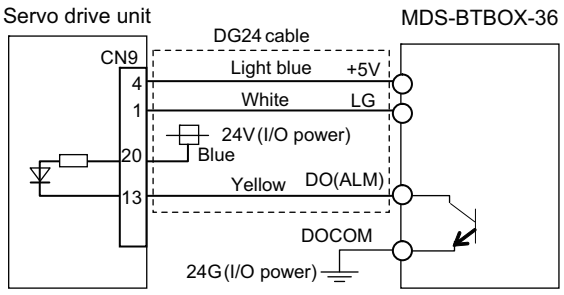
Retwist and straighten the core as shown below.

Unraveling or bending of core

Make sure to retwist and straighten the core

(e) Wiring of the battery voltage drop warning output

The battery voltage drop warning is detected in the MDS-BTBOX-36 and output to the servo drive unit as digital signal.Connect the battery voltage drop warning signal to one of the servo drive units supported by MDS-BTBOX-36. For the connected servo axis, set the servo parameter "SV082/bitF-C" to "2" to enable this signal input. When using 2 or 3-axis drive unit, set the value to one of the axes and set other axes in the same unit to "0" (No signal).



Battery voltage drop warning signal connection diagram

(f) When backing up for more than 8 axes

Add a MDS-BTBOX-36 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 MDS-BTBOX-36, start the control powers ON simultaneously.

⚠ CAUTION

1. **The battery voltage drop warning signal and SLS (Safely Limited Speed) function door state signal cannot be connected to the same drive unit. To use these function together as a system, connect to the different drive unit.**
2. **Battery voltage drop warning (9F) can also occur when the cable between the battery box and drive unit is broken.**
3. **For 2-axis or 3-axis drive unit, the parameter error "E4" or drivers communication error "82" occurs at all the axes when the setting of SV082(SSF5)/bitF-C differs according to axes (except 0 setting).**
4. **The drive unit which is connected to the battery box and cell battery cannot be used together.**
5. **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.**
6. **Replace the batteries while applying the control power of all drive units which are connected to the battery box.**
7. **When changing the wiring of the CN9 control input, change after SV082(SSF5)/bitF-C is set to 0. Otherwise unexpected alarms can be detected because of a mismatch of the control input signal and setting parameter.**
8. **Battery voltage drop warning (9F) is released by turning the drive unit power ON again after replacing the battery.**

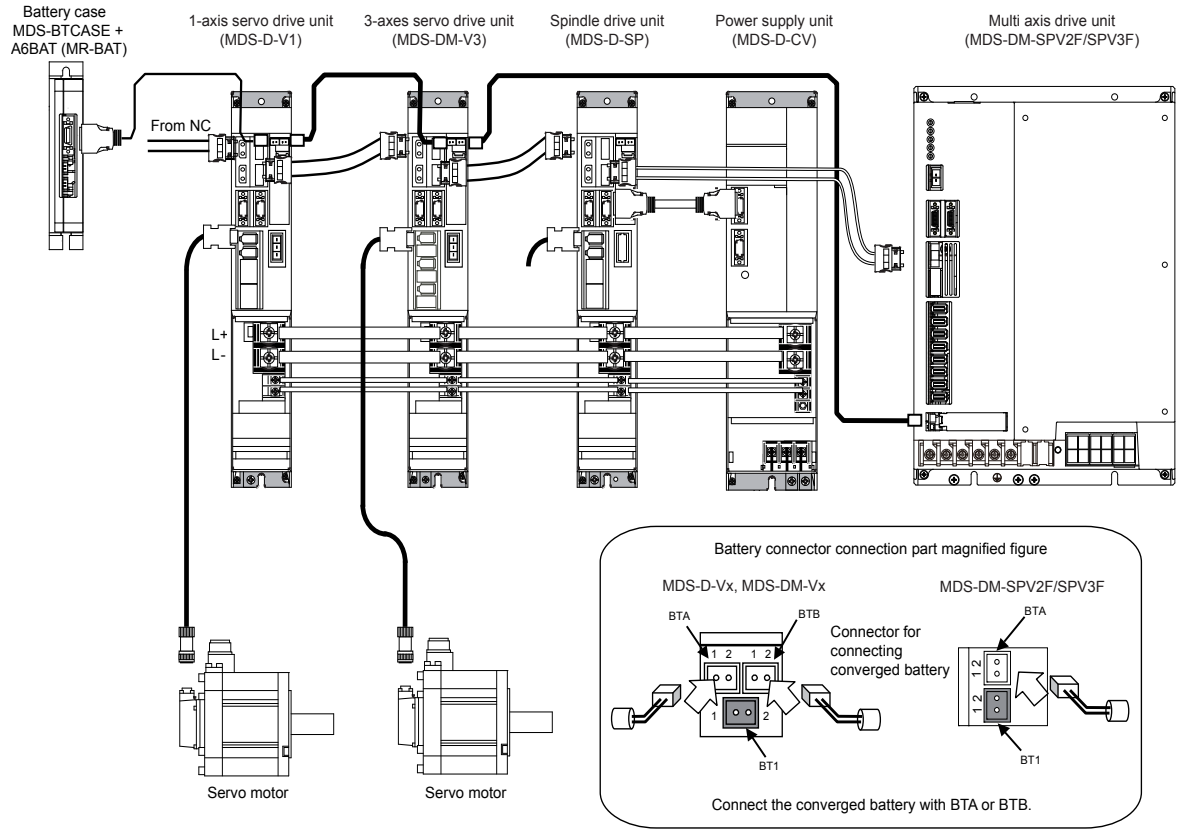
(4) Converged battery option

When using the following battery options, the wiring between units which configure an absolute position system is required.

Battery option type	Installation type	Battery charge
A6BAT (MR-BAT)	Dedicated case type (built-in MDS-BTCASE)	Possible
MDS-BTBOX-36	Unit and battery integration type	Possible

System configuration

< A6BAT(MR-BAT) >



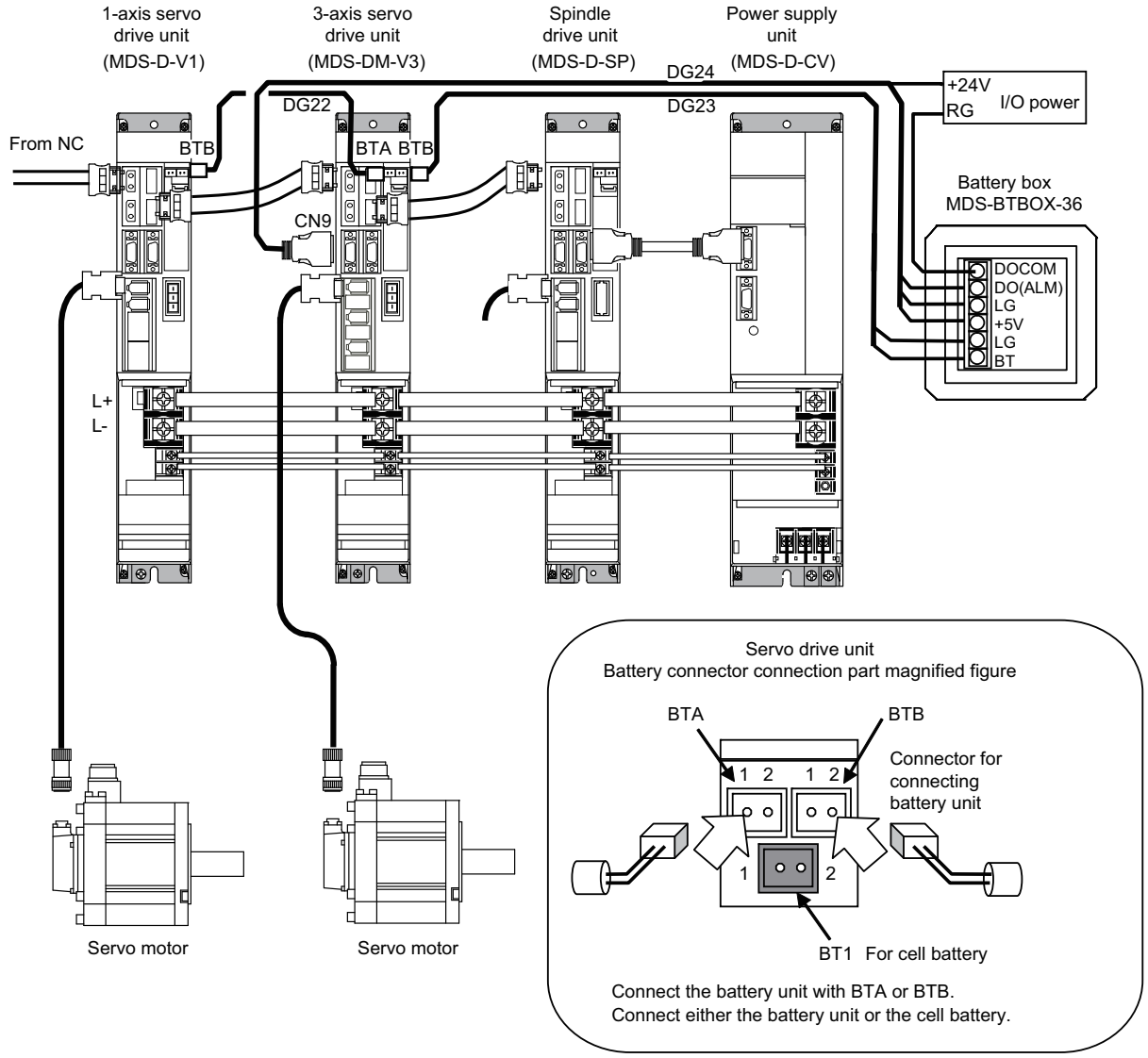
POINT

1. This wiring is not required for the drive unit or spindle drive unit which is not an absolute system.

2. Use a shield cable for wiring between drive units.
The drive unit could malfunction.

< MDS-BTBOX-36 >

(a) MDS-D-V1/V2 Series, MDS-DM-V3 Series connected in serial



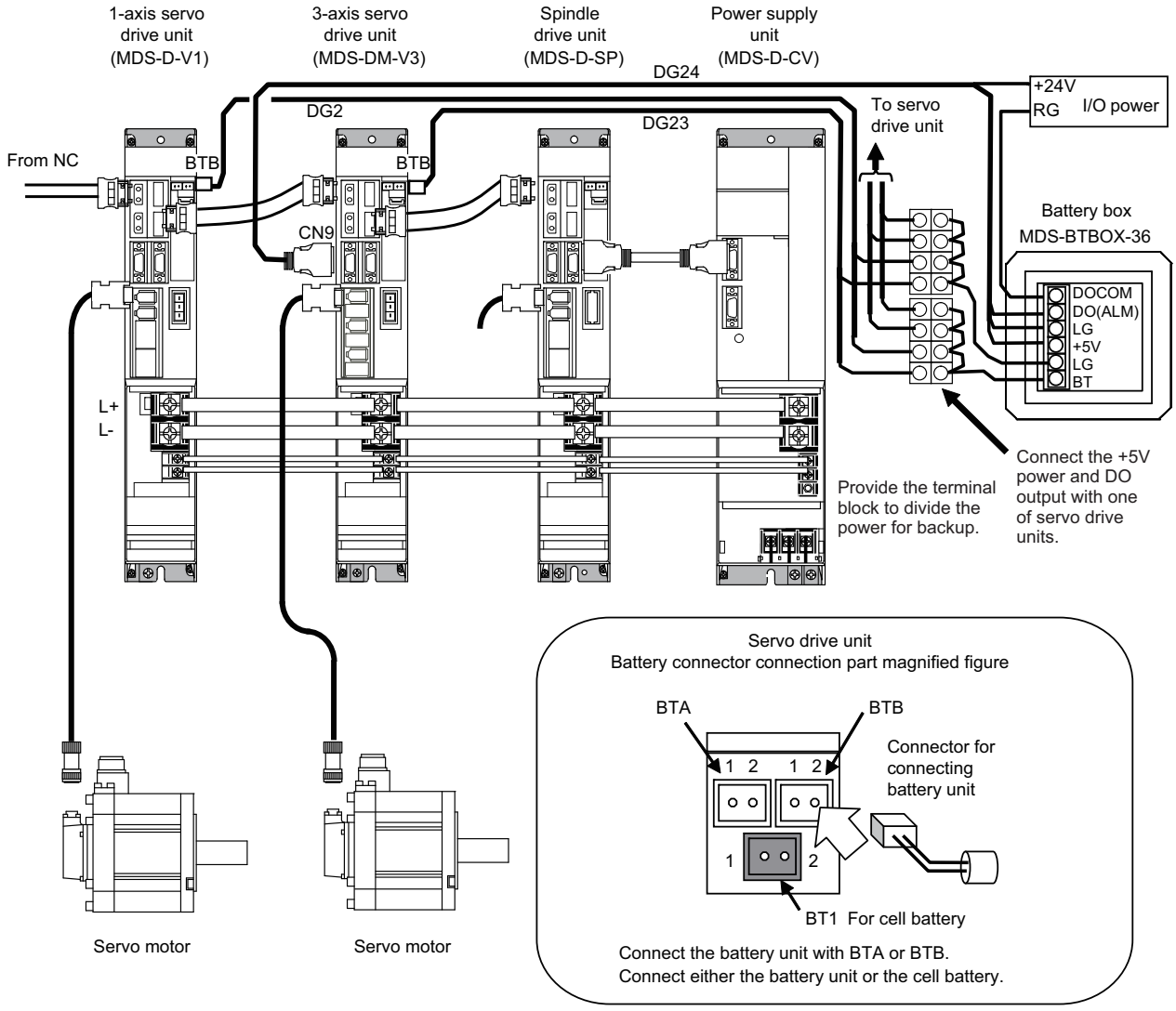
⚠CAUTION

1.24V power for DO output must always be turned ON before the NC power input.

2. Spindle drive unit has no battery voltage drop warning function. Wiring to CN9 of drive unit must be always connected to servo drive unit.

3. The total length of battery cable (from the battery unit to the last connected drive unit) must be 3m or less.

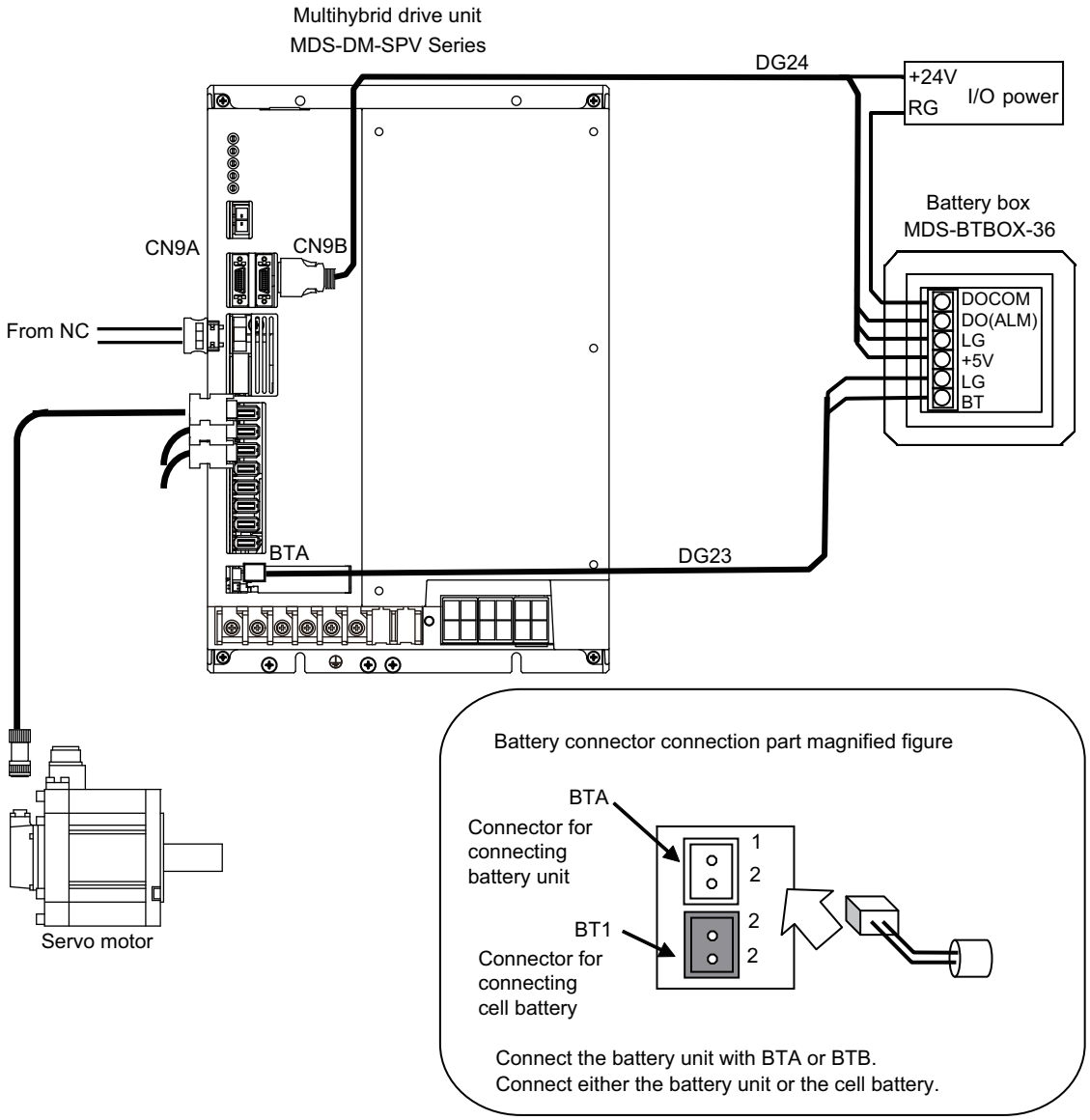
(b) MDS-D-V1/V2 Series, MDS-DM-V3 Series connected in parallel



⚠ CAUTION

1. **24V power for DO output must always be turned ON before the NC power input.**
2. **Spindle drive unit has no battery voltage drop warning function. Wiring to CN9 of drive unit must be always connected to servo drive unit.**
3. **The total length of battery cable (from the battery unit to the last connected drive unit) must be 3m or less.**

(c) MDS-DM-SPV Series



⚠ CAUTION

1. 24V power for DO output must always be turned ON before the NC power input.

2. Connect the cable for alarm with CN9B on the drive unit. CN9A cannot receive the battery voltage drop warning.

3. The total length of battery cable (from the battery unit to the last connected drive unit) must be 3m or less.

5-1-2 Ball screw side encoder (OSA105ET2A)

(1) Specifications

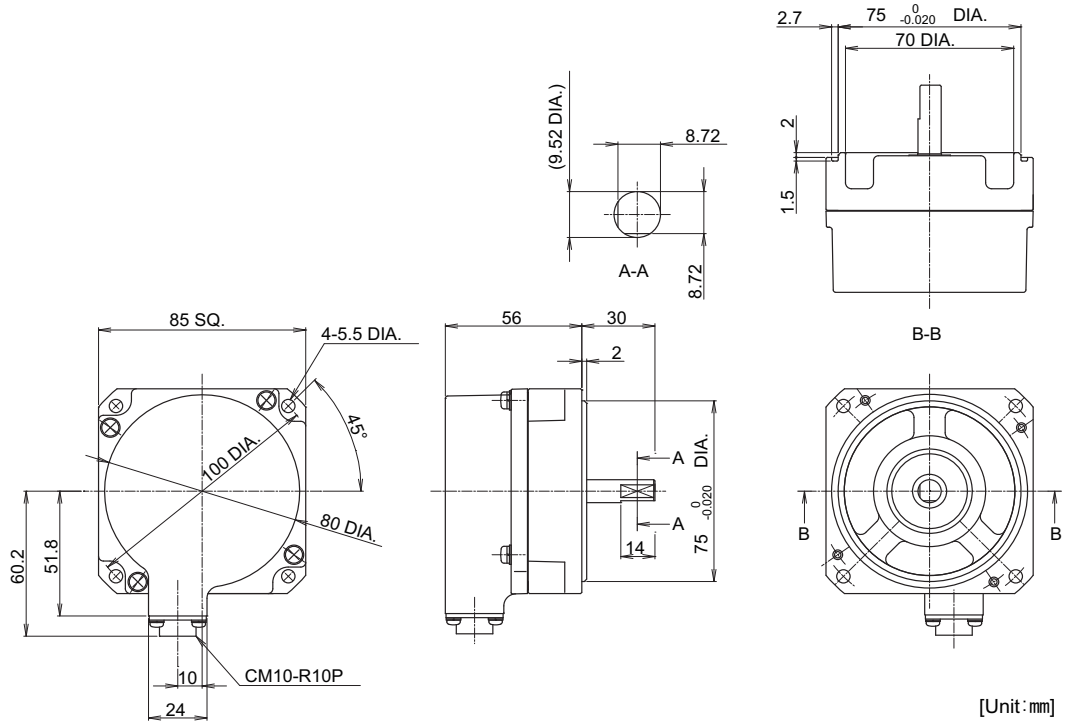
Encoder type		OSA105ET2A
Electrical characteristics	Encoder resolution	1,000,000 pulse/rev
	Detection method	Absolute position method (battery backup method)
	Accuracy (*1)	±3 seconds
	Tolerable rotation speed at power off (*2)	500r/min
	Encoder output data	Serial data
	Power consumption	0.3A
Mechanical 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/19.8N
	Mass	0.6kg
	Degree of protection	IP65 (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.

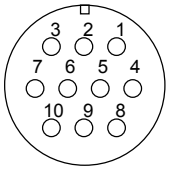
(*2) If the tolerable rotation speed at power off is exceeded, the absolute position cannot be repaired.

(2) Outline dimension drawings

OSA105ET2A



(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

5-2 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/ MPCI 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.

(3) 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.

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	$10^4rad/s^2$ or less	$10^4rad/s^2$ 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 amplitude (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)	

(Note) Confirm that the gear ratio (pulley ratio) of the spindle end to the encoder is 1:1.

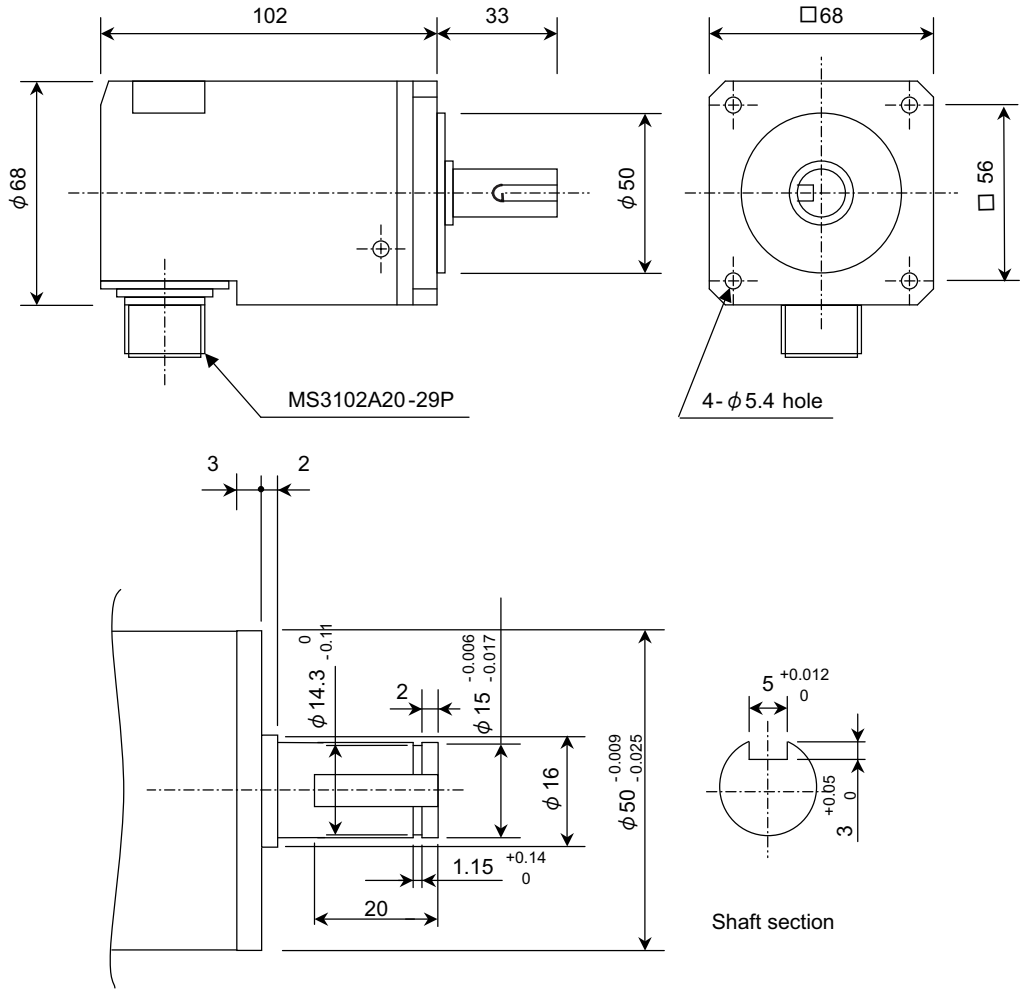
(2) Detection signals

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	-		

(3) Outline dimension drawings



[Unit: mm]

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)

(1)

Symbol	The number of compatible detection gear teeth
64	64
12	128
25	256

(2)

Symbol	Length of the cable
10	400mm
20	800mm
30	1200mm
40	1600mm
60	2000mm

<Detection gear type>

MU1606N (1) (2)

(1)

Symbol	The number of detection gear teeth
6	64
7	128
8	256

(2) Each specification number

(2) Specifications

	Series type	TS5690N64xx					TS5690N12xx					TS5690N25xx				
Sensor	xx (The end of the type name)	10	20	30	40	60	10	20	30	40	60	10	20	30	40	60
	Length of lead [mm]	400 ±10	800 ±20	1200 ±20	1600 ±30	2000 ±30	400 ±10	800 ±20	1200 ±20	1600 ±30	2000 ±30	400 ±10	800 ±20	1200 ±20	1600 ±30	2000 ±30
Detection gear	Type	MU1606N601					MU1606N709					MU1606N805				
	The number of teeth	64					128					256				
	Outer diameter [mm]	Φ52.8					Φ104.0					Φ206.4				
	Inner diameter [mm]	Φ40H5					Φ80H5					Φ140H5				
	Thickness [mm]	12					12					14				
	Shrink fitting [mm]	0.020 to 0.040					0.030 to 0.055					0.050 to 0.085				
Notched fitting section	Outer diameter [mm]	Φ72.0					Φ122.0					Φ223.6				
	Outer diameter tolerance [mm]	+0.010 to +0.060					-0.025 to +0.025					-0.025 to +0.025				
The number of output pulse	A/B phase	64					128					256				
	Z phase	1					1					1				
Detection resolution [p/rev]		2 million					4 million					8 million				
Absolute accuracy at stop		150"					100"					95"				
Tolerable speed [r/min]		40,000					20,000					10,000				
Signal output		Mitsubishi high-speed serial														

CAUTION !

1.Selected encoders must be able to tolerate the maximum rotation speed of the spindle.

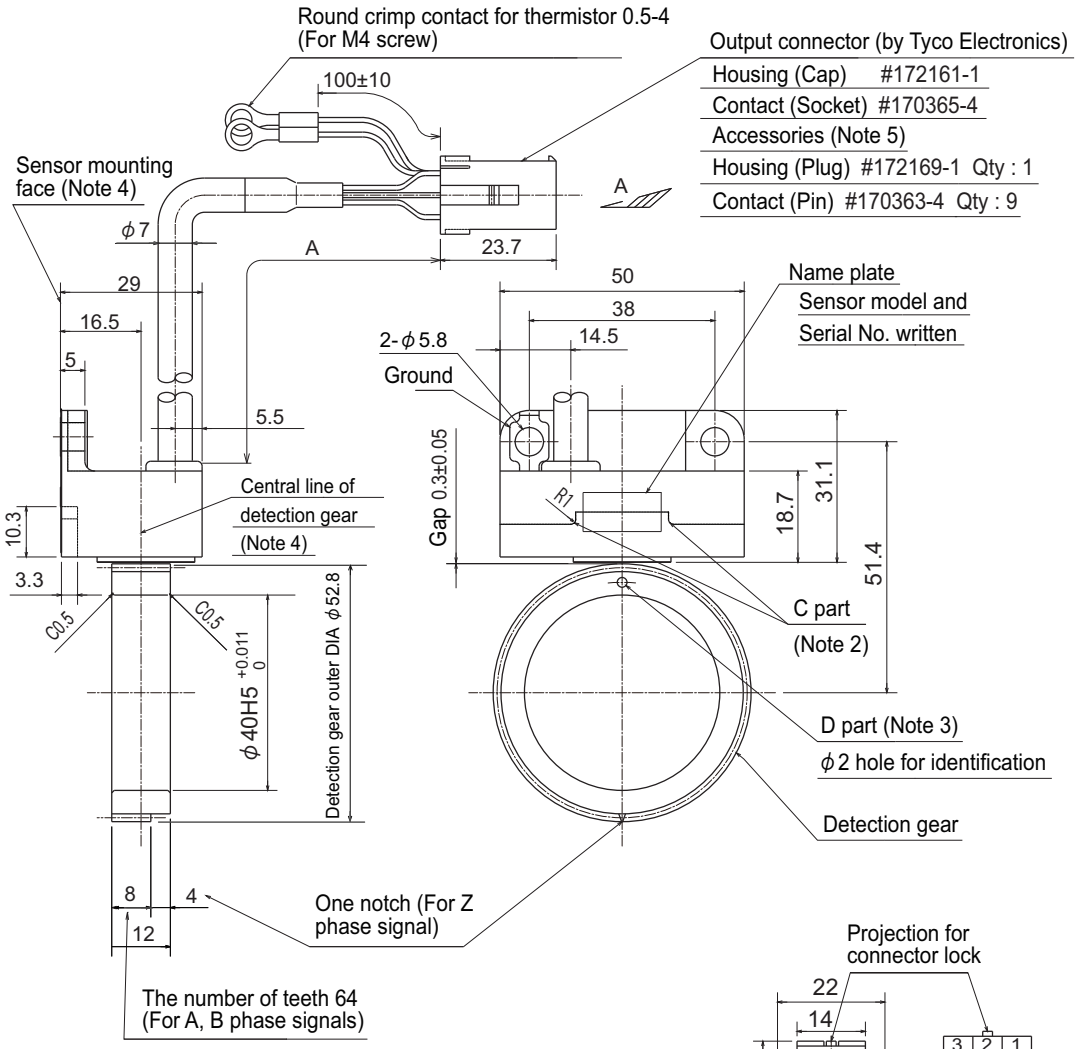
2.Please contact your Mitsubishi Electric dealer for the special products not listed above.

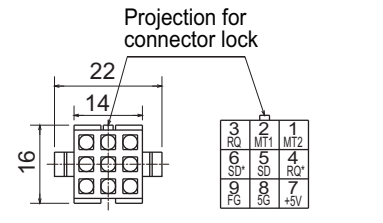
(3) Outline dimension drawings

CAUTION ! **Always apply the notched fitting section machining with the specified dimensions to the sensor installation surface.**

<TS5690N64xx + MU1606N601>

[Unit: mm]





(Note 1) Handle with care as this is a precision component.
Pay special attention not to apply excessive external force on the sensor's detection face. Applying such force will cause a fault.

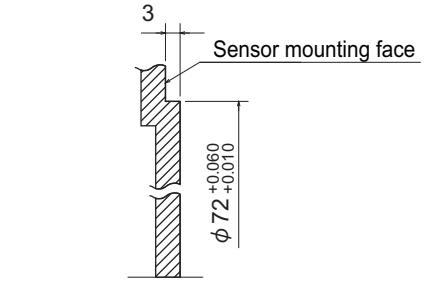
(Note 2) In installing the sensor, keep the protruding fitting of $\phi 72^{+0.060}_{+0.010}$ mm on the machine side, and push the C part of the sensor mounting seat against the fitting.

(Note 3) In installing the detection gear, make sure that the D part side comes the opposite side of the sensor installation side (sensor's lead wire side).

(Note 4) The diviation of the center of the detection gear is 16.5±0.25mm from the sensor mounting face.

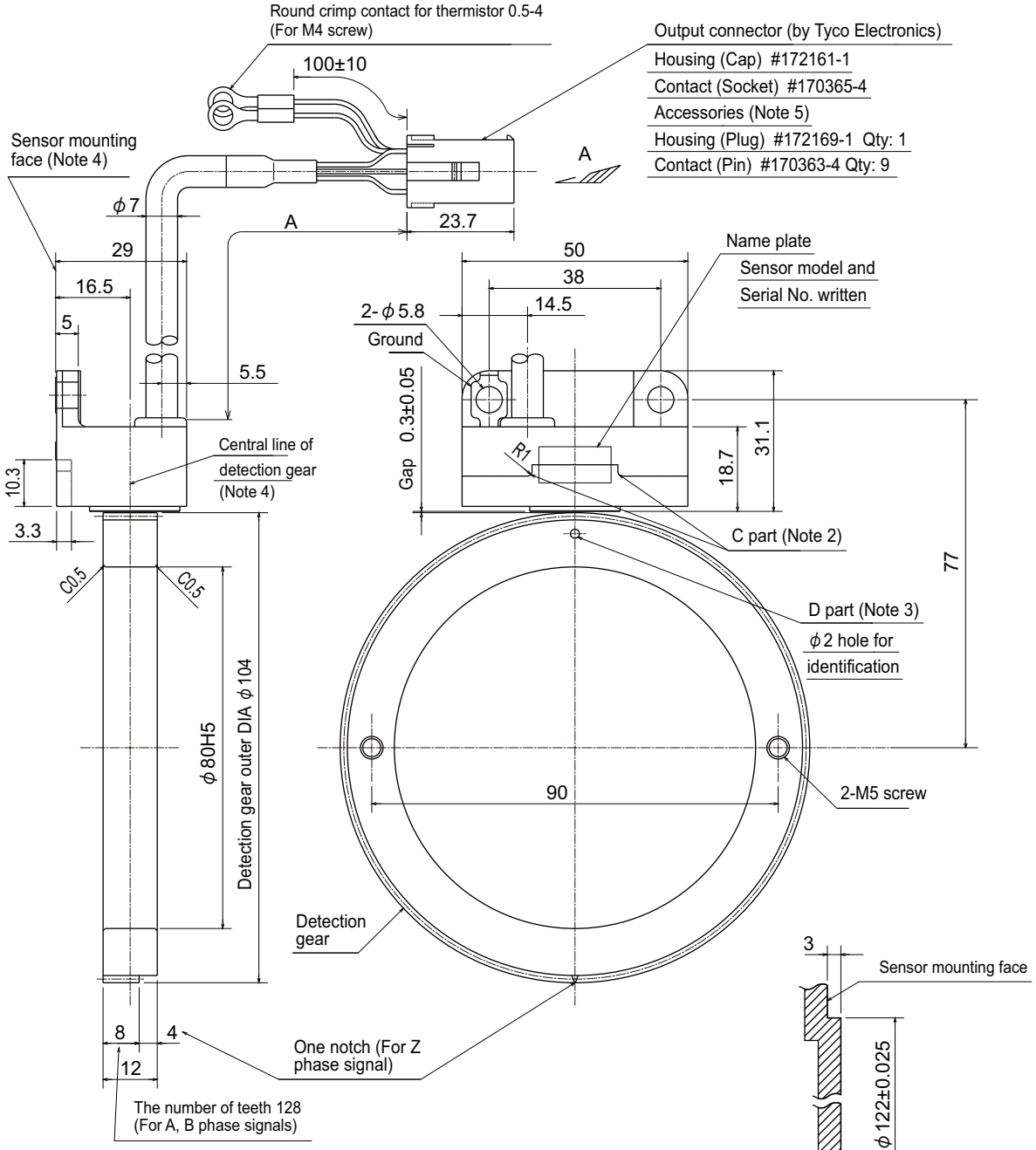
(Note 5) A connector of the signal cable side (one plug and nine pins) is attached.

Sensor		Detection gear
Parts name	Lead wire length A [mm]	Parts name
TS5690N6410	400±10	MU1606N601
TS5690N6420	800±20	
TS5690N6430	1200±20	
TS5690N6440	1600±30	
TS5690N6460	2000±30	



<TS5690N12xx + MU1606N709>

[Unit: mm]



(Note 1) Handle with care as this is a precision component.
Pay special attention not to apply excessive external force on the sensor's detection face. Applying such force will cause a fault.

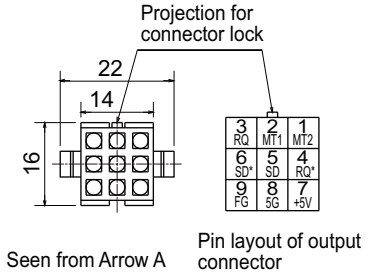
(Note 2) In installing the sensor, keep the protruding fitting of φ122±0.025 mm on the machine side, and push the C part of the sensor mounting seat against the fitting.

(Note 3) In installing the detection gear, make sure that the D part side comes the opposite side of the sensor installation side (sensor's lead wire side).

(Note 4) The diviation of the center of the detection gear is 16.5±0.25mm from the sensor mounting face.

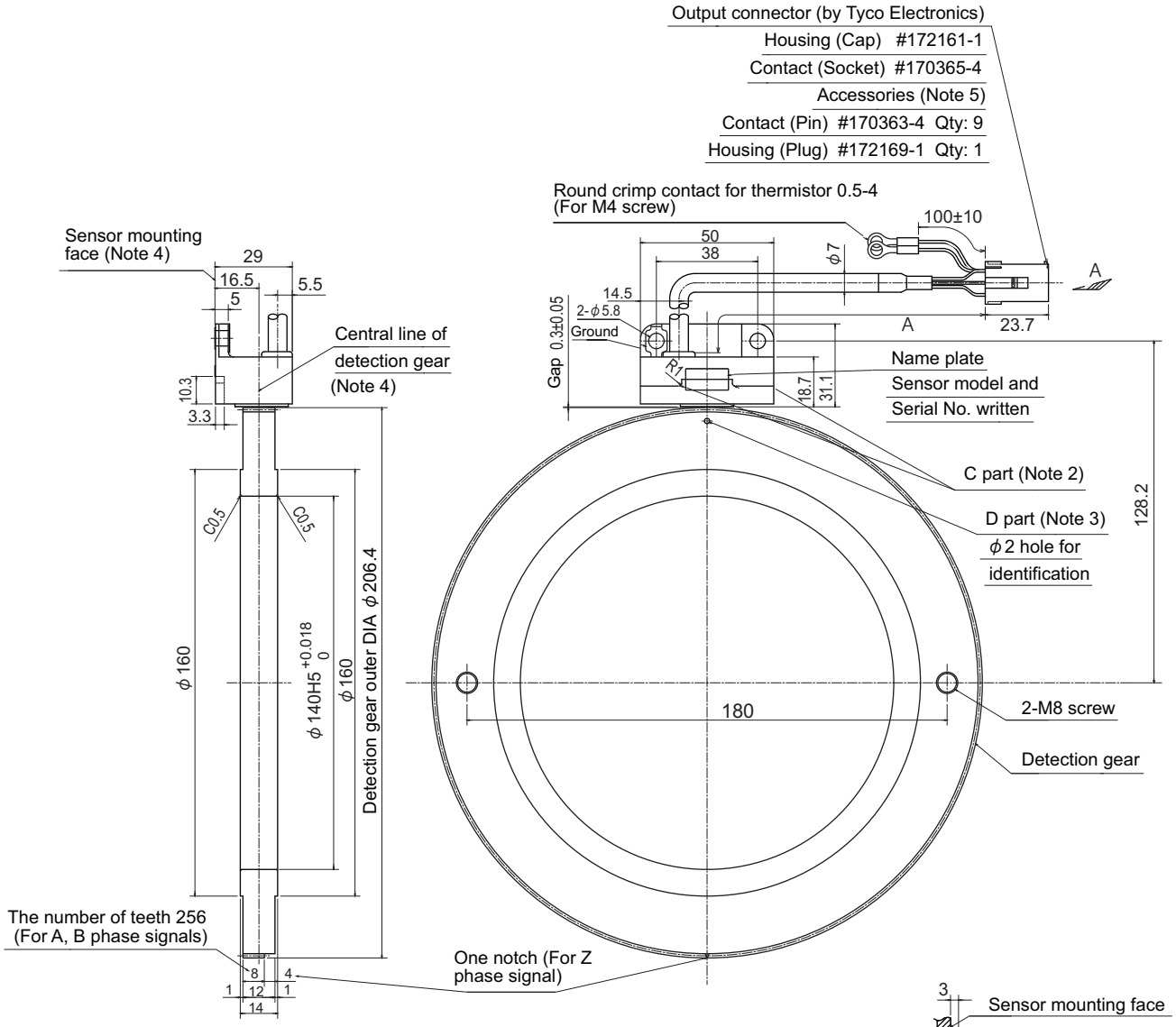
(Note 5) A connector of the signal cable side (one plug and nine pins) is attached.

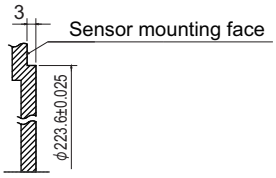
Sensor		Detection gear
Parts name	Lead wire length A [mm]	Parts name
TS5690N1210	400±10	MU1606N709
TS5690N1220	800±20	
TS5690N1230	1200±20	
TS5690N1240	1600±30	
TS5690N1260	2000±30	



<TS5690N25xx + MU1606N805>

[Unit: mm]





(Note 1) Handle with care as this is a precision component. Pay special attention not to apply excessive external force on the sensor's detection face. Applying such force will cause a fault.

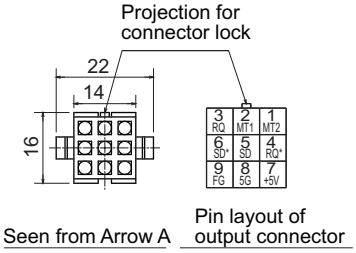
(Note 2) In installing the sensor, keep the protruding fitting of φ223.6±0.025 mm on the machine side, and push the C part of the sensor mounting seat against the fitting.

(Note 3) In installing the detection gear, make sure that the D part side comes the opposite side of the sensor installation side (sensor's lead wire side).

(Note 4) The diviation of the center of the detection gear is 16.5±0.25mm from the sensor mounting face.

(Note 5) A connector of the signal cable side (one plug and nine pins) is attached.

Sensor		Detection gear
Parts name	Lead wire length A [mm]	Parts name
TS5690N2510	400±10	MU1606N805
TS5690N2520	800±20	
TS5690N2530	1200±20	
TS5690N2540	1600±30	
TS5690N2560	2000±30	



5-2-3 Spindle side accuracy serial output encoder (ERM280, MPCI Series) (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	ERM280 1200	EIB192M C4 1200	0.0000183° (19,660,800p/rev)	20000 r/min
		EIB392M C4 1200		
	ERM280 2048	EIB192M C6 2048	0.0000107° (33,554,432p/rev)	11718 r/min
		EIB392M C6 2048		
Mitsubishi Heavy Industries Machine Tool	MPCI series	ADB-20J20	0.00005° (7200000p/rev)	10000 r/min

<Contact information about machine side encoder>

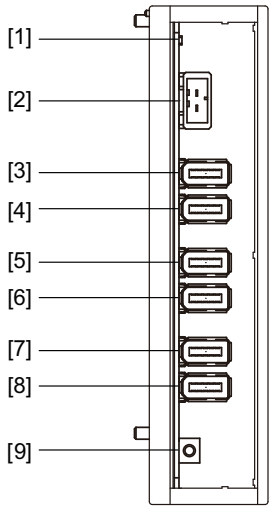
- HEIDENHAIN CORPORATION: http://www.heidenhain.com/
- Mitsubishi Heavy Industries Machine Tool: http://www.mhi-machinetool.com/en/index.html

CAUTION ! **Confirm specifications of each encoder manufacturer before using the machine side encoder.**

5-3 Encoder interface unit

5-3-1 Scale interface unit MDS-EX-SR

(1) Appearance



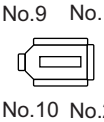
(2) Specifications

Type	MDS-EX-SR
Manufacturer	MITSUBISHI
Output signal	Mitsubishi high-speed serial signal
Degree of protection	IP20
Mass	500g

(3) Environment

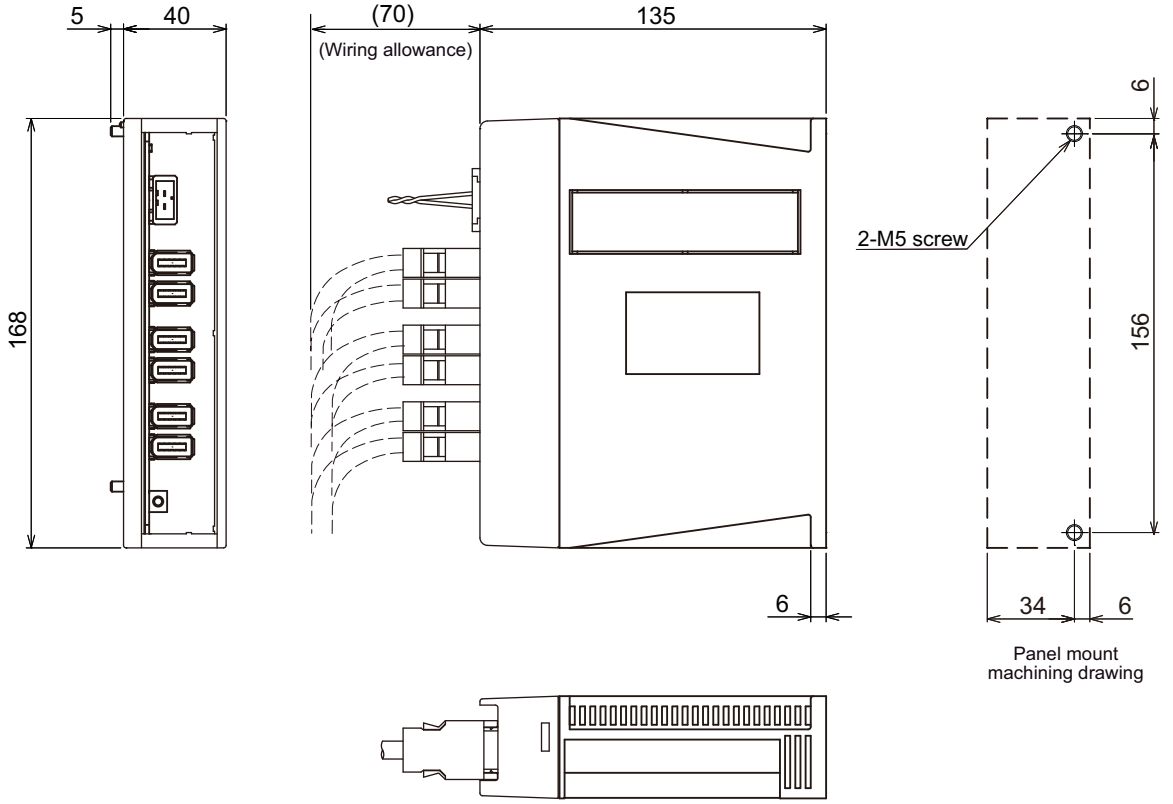
Environment	Conditions
Ambient temperature	0°C to +55°C (with no freezing)
Ambient humidity	90% RH or less (with no dew condensation)
Storage temperature	-15°C to +70°C (with no freezing)
Storage humidity	90% RH or less (with no dew condensation)
Atmosphere	Indoors (no direct sunlight); no corrosive 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

(4) Each part name

	Name	Application	Connector specifications
[1]	24V	24V power supply status indication LED	-
[2]	CN22	Control power (24VDC) input connector	
[3]	LA	MDS-DM-SPVxF (L-axis:CN3L) connection connector	
[4]	LI	Machine side encoder connection connector for servo (L axis)	
[5]	MA	MDS-DM-SPVxF (M-axis:CN3M) connection connector	
[6]	MI	Machine side encoder connection connector for servo (M axis)	
[7]	SA	MDS-DM-SPVxF (S-axis:CN3S) connection connector	
[8]	SI	Machine side encoder connection connector for servo (S axis)	
[9]	FG	Spare FG terminal (This is not used at this point.)	-

(5) Outline dimension drawings

[Unit: mm]



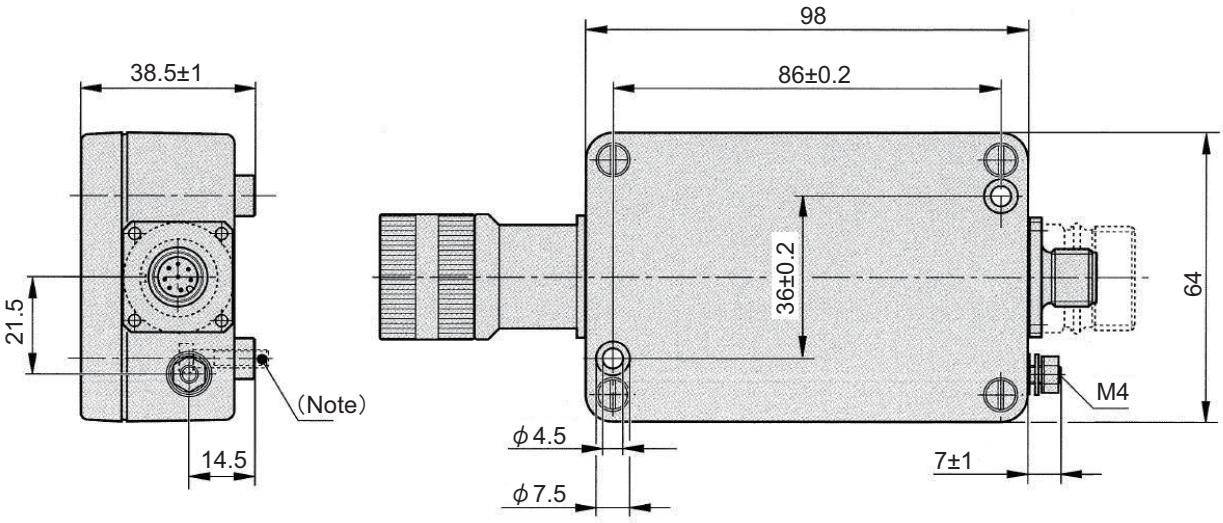
5-3-2 Serial output interface unit for ABZ analog encoder EIB192M (Other manufacturer's product)

(1) Appearance

(2) Specifications

Type	EIB192M A4 20μm	EIB192M C4 1200	EIB192M C4 2048
Manufacturer	HEIDENHAIN		
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 product, contact the manufacturer directly.**

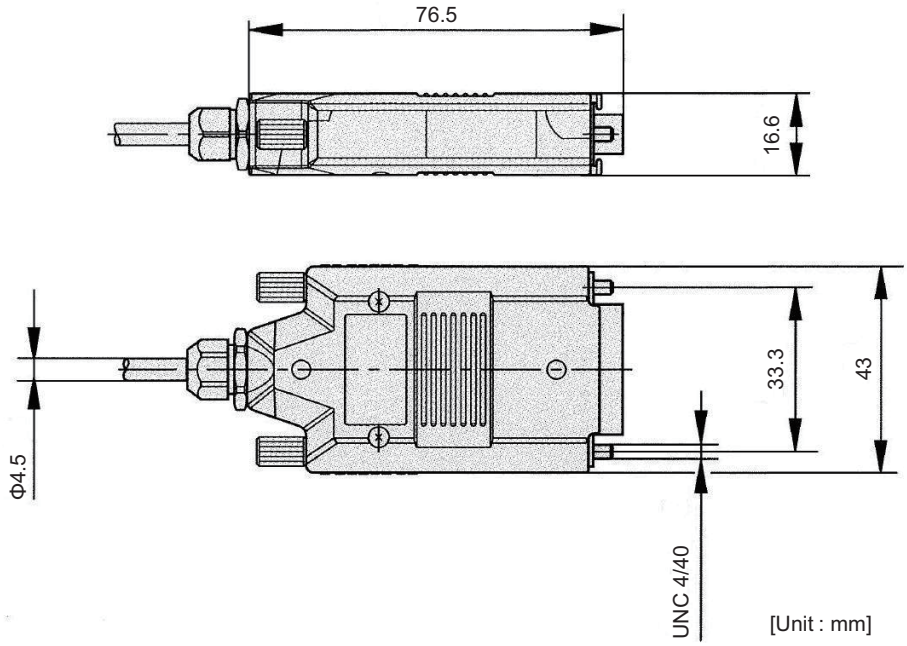
5-3-3 Serial output interface unit for ABZ analog encoder EIB392M (Other manufacturer's product)

(1) Appearance

(2) Specifications

Type	EIB392M A4 20μm	EIB392M C4 1200	EIB392M C4 2048
Manufacturer	HEIDENHAIN		
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		

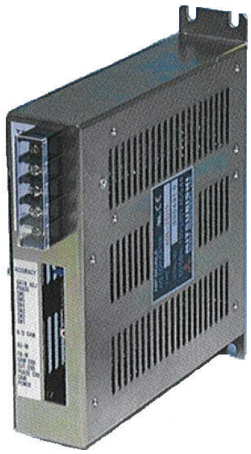
(3) Outline dimension drawings



CAUTION ! **These are other manufacturer's products. When purchasing these product, contact the manufacturer directly.**

5-3-4 Serial output interface unit for ABZ analog encoder ADB-20J Series (Other manufacturer's product)

(1) Appearance

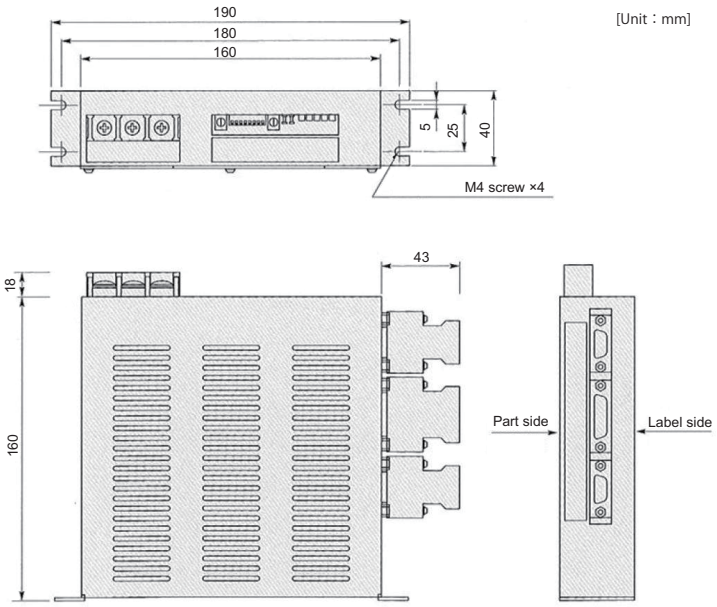


(2) Specifications

Type	ADB-20J20	ADB-20J60		ADB-20J71
Manufacturer	Mitsubishi Heavy Industries Machine Tool Co., Ltd.			
Maximum response speed	10,000r/min	3,600m/min	5,000r/min	10,000r/min
Output signal	Mitsubishi high-speed serial signal			
Compatible encoder	MPCI series	MPS Series	MPI Series	MPRZ series
Minimum detection resolution	0.00005° (7,200,000p/rev)	0.05μm	0.000025° (1,440,000p/rev)	0.000043° (8,388,608p/rev)
Working temperature	0°C to 55°C			
Degree of protection	IP20			
Mass	0.9kg			

(3) Outline dimension drawings

[Unit : mm]



CAUTION ! **These are other manufacturer's products. When purchasing these product, contact the manufacturer directly.**

5-4 Drive unit option

5-4-1 Optical communication repeater unit (FCU7-EX022)

When the distance of the optical communication cable between NC control unit and drive unit is over 30m (M700V/M70V/E70 Series: maximum 30m, M700/M70/C70 Series: maximum 20m), the communication can be performed by relaying the optical signal.
Using up to two units, relay of the total length of up to 90m can be performed.

<Product features>

(a) When the distance of the optical communication cable between NC control unit and drive unit is over 30m, the communication can be performed by relaying the optical signal.
(b) The relay between NC control unit and drive unit can be performed for up to two channels.
(c) If the distance between NC control unit and drive unit is even within 30m, the cable can be divided by the relay in transporting the machine.
(d) Same mounting dimension as the remote I/O unit (DX unit).

CAUTION ! **This unit can not be used between drive units.**

(1) Specifications

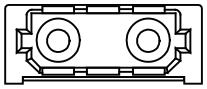
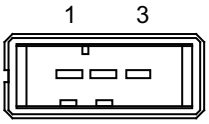
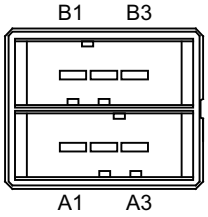
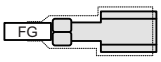
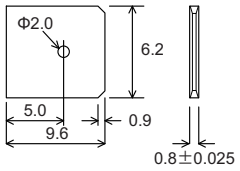
Item			FCU7-EX022
DC24V input	Input voltage		24V±10% (21.6V to 26.4V)
	Inrush current		35A
	Power consumption		10W
	Consumption current		0.4A
Optical interface	Channel number		2 channels
	Connectable number		Maximum 2
Environment	Ambient temperature	Operation	0°C to +55°C
		Storage	-20°C to +60°C
	Ambient humidity	Operation (long term)	+10%RH to +75%RH (with no dew condensation)
		Operation (short term)	+10%RH to +95%RH (with no dew condensation. Short term is within about one month.)
		Storage	+10%RH to +75%RH (with no dew condensation)
	Vibration	Operation	4.9m/s^2
		Transportation	34.3m/s^2
	Impact resistance	Operation	29.4m/s^2
	Atmosphere		No corrosive gas, oil mist, or dust
Dimension	Dimension		(depth)135mm × (width)40mm × (height)168mm
	Mounting method		Screw cramp with M5 2 screw cramps
Mass			0.42kg

(2) Explanation of connectors

Connector name	Application	Remarks
OPT1IN, OPT1OUT, OPT2IN, OPT2OUT	Optical connector	
DCIN	DC24V Power connector	
DCOUT	DC24V/ Power OFF detection output connector	Relays the PD25/27 output to NC control unit.
ACFAIL	Power OFF detection connector	Relays the power OFF detection signal (ACFAIL) when sharing 24V power from PD25/PD27 for NC control unit and optical communication repeater unit. It will not be used when dedicated general-purpose power supply for optical communication repeater unit is prepared.
FG	FG Faston terminal	

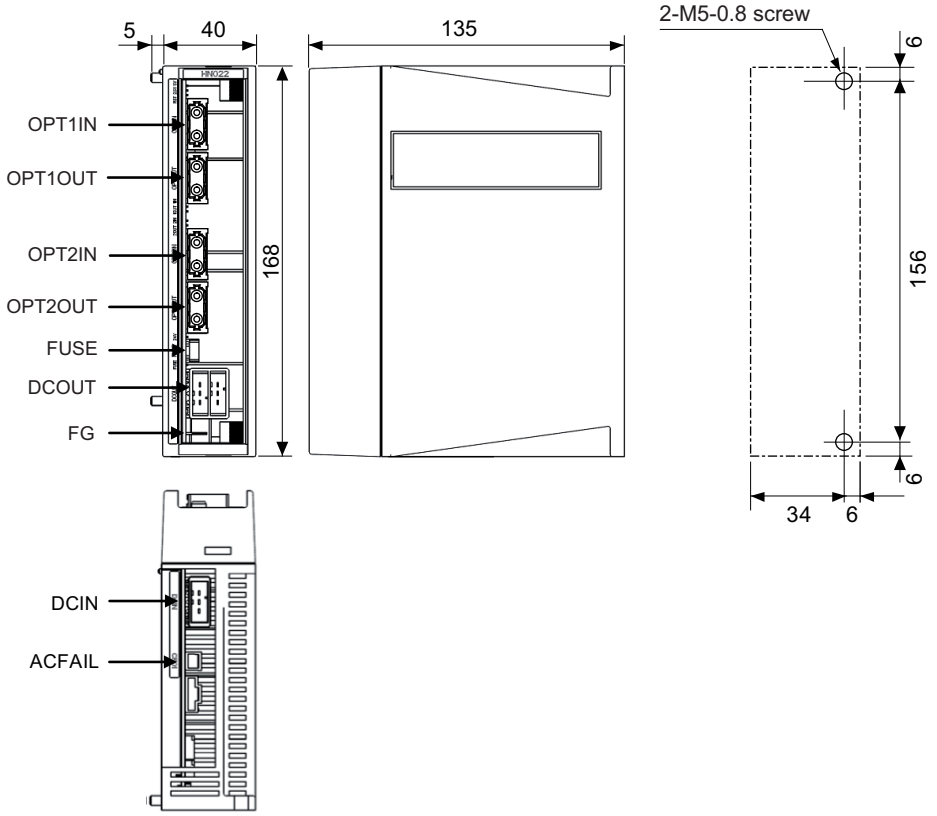
DCIN		DCOUT				ACFAIL	
Pin No.	**Name**	**Pin No.**	**Name**	**Pin No.**	**Name**	**Pin No.**	**Name**
1	DC24V	**A1**	ACFAIL	**B1**	DC24V	**1**	COM
2	0V (RG)	**A2**	COM	**B2**	0V (RG)	**2**	ACFAIL
3	FG	**A3**	NC	**B3**	FG		

< Connector pin layout >

Optical communication I/F (OPT1IN, OPT1OUT, OPT2IN, OPT2OUT)	DC24V input (DCIN)	DC24V output (DCOUT)	Power OFF input ACFAIL (Terminal name:CF01)	FG terminal (FG)
				
<Cable side connector type> (PCF type) Connector: CF-2D101-S Recommended manufacturer: Japan Aviation Electronics (POF type) Connector: PF-2D101 Recommended manufacturer: Japan Aviation Electronics	<PCB side connector type> Connector: 2-178293-5 Recommended manufacturer: Tyco Electronics <Cable side connector type> Connector: 2-178288-3 Contact: 1-175218-5 Recommended manufacturer: Tyco Electronics	<PCB side connector type> Connector: 3-178137-5 Recommended manufacturer: Tyco Electronics <Cable side connector type> Connector: 2-178127-6 Contact: 1-175218-5 Recommended manufacturer: Tyco Electronics	<PCB side connector type> Connector: 53103-0230 Recommended manufacturer: MOLEX <Cable side connector type> Connector: 005057-9402 Contact: 0016020103 Recommended manufacturer: MOLEX	<Cable side faston terminal type name> Type name: 175022-1 (For AWG20-14 250 series) Recommended manufacturer: Tyco Electronics Terminal protection tube: 174817-2 (Yellow)  Unit side tab terminal shape (Note) The faston terminal "175022-1" of the cable side is a simple lock type. Make sure to insert until the simple lock pin is in the Φsecond hole. Firmly press the simple lock release tab when unplugging it.

(3) Outline dimension drawings

[Unit: mm]

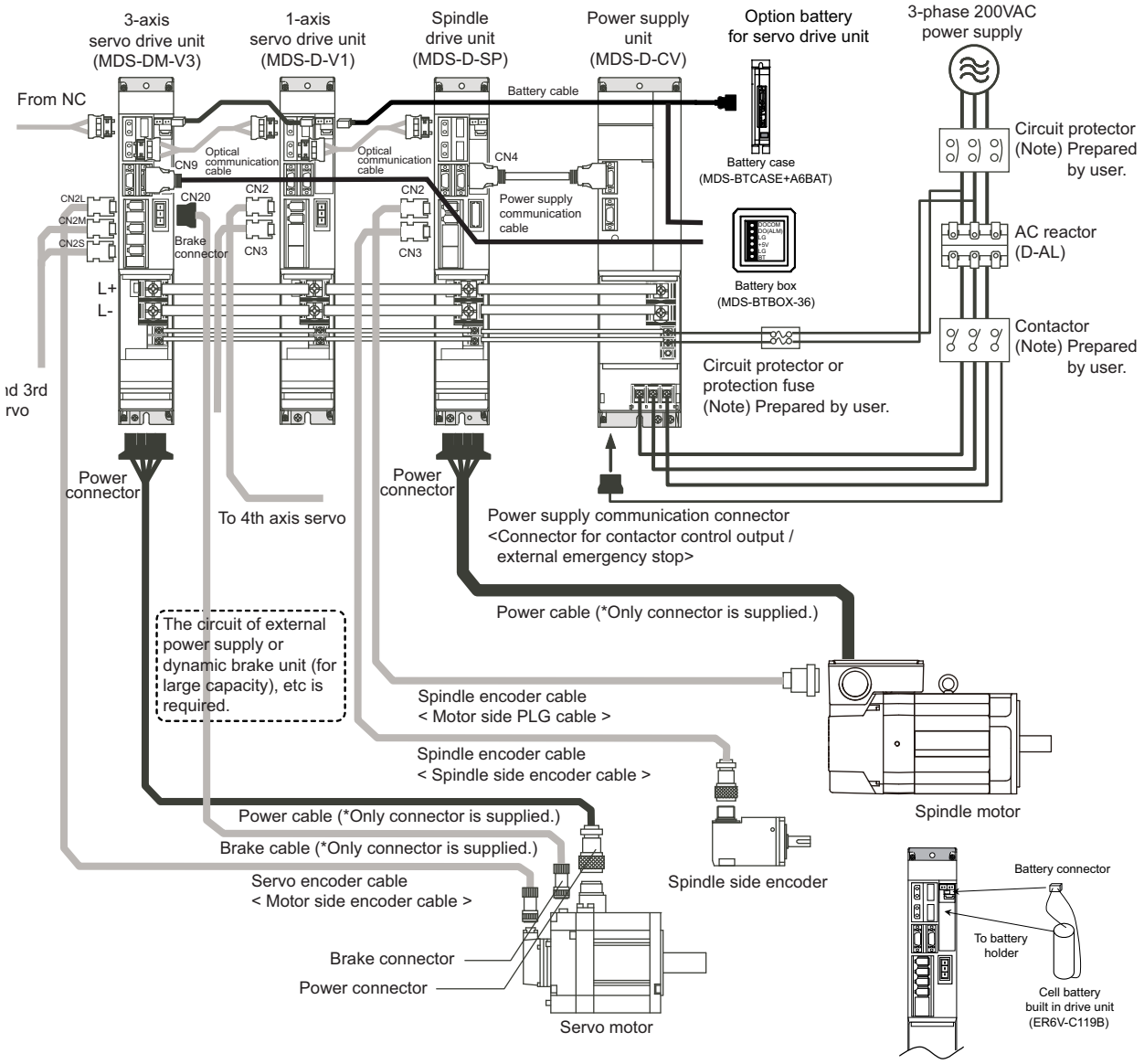


5-5 Cables and connectors

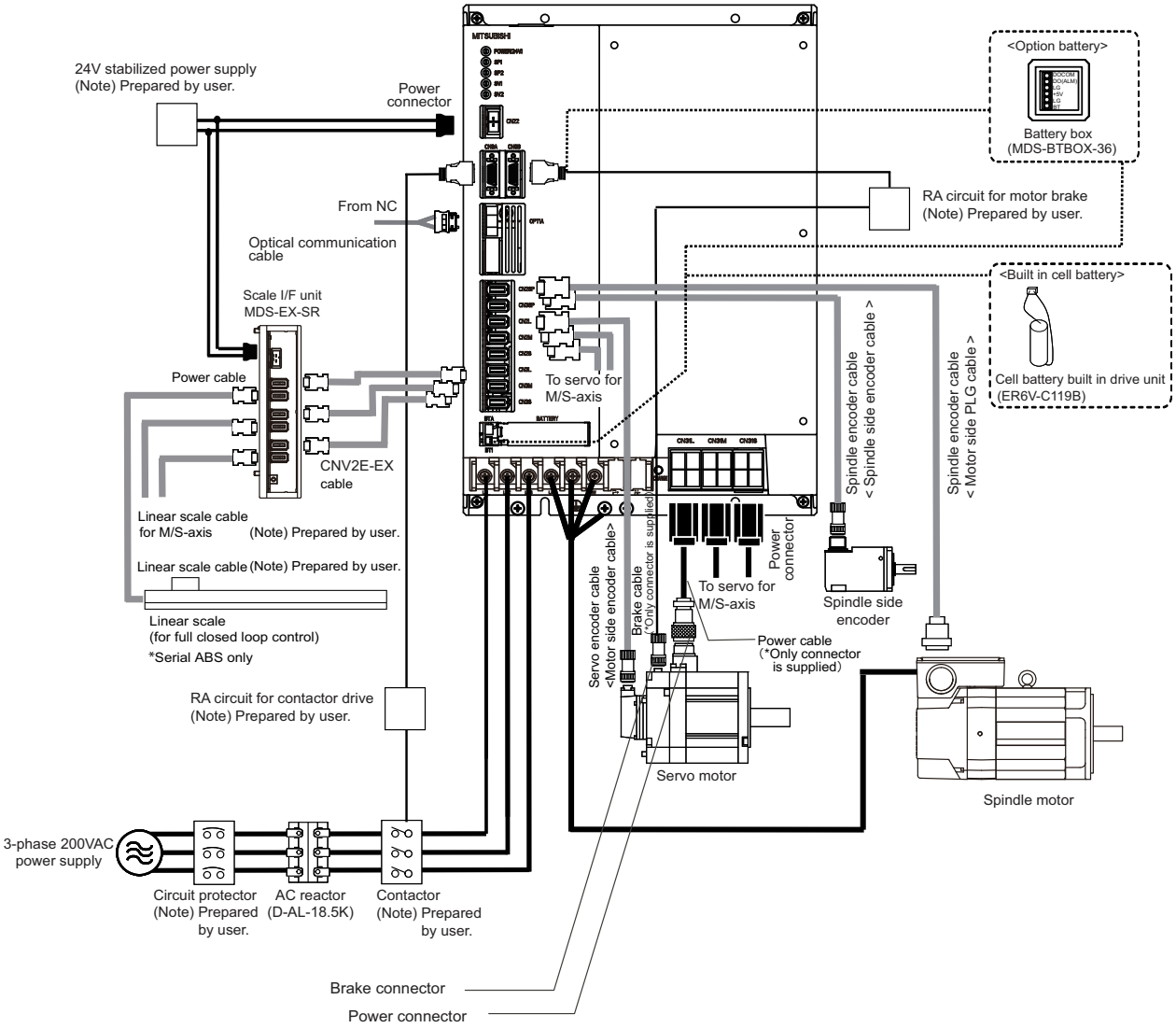
5-5-1 Cable connection diagram

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.

<MDS-DM-V3 Series>

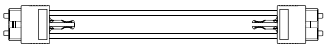
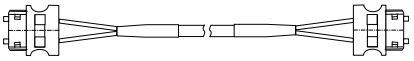


<MDS-DM-SPV Series>



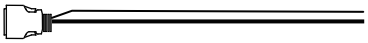
5-5-2 List of cables and connectors

< Optical communication cable>

Item		Model	Contents	
For CN1A/ CN1B/ OPT1A	Optical communication cable For wiring between drive units (inside panel)	G396-L ☐ M ☐ : Length 0.3, 0.5, 1, 2, 3, 5m	Drive unit side connector (Japan Aviation Electronics Industry) Connector: PF-2D103	Drive unit side connector (Japan Aviation Electronics Industry) Connector: PF-2D103
				
	Optical communication cable For wiring between drive units (outside panel) For optical servo communication repeater unit	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 battery unit	Battery cable (For drive unit - battery unit)	DG21- ☐ M ☐ : Length 0.3, 0.5, 1, 5m	Drive unit side connector (Hirose Electric) Connector: DF1B-2S-2.5R Contact: DF1B-2428SCA (Note 2)	Battery unit side connector (3M) Connector: 10120-3000VE Shell kit : 10320-52F0-008
				
				Compatible part (Note 1) (J.S.T) Connector : MS-P20-L Shell kit : MS20-2B-28
	Battery cable (For drive unit - battery box)	DG23- ☐ M ☐ : Length 0.3, 0.5, 1, 2, 3, 5, 7, 10m	Drive unit side connector (Hirose Electric) Connector: DF1B-2S-2.5R Contact: DF1B-2428SCA (Note 2)	Battery box side (Note 3)
				
	5V supply/DO output cable (For drive unit - battery box)	DG24- ☐ M ☐ : Length 0.3, 0.5, 1, 2, 3, 5, 7, 10m	Drive unit side connector (3M) Connector: 10120-6000EL Contact: 10320-3210-000	Battery box side (Note 3)
				
For drive unit	Battery cable (For drive unit - drive unit) *This cable is required to supply the power from the battery unit to multiple drive units.	DG22- ☐ M ☐ : Length 0.3, 0.5, 1, 2, 3, 5, 7, 10m	Drive unit side connector (Hirose Electric) Connector: DF1B-2S-2.5R Contact: DF1B-2428SCA (Note 2)	Drive unit side connector (Hirose Electric) Connector: DF1B-2S-2.5R Contact: DF1B-2428SCA (Note 2)
				
For CN9	Battery cable Connector set:	FCUA-CS000	Drive unit side connector (3M) Connector: 10120-3000VE Shell kit : 10320-52F0-008	Power supply unit side connector (3M) 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

(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: DF1B-TA2428SHC

(Note 3) The battery box side is connected using a bare conductor or a bar terminal.

< Power supply communication cable and connector >

Item		Model	Contents	
For CN4/9	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
For CN4/9	Power supply communication cable connector set	FCUA-CS000	Drive unit side connector (3M) Connector: 10120-3000VE Shell kit : 10320-52F0-008	Power supply unit side connector (3M) Connector: 10120-3000VE Shell kit : 10320-52F0-008
			Compatible part (Note) (J.S.T) Connector : MS-P20-L Shell kit : MS20-2B-28	Compatible part (Note) (J.S.T) Connector : MS-P20-L Shell kit : MS20-2B-28
For CN23	Contactor control output / external emergency stop for connector	CNU23S(AWG14)	Power supply unit side connector (DDK) Connector: DK-3200M-06RXY Contact: DK-3REC2LLP1-100	

(Note) The names of compatible parts may be changed at the manufacturer's discretion. Contact each manufacturer for more information.

< Optical communication repeater unit >

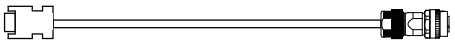
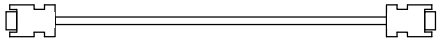
Item		Model	Contents	
For OPT1/2	Optical communication cable For wiring between drive unit and optical communication repeater unit/ For wiring between optical communication repeater units	G380-L ☐ M ☐ : Length 5, 10, 12, 15, 20, 25, 30m	Drive unit side/ Optical communication repeater unit side connector (Tyco Electronics) Connector: 1123445-1	Optical communication repeater unit side connector (Tyco Electronics) Connector: 1123445-1
For DCIN	For optical communication repeater unit DC24V power cable	F070 ☐ : Length 0.5, 1.5, 3, 5, 8, 10, 15, 20m	DC24V power side terminal (J.S.T.) Crimp terminal: V1.25-3 or V1.25-4 × 2	Optical communication repeater unit side connector (Tyco Electronics) Connector: 2-178288-3 Contact: 1-175218-5 × 3 (Note 1)
For DCIN/ ACFAIL	For optical communication repeater unit/ For connecting Mitsubishi power unit PD25, PD27 DC24V power cable (power OFF detection)	F110 ☐ : Length 0.5, 1.5, 3, 5, 8, 10, 15m	DC24V power side connector (Tyco Electronics) Connector: 3-178127-6 Contact: 1-175218-5 (for AWG16) × 3 (Note 1) 1-175217-5 (for AWG22) × 2 (Note 2)	Optical communication repeater unit side connector < DCIN > (Tyco Electronics) Connector: 2-178288-3 Contact: 1-175218-5 × 3 (Note 1) < ACFAIL (CF01) > (MOLEX) 005057-9402 0016020103 × 2 (Note 3)

(Note 1) Hand crimping tools: 91558-1

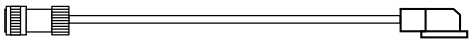
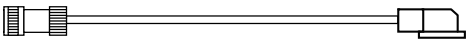
(Note 2) Hand crimping tools: 91557-1

(Note 3) Hand crimping tools: 57036-5000

< Servo encoder cable and connector >

Item		Model	Contents
For CN2/ CN2L/M/S	For HF Motor side encoder cable	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 MDS-EX-SR	For MDS-EX-SR Motor side encoder relay cable	CNV2E-EX- ☐ M ☐ : Length 0.3,0.5, 1m	MDS-DM-SPVxF unit side connector (3M) Receptacle : 36210-0100PL Shell kit : 36310-3200-008  MDS-EX-SR unit side connector (3M) Receptacle : 36210-0100PL Shell kit : 36310-3200-008 (MOLEX) Connector set: 54599-1019
For servo motor encoder/ Ball screw side encoder	Motor side encoder connector/ Ball screw side encoder connector	CNE10-R10S(9) Applicable cable outline ø6.0 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 ø6.0 to 9.0mm	 Servo motor encoder/ Ball screw side encoder side connector (DDK) Plug : CMV1-AP10S-M2 Contact: CMV1-#22ASC-S1
For CN2	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

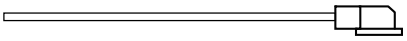
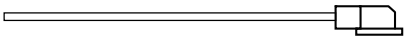
(Note 1) The names of compatible parts may be changed at the manufacturer's discretion. Contact each manufacturer for more information.

Item			Model	Contents
For CN2/ CN2L/M/S	Direct connection type	For HF-KP Motor side encoder cable	CNV2E-K1P- ☐ M Lead out in direction of motor shaft ☐ : Length 2, 3, 4, 5, 7, 10,m Compatible with only IP65	Drive unit side connector (3M) Receptacle: 36210-0100PL Shell kit : 36310-3200-008 (MOLEX) Connector set: 54599-1019 Motor encoder side connector (Tyco Electronics) Connector: 1674320-1  Compatible part (Note 2) (MOLEX) Connector set : 54599-1019 (J.S.T.) Plug connector : XV-10P-03-L-R Cable kit : XV-PCK10-R
			CNV2E-K2P- ☐ M Lead out in opposite direction of motor shaft ☐ : Length 2, 3, 4, 5, 7, 10,m Compatible with only IP65	Drive unit side connector (3M) Receptacle: 36210-0100PL Shell kit : 36310-3200-008 (MOLEX) Connector set: 54599-1019 Motor encoder side connector (Tyco Electronics) Connector: 1674320-1  Compatible part (Note 2) (MOLEX) Connector set : 54599-1019 (J.S.T.) Plug connector : XV-10P-03-L-R Cable kit : XV-PCK10-R
	Relay type (Note 1)	For HF-KP Motor side encoder relay cable (motor side)	CNV22J-K1P-0.3M Lead out in direction of motor shaft Length: 0.3m Compatible with only IP65	Relay side connector (DDK) Plug: CM10-CR10P-M Motor encoder side connector (Tyco Electronics) Plug : 1747464-1 Contact: 1674335-4 
			CNV22J-K2P-0.3M Lead out in opposite direction of motor shaft Length: 0.3m Compatible with only IP65	Relay side connector (DDK) Plug: CM10-CR10P-M Motor encoder side connector (Tyco Electronics) Plug : 1747464-1 Contact: 1674335-4 
		For HF-KP Motor side encoder relay cable (Drive unit side)	CNV2E-8P- ☐ M ☐ : Length 15, 20, 25, 30m	Drive unit side connector (3M) Receptacle: 36210-0100PL Shell kit : 36310-3200-008 Relay side connector (DDK) Plug : CMV1-SP10S-M2 Contact: CMV1-#22ASC-S1  Compatible part (Note 2) (MOLEX) Connector set : 54599-1019 (J.S.T.) Plug connector : XV-10P-03-L-R Cable kit : XV-PCK10-R

(Note 1) When using cable of 15m or longer, use relay cable.

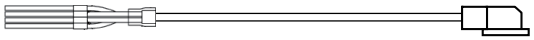
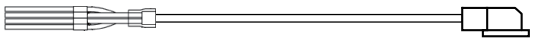
(Note 2) The names of compatible parts may be changed at the manufacturer's discretion. Contact each manufacturer for more information.

< Brake cable and connector >

Item		Model	Contents
For motor brake	Brake connector for HF	CNB10-R2S(6) Applicable cable outline ø4.0 to 6.0mm	Servo motor side brake connector (DDK) Plug : CMV1-SP2S-S Contact: CMV1-#22BSC-S2 
		CNB10-R2L(6) Applicable cable outline ø4.0 to 6.0mm	Servo motor side brake connector (DDK) Plug : CMV1-AP2S-S Contact: CMV1-#22BSC-S2 
	Brake cable for HF-KP	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	CNU20S(AWG14)	Servo drive unit side connector (DDK) Connector : DK-3200S-03R Contact: DK-3REC2LLP1-100 (Note 1) 

(Note 1) Hand crimping tools: 357J-22113

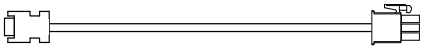
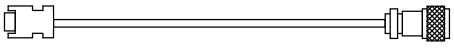
< Power connector >

Item		Model	Contents
For motor power	Power connector for HF75, 105, 54,104,154, 224, 123, 223, 142	CNP18-10S(14) Applicable cable outline ø10.5 to 14mm	Motor side power connector (DDK) Plug: CE05-6A18-10SD-C-BSS Clamp: CE3057-10A-1 (D240) 
		CNP18-10L(14) Applicable cable outline ø10.5 to 14mm	Motor side power connector (DDK) Plug: CE05-8A18-10SD-C-BAS Clamp: CE3057-10A-1 (D240) 
	Power connector for HF204, 354, 303, 453, 302	CNP22-22S(16) Applicable cable outline ø12.5 to 16mm	Motor side power connector (DDK) Plug: CE05-6A22-22SD-C-BSS Clamp: CE3057-12A-1 (D240) 
		CNP22-22L(16) Applicable cable outline ø12.5 to 16mm	Motor side power connector (DDK) Plug: CE05-8A22-22SD-C-BAS Clamp: CE3057-12A-1 (D240) 
	Power cable for HF-KP	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) 
For TE1	Power connector for MDS-DM-V3	CNU1S(AWG14)	Drive unit side power connector (DDK) Housing: DK-5200S-04R Contact : DK-5RECSLP1-100 
For CN31 L/M/S	Power connector for MDS-DM-SPV Series	RCN31S RCN31M Applicable cable outline ø1.25 to 5.5mm	Drive unit side power connector (DDK) Housing: DK-5200M-04R Contact : DK-5RECSLP1-100 (For AWG 14,16) Contact : DK-5RECMLP1-100 (For AWG 10,12) 

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

Item		Model	Contents
For CN22	Control power connector for MDS-DM-SPV Series	RCN22 Applicable cable outline ø0.5 to 1.25mm	Drive unit side control power connector (DDK) Housing: DK-3200S-02R Contact: DK-3RECLLP1-100 
		RCN22S Applicable cable outline ø1.25 to 2.2mm	Drive unit side control power connector (DDK) Housing: DK-3200S-02R Contact: DK-3REC2LLP1-100 

< 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: MS3106A20-29S(D190) Straight back shell: CE02-20BS-S Clamp: CE3057-12A-3 
			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: MS3106A20-29S(D190) Angle back shell: CE-20BA-S Clamp : CE3057-12A-3 
			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.

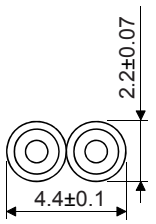
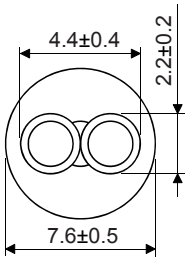
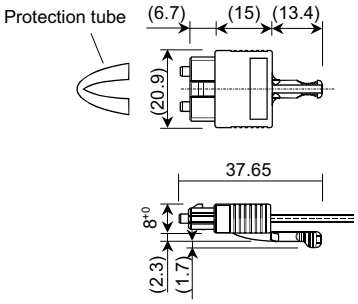
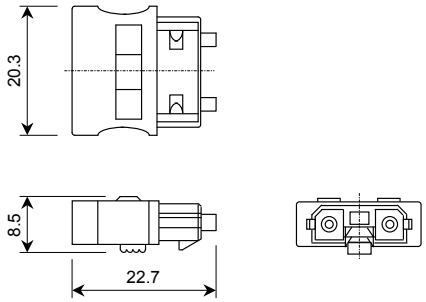
Item		Model	Contents
For spindle motor	Motor side PLG connector Spindle side accuracy encoder TS5690 connector	CNEPGS	Spindle motor side connector (Tyco Electronics) Connector: 172169-1 Contact:170363-1(AWG26-22) 170364-1(AWG22-18) 
For spindle motor	Spindle side encoder OSE-1024 cable	CNE20-29S(10) Applicable cable outline Φ6.8 to 10mm	Spindle motor side connector (DDK) Connector:MS3106A20-29S(D190) Straight back shell: CE02-20BS-S Clamp: CE3057-12A-3 
		CNE20-29S(10) Applicable cable outline Φ6.8 to 10mm	Spindle motor side connector (DDK) Connector:MS3106A20-29S(D190) Angle back shell: CE-20BA-S Clamp: CE3057-12A-3 
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.: http://www.hirose.com/
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 Ltd.: http://www.molex.com/

5-5-3 Optical communication cable specifications

(1) Specifications

Cable model		G396-L ☐ M	G380-L ☐ M
Specification application		For wiring inside panel	For wiring outside panel For long distance wiring
Cable length		0.3, 0.5, 1.0, 2.0, 3.0, 5.0m	5.0, 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 (Note 1)	-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/OPT1A 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

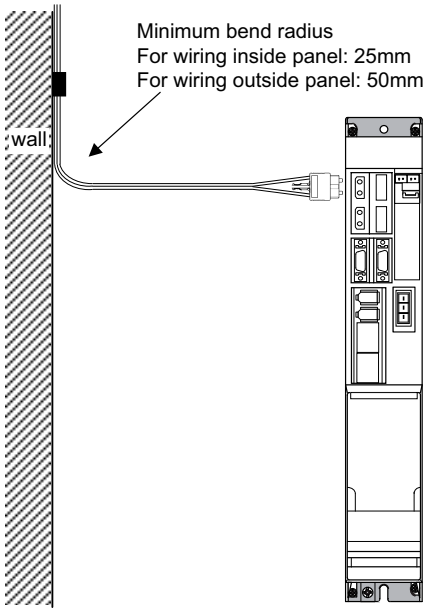
Optical communication cable is made from optical fiber. If optical fiber is added a power such as a major shock, lateral pressure, haul, sudden bending or twist, its inside distorts or breaks, and optical transmission will not be available. Especially, as optical fiber for G396-L □ M is made of synthetic 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/OPT1A 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.
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 (G380-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/OPT1A 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/CN1B/OPT1A 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/OPT1A 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

6-1-1 Example of wires by unit

Selected wires must be able to tolerate rated current of the unit's terminal 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. In the UL standards, certification conditions are to use wires of 60°C and 75°C product. (UL508C)
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.
Example of wire selections according to each standard is as follows.

(1) 600V vinyl insulated wire (IV wire) 60°C product (Example according to IEC/EN60204-1, UL508C)

<MDS-DM-V3 Series>

Unit type		Terminal name					
		TE1 (U, V, W, ⏚)		TE2 (L+, L-)		TE3 (L11, L21)	
		mm^2	AWG	mm^2	AWG	mm^2	AWG
Servo drive unit	MDS-DM-V3-202020	2	14	Match with TE2 of selected power supply unit		2	14
	MDS-DM-V3-404040						

<MDS-DM-SPV Series>

Unit type		Terminal name							
		TE1 (L1, L2, L3)		TE1 (U, V, W)		CN31L/M/S (U,V,W,PE)		CN22 (VDD.SG)	
		mm^2	AWG	mm^2	AWG	mm^2	AWG	mm^2	AWG
Drive unit	MDS-DM-SPV3F-10080	30	3	5.5	10	3.5	12	2	14
	MDS-DM-SPV3F-16080			14	6				
	MDS-DM-SPV3F-20080			22	4				
	MDS-DM-SPV3F-200120			22	4	5.5	10		
	MDS-DM-SPV2F-10080			5.5	10	3.5	12		
	MDS-DM-SPV2F-16080			14	6				
	MDS-DM-SPV2F-20080			22	4				

(2) 600V double (heat proof) vinyl insulated wire (HIV wire) 75°C product (Example according to IEC/EN60204-1, UL508C)

<MDS-DM-V3 Series>

Unit type		Terminal name					
		TE1 (U, V, W, ⏚)		TE2 (L+, L-)		TE3 (L11, L21)	
		mm^2	AWG	mm^2	AWG	mm^2	AWG
Servo drive unit	MDS-DM-V3-202020	2	14	Match with TE2 of selected power supply unit		2	14
	MDS-DM-V3-404040						

<MDS-DM-SPV Series>

Unit type		Terminal name							
		TE1 (L1, L2, L3)		TE1 (U, V, W)		CN31L/M/S (U,V,W,PE)		CN22 (VDD.SG)	
		mm^2	AWG	mm^2	AWG	mm^2	AWG	mm^2	AWG
Drive unit	MDS-DM-SPV3F-10080	22	4	5.5	10	3.5	12	2	14
	MDS-DM-SPV3F-16080			8	8				
	MDS-DM-SPV3F-20080			22	4				
	MDS-DM-SPV3F-200120			22	4	5.5	10		
	MDS-DM-SPV2F-10080			5.5	10	3.5	12		
	MDS-DM-SPV2F-16080			8	8				
	MDS-DM-SPV2F-20080			22	4				

(3) 600V bridge polyethylene insulated wire (IC) 105 °C product (Example according to JEAC8001)

<MDS-DM-V3 Series>

Unit type		Terminal name					
		TE1 (U, V, W, ⏚)		TE2 (L+, L-)		TE3 (L11, L21)	
		mm^2	AWG	mm^2	AWG	mm^2	AWG
Servo drive unit	MDS-DM-V3-202020	2	14	Match with TE2 of selected power supply unit		1.25 to 2	16 to 14
	MDS-DM-V3-404040						

<MDS-DM-SPV Series>

Unit type		Terminal name							
		TE1 (L1, L2, L3)		TE1 (U, V, W)		CN31L/M/S (U,V,W,PE)		CN22 (VDD.SG)	
		mm^2	AWG	mm^2	AWG	mm^2	AWG	mm^2	AWG
Drive unit	MDS-DM-SPV3F-10080	14	6	3.5	12	2	14	1.25 to 2	16 to 14
	MDS-DM-SPV3F-16080			5.5	10				
	MDS-DM-SPV3F-20080			14	6				
	MDS-DM-SPV3F-200120			14	6	3.5	12		
	MDS-DM-SPV2F-10080			3.5	12	2	14		
	MDS-DM-SPV2F-16080			5.5	10				
	MDS-DM-SPV2F-20080			14	6				

⚠ 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 rated output and 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.

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-D-CV-**	**37**	**75**	**110**	**185**	**300**	**370**	**450**	**550**
	MDS-DM-SPV2F-	**-**	**-**	**-**	**xxx80**	**-**	**-**	**-**	**-**
	MDS-DM-SPV3F-	**-**	**-**	**-**	**xxx80 200120**	**-**	**-**	**-**	**-**
Rated output		3.7kW	7.5kW	11kW	18.5kW	30kW	37kW	45kW	55kW
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-D-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".

⚠ 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 "6-4-1 Circuit protector ".**

6-2-2 Selection of contactor

Select the contactor selection current that is calculated from the rated output and 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.

(1) For power supply

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-D-CV-**	**37**	**75**	**110**	**185**	**300**	**370**	**450**	**550**
	MDS-DM-SPV2F-	**-**	**-**	**-**	**xxx80**	**-**	**-**	**-**	**-**
	MDS-DM-SPV3F-	**-**	**-**	**-**	**xxx80 200120**	**-**	**-**	**-**	**-**
Rated output		3.7kW	7.5kW	11kW	18.5kW	30kW	37kW	45kW	55kW
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-T80 -AC200V	S-N150 -AC200V	S-N150 -AC200V	S-N180 -AC200V
Conventional freeair thermal current of the selection example of contactor		20A	50A	50A	100A	135A	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-D-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".

(2) For spindle coil changeover

< Example of selecting a contactor for the coil changeover

(Use a same contactor regardless of low-speed coil or high-speed coil) >

Unit type	Contactor type
MDS-DM-SPV2/SPV2F-10080 MDS-DM-SPV3/SPV3F-10080 MDS-DM-SPV2/SPV2F-16080 MDS-DM-SPV3/SPV3F-16080	S-T35
MDS-DM-SPV2/SPV2F-20080 MDS-DM-SPV3/SPV3F-20080	S-T65

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

Unit	Earth leakage current	Maximum earth leakage current
MDS-DM-V3 Series	3mA	6mA
MDS-DM-SPV3F Series	9mA	21mA
MDS-DM-SPV2F Series	8mA	19mA

(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.

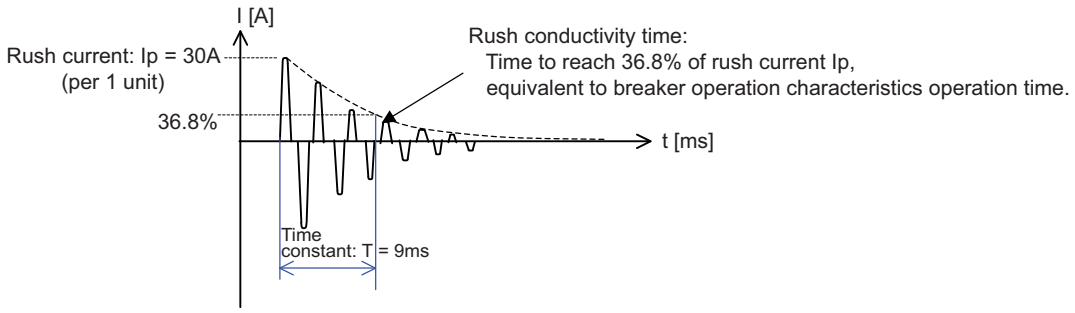
2. A higher frequency earth leakage current will always be generated because the inverter circuit in the drive unit switches the transistor at high speed. Always ground to reduce the higher frequency earth leakage current as much as possible.

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 (for MDS-DM-V3)

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. A circuit protector with inertial delay is available to prevent unnecessary tripping. Select the product to be used according to the machine specifications.
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.



Note) Rush current of MDS-D-37/75 is 38A.

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 (for MDS-DM-V3)

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, 20 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.

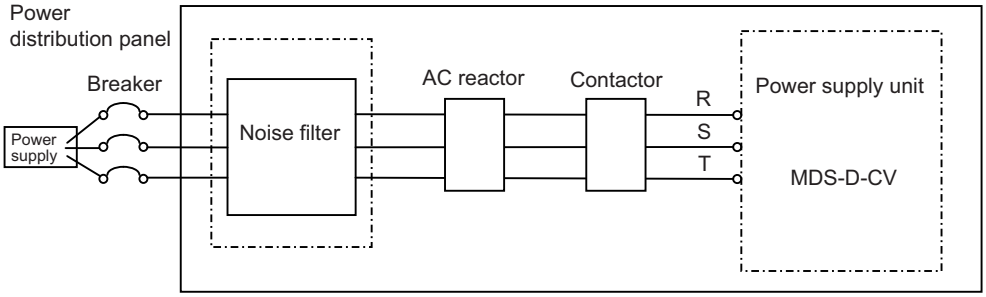
6-5 Noise filter

(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:

Densei-lambda MX13 Series
Soshin Electric HF3000C-TM Series

Contact:

Densei-lambda Co., Ltd. Telephone: 0120-507039 http://www.densei-lambda.com
Soshin Electric Co., Ltd. Telephone: 03-3775-9112 (+81-3-3775-9112) http://www.soshin.co.jp

(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 120V product is applied. When the brake operation time is delayed, use a 220V product. Always confirm the operation with an actual machine.

(2) Specifications

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

Varistor specifications

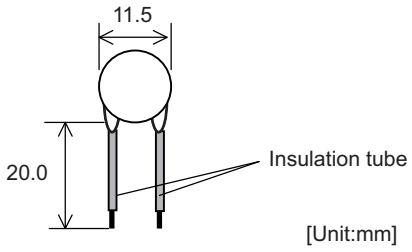
Varistor type	Varistor voltage rating (range)	Rating							Max. limit voltage	Electrostatic capacity (reference value)
		Tolerable circuit voltage		Surge current withstand level (A)		Energy withstand level (J)		Power		
	(V)	AC(V)	DC(V)	1 time	2 times	10/ 1000μs	2ms	(W)	(V)	(pF)
ERZV10D121 TND10V-121K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

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

(Note 2) 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

ERZV10D121, ERZV10D221



POINT

Normally use a product with 120V varistor voltage. If there is no allowance for the brake operation time, use the 220V product. A varistor whose voltage exceeds 220V cannot be used, as such varistor will exceed the specifications of the relay in the 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.

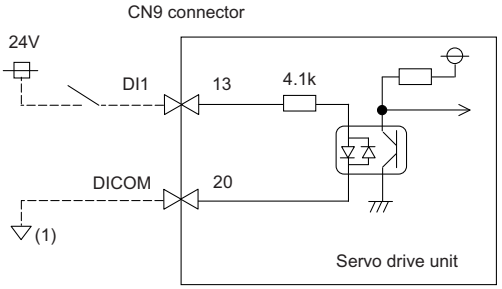
Input condition		Output condition	
Switch ON	18VDC to 25.2VDC 4.3mA or more	**Output voltage**	24VDC ±5%
		Tolerable output current Io	50mA or less
Switch OFF	4VDC or less 2mA or less		

For a switch or relay to be wired, use a switch or relay that satisfies the input/output (voltage, current) conditions.

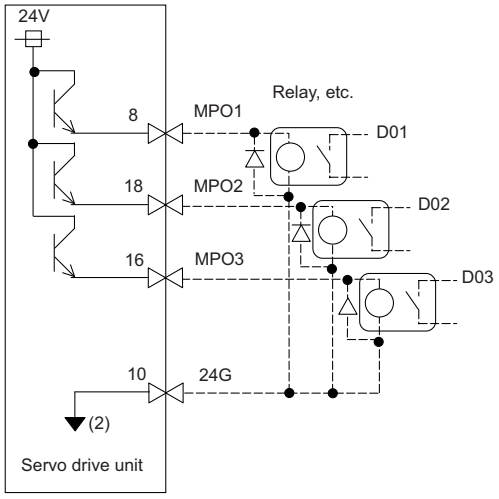
Interface name	Selection example
For digital input signal (CN9,CN9B/CN9A)	Use a minute signal switch which is stably contacted and operated even with low voltage or current <Example> OMRON: G2A, G6B type, MY type, LY type
For digital output signal (CN9,CN9B/CN9A)	Use a compact relay operated with rating of 24VDC, 50mA or less. <Example> OMROM: G6B type, MY type

<MDS-DM-V3 Series>

Input circuit



Output circuit



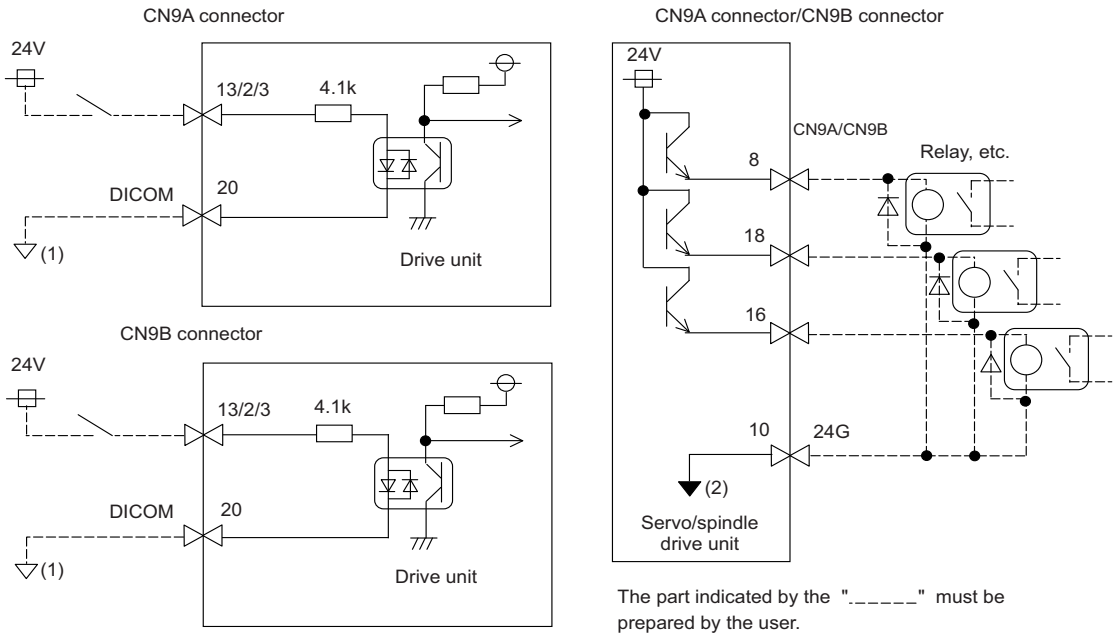
The part indicated by the "_____" must be prepared by the user.

(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.

Input/output signal of MDS-DM-V3 Series (CN9 connector)

	Device name	Connector pin No.	Signal name	Signal changeover parameter
Servo input signal	MPI1	CN9-13	Safety observation function door state signal	SV082/bitF-C=1
			Battery box voltage drop signal	SV082/bitF-C=2
Servo output signal	MPO1	CN9-8	(Reservation)	
	MPO2	CN9-18	Servo specified speed signal	SV082/bit9,8=01
	MPO3	CN9-16	(Reservation)	

<MDS-DM-SPV Series>



(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.

Input/output signal of MDS-DM-SPV Series (CN9A,CN9B connector)

	Device name	Connector pin No.	Signal name	Signal changeover parameter
Servo input signal	MPI1	CN9B-13	Safety observation function door state signal	SV082/bitF-C=1
			Battery box voltage drop signal	SV082/bitF-C=2
	MPI2	CN9A-2	(Reservation)	
	MPI3	CN9A-3	(Reservation)	
Servo output signal	MPO1	CN9B-8	Motor brake control signal	
	MPO2	CN9A-8	Servo specified speed signal	SV082/bit9,8=01
	MPO3	CN9A-18	(Reservation)	

Input/output signal of MDS-DM-SPV Series (CN9A,CN9B connector)

	Device name	Connector pin No.	Signal name	Signal changeover parameter
Spindle input signal	MPI1	CN9B-2	Safety observation function door state signal	SP227/bitF-C=1
			Proximity switch signal	SP227/bitF-C=2
	MPI2	CN9A-13	(Reservation)	
	MPI3	CN9B-3	External emergency stop signal	SP032/bit7-0=59
Spindle output signal	MPO1	CN9B-18	Coil changeover signal	
	MPO2	CN9B-16	Spindle specified speed signal	SP229/bitC=1
	MPO3	CN9A-16	Contactor control signal	

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.

$$P = 2\pi NT \text{ (W)} \quad \text{---(7-1)}$$

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).

$$ta = \frac{1.05 \times 10^{-2} \times (J_L/\eta + J_M) \times N}{(0.8 \times T_{MAX} - T_L)} \quad (ms) \quad \cdots (7\text{-}2)$$

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.

$$Ta1 = \frac{1.05 \times 10^{-2} \times (J_L/\eta + J_M) \times N}{ta} \times (1 - e^{\frac{-Kp \times ta}{1000}}) + T_L \quad (N \cdot m) \quad \cdots (7\text{-}3)$$

$$Nm = N \times \{1 - \frac{1000}{Kp \times ta} \times (1 - e^{\frac{-Kp \times ta}{1000}})\} \quad (r/min) \quad \cdots (7\text{-}4)$$

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)

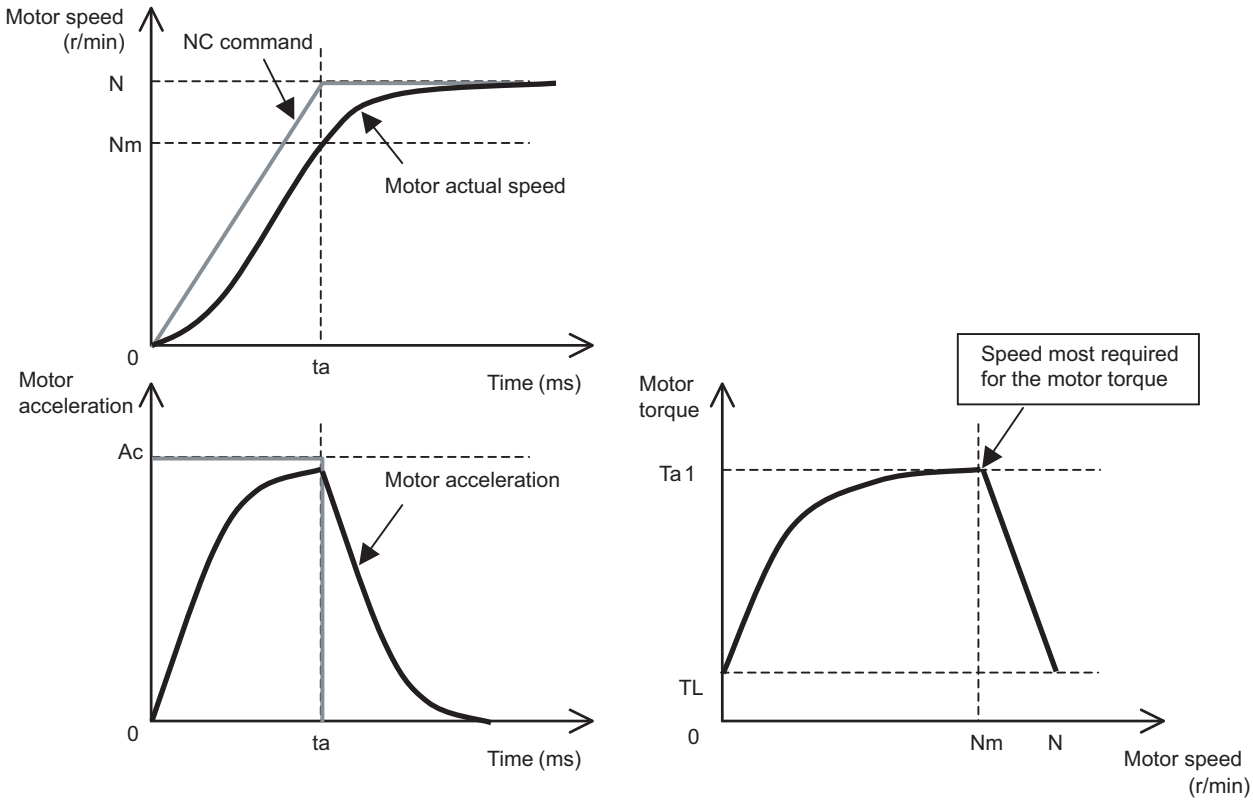


Fig.1 Speed, acceleration and torque characteristics when using the NC command linear acceleration/deceleration pattern + servo standard position control

(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.

$$Ta1 = \frac{1.05 \times 10^{-2} \times (J_L/\eta + J_M) \times N}{ta} \times (1 - 0.586 \times e^{\frac{-2 \times Kp \times ta}{1000}}) + T_L \quad (N \cdot m) \quad \cdots (7\text{-}5)$$

$$Nm = N \times \{1 - \frac{1000}{1.3 \times Kp \times ta} \times (1 - 1.5 \times e^{\frac{-2 \times Kp \times ta}{1000}})\} \quad (r/min) \quad \cdots (7\text{-}6)$$

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)

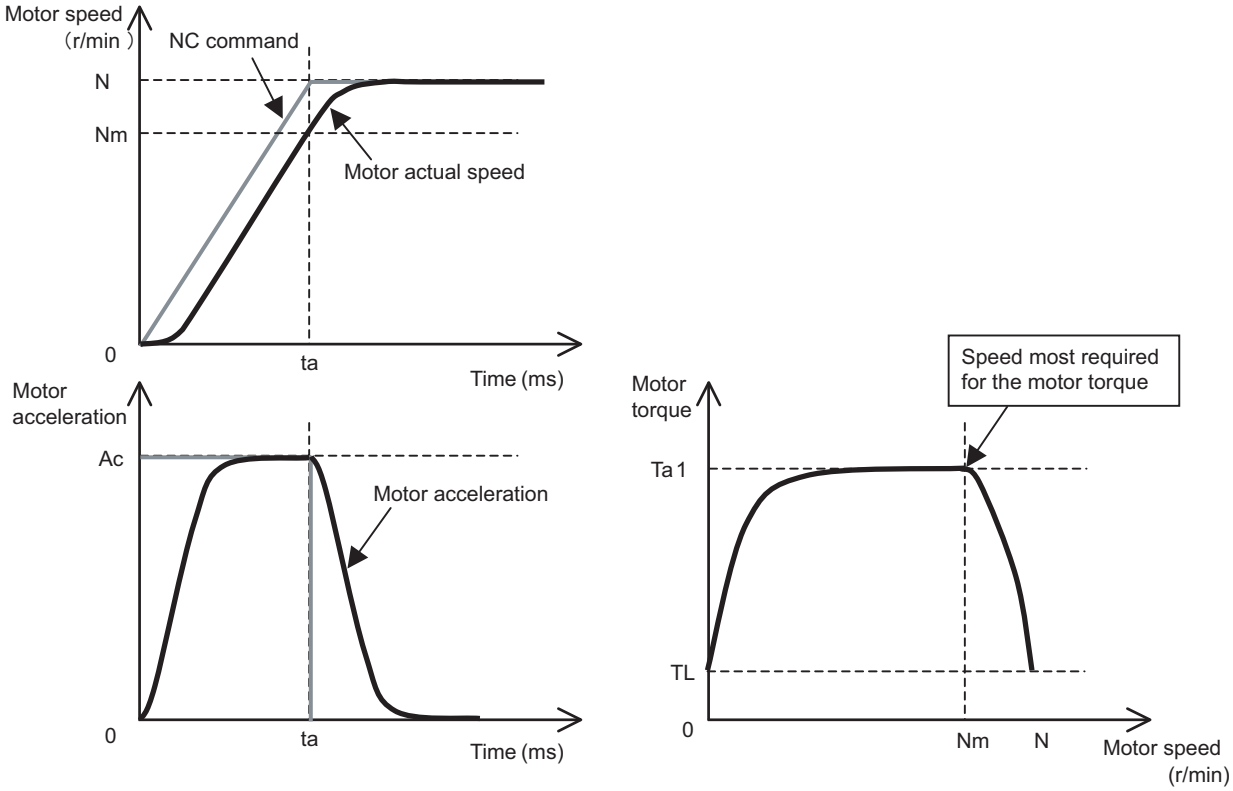


Fig.2 Speed, acceleration and torque characteristics when using the NC command linear acceleration/deceleration pattern + servo SHG control

(d) Approximation when using the NC command soft acceleration/deceleration pattern + feed forward (high-speed accuracy) 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.

$$T_a1 = \frac{1.05 \times 10^{-2} \times (J_L/\eta + J_M) \times N}{ta} + T_L \quad (N \cdot m) \quad \bullet\bullet\bullet (7\text{-}7)$$

$$Nm = N \times (1 - \frac{1}{2} \times \frac{tb}{ta}) \quad (r/min) \quad \bullet\bullet\bullet (7\text{-}8)$$

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)

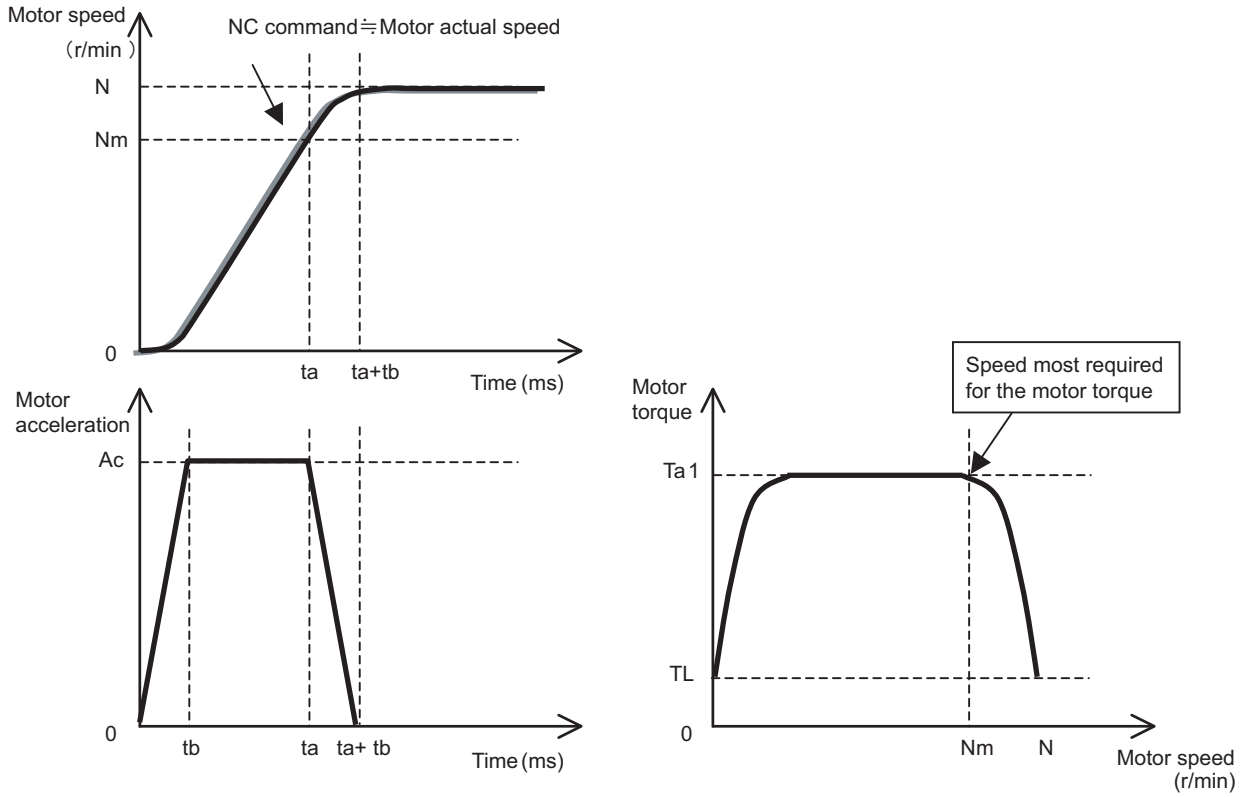
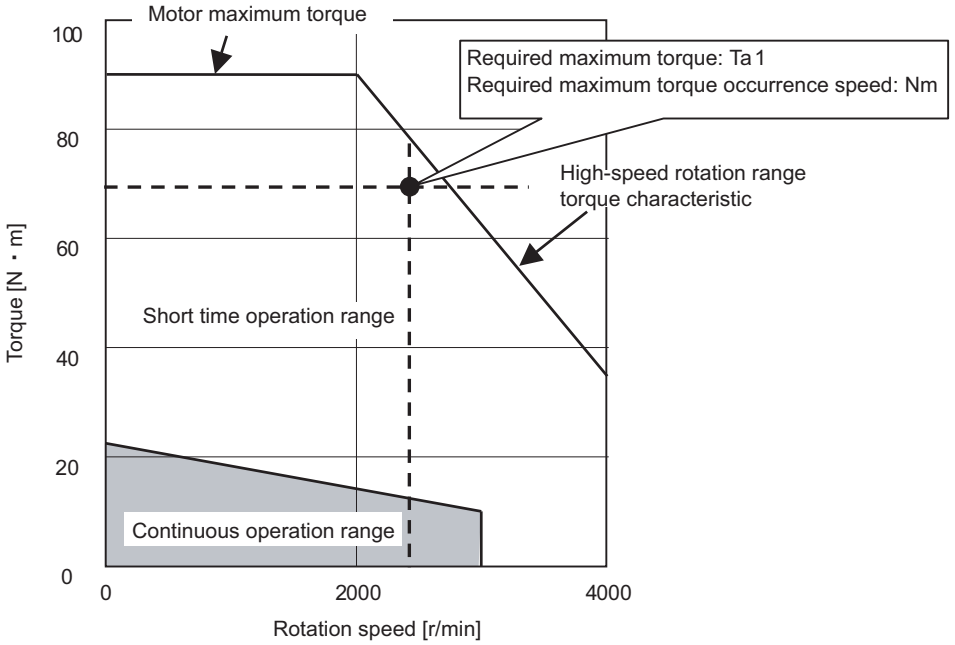


Fig 3. Speed, acceleration and torque characteristic when using the NC command soft acceleration/deceleration pattern + feed forward (high-speed accuracy) control

(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. 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).

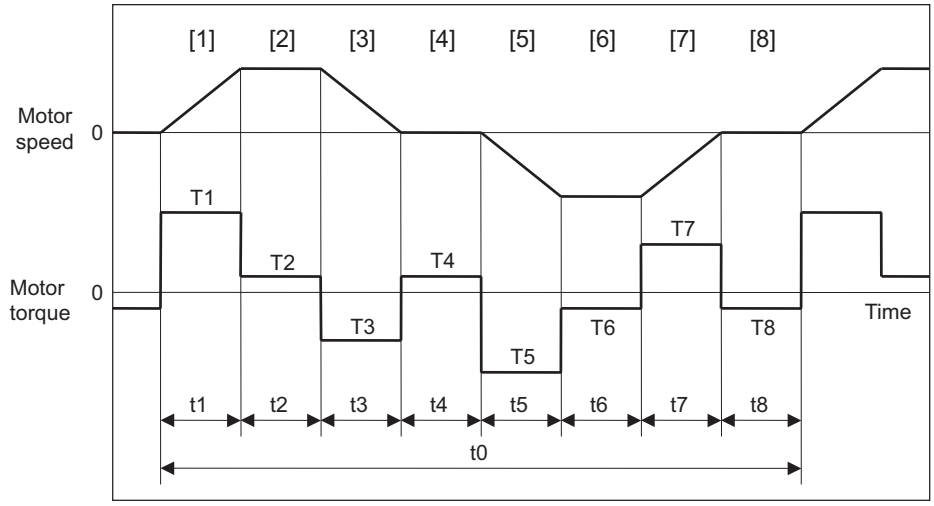


Fig. 1 Continuous operation pattern

$$Trms = \sqrt{\frac{T1^2 \cdot t1 + T2^2 \cdot t2 + T3^2 \cdot t3 + T4^2 \cdot t4 + T5^2 \cdot t5 + T6^2 \cdot t6 + T7^2 \cdot t7 + T8^2 \cdot t8}{t0}} \quad \cdots (7\text{-}9)$$

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 linear 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.

$$TL \leqq 0.6 \cdot Tst \quad \cdots (7\text{-}12)$$

(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

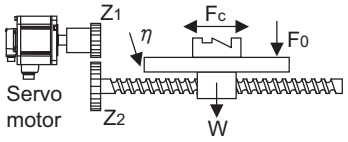
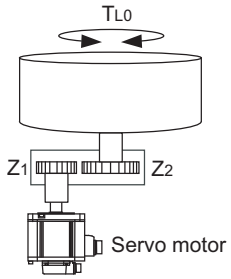
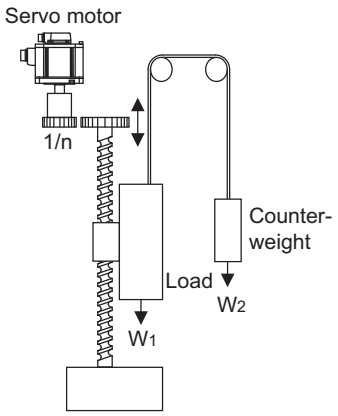
Period	Load torque calculation method	Explanation
[1]	(Amount of acceleration torque) + (Kinetic friction torque) + (Unbalance torque)	Normally the acceleration/deceleration time constant is calculated so that this torque is 80% of the maximum torque of the motor.
[2]	(Kinetic friction torque) + (Unbalance 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.

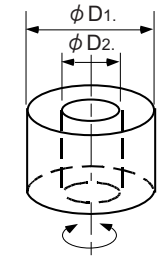
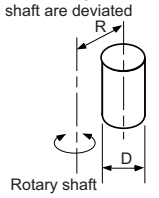
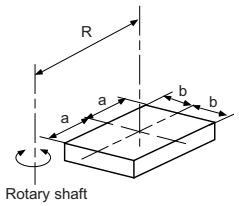
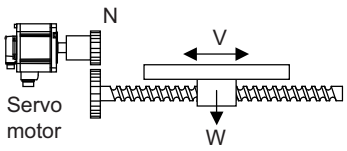
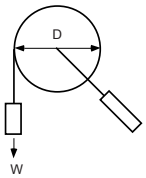
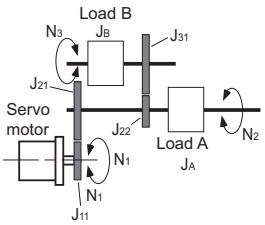
7-1-3 Motor shaft conversion load torque

The calculation method for a representative load torque is shown.

Type	Mechanism	Calculation expression
Linear movement		$T_L = \frac{F}{2\times10^3\pi\eta}\cdot(\frac{V}{N}) = \frac{F\cdot\Delta S}{2\times10^3\pi\eta}$ 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.** **$F=Fc+\mu(W\cdot g+F_0)$** 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
Rotary movement		$T_L = \frac{Z_1}{Z_2}\cdot\frac{1}{\eta}\cdot T_{L0}+T_F = \frac{1}{n}\cdot\frac{1}{\eta}\cdot T_{L0}+T_F$ 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
Vertical movement		**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) $T_U = \frac{(W_1-W_2)\cdot g}{2\times10^3\pi\eta}\cdot(\frac{V}{N}) = \frac{(W_1-W_2)\cdot g\cdot\Delta S}{2\times10^3\pi\eta}$ $T_F = \frac{\mu\cdot(W_1+W_2)\cdot g\cdot\Delta S}{2\times10^3\pi\eta}$ 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

7-1-4 Expressions for load inertia calculation

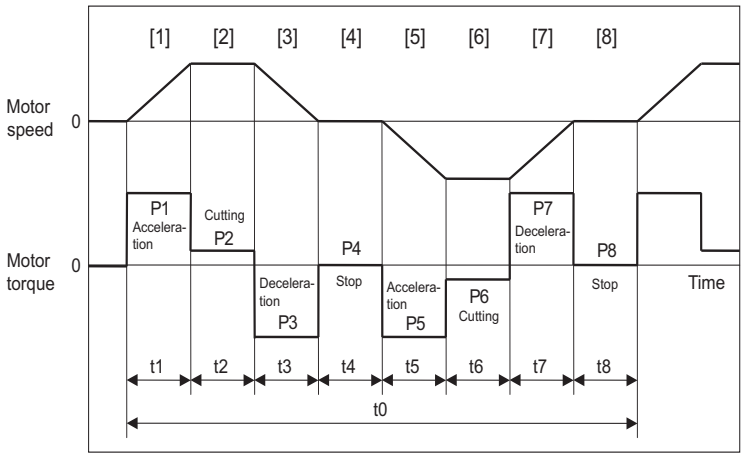
The calculation method for a representative load inertia is shown.

Type	Mechanism	Calculation expression
Cylinder	Rotary shaft is cylinder center 	$J_L = \frac{\pi \cdot \rho \cdot L}{32} \cdot (D_1^4 - D_2^4) = \frac{W}{8} \cdot (D_1^2 + D_2^2)$ 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)
	When rotary shaft and cylinder shaft are deviated 	$J_L = \frac{W}{8} \cdot (D^2 + 8R^2)$ 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 cylinder (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 $\geqq$ 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

When using MDS-DM-V3 Series, selection of the power supply unit is required.
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 x motor output coefficient β 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-D Series >

Spindle motor rated output	Combined spindle drive unit MDS-D-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

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 x 1.2, output at acceleration/deceleration x 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

< MDS-DM-V3 Series>

Motor HF	75	105	54	104	154	123	223(L,M)	223(S)	142	302(L,M)	302(S)
Rated output (kW)	0.75	1.0	0.5	1.0	1.5	1.2	2.1	2.2	1.4	2.2	3.0
Maximum momentary output (kW)	2.6	3.6	2.3	5.0	8.0	4.0	7.5	7.5	3.8	7.4	7.4

Motor HF-KP	23	43	73
Rated output (kW)	0.2	0.4	0.75
Maximum momentary output (kW)	0.72	1.72	2.85

(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 rate output and the maximum momentary output.

(1) Calculation of required rated output

(a) When there is only one servo motor axis

Power supply unit rated capacity > Σ (Spindle rated output) + (Servo motor rated output)

(b) When there are two or more servo motor axes

Power supply unit rated capacity > Σ (Spindle rated output) + 0.7 Σ (Servo motor rated output)

Substitute the output calculated from "7-3-1(1)" and "7-3-2(1)" to the expression (a) and (b), 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 servo motor accelerating/ decelerating simultaneously + Maximum momentary output of direct drive motor 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-D Series >

Unit / MDS-D-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

CAUTION !

1. When two or more servo motor axes are connected, do the calculation with the largest rated capacity of the servo motor if a value obtained by multiplying the total sum of the servo motor rated output by "0.7" is smaller than the largest rated capacity of the servo motors.
   Example: HF Series
   (1)For "HF903 (9.0kW) + HF104 (1.0kW)", "0.7 x (9.0 + 1.0) =7.0 < 9.0" is applied.
   So, do the calculation with applying "9.0kW" to the total sum of the servo motor's rated output.
   (2)For "HF903 (9.0kW) + HF903 (9.0kW)", "0.7 x (9.0 + 9.0) = 12.6 > 9.0" is applied.
   So, do the calculation with applying "12.6kW" to the total sum of the servo motor's rated output.
   Example: HF-H Series
   (1)For "HF-H903 (9.0kW) + HF-H104 (1.0kW)", "0.7 x (9.0 + 1.0) =7.0 < 9.0" is applied.
   So, do the calculation with applying "9.0kW" to the total sum of the servo motor's rated output.
   (2)For "HF-H903 (9.0kW) + HF-H903 (9.0kW)", "0.7 x (9.0 + 9.0) = 12.6 > 9.0" is applied.
   So, do the calculation with applying "12.6kW" to the total sum of the servo motor's rated output.
2. When reducing the time constant replacing the conventional motor with the HF or HF-KP 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.
3. When the large capacity drive unit (MDS-D-SP-400/640) 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.
4. 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 rate output required for power supply

The spindle rate output required for power supply is calculated from the following expression.

Spindle rate output required for power supply =
MAX (Spindle motor continuous rated output, Spindle motor output at accelerating/decelerating, Spindle motor short-time output) x motor output coefficient γ of combined spindle drive unit

(Note) For the spindle rate output required for the power supply, multiply the largest one of "spindle motor continuous rate 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 rate output required for power supply

For the servo motor rate output required for power supply, use the value calculated in 7-3-2 (1).

(3) Calculation of rate output required for power supply

(a) When there is only one servo motor axis

Rated capacity required for power supply =
Σ(Spindle rate output required for power supply) + (servo motor rate output required for power supply)

(b) When there are two or more servo motor axes

Rated capacity required for power supply =
Σ (Spindle rate output required for power supply) + 0.7 Σ (servo motor rate output required for power supply)

Substitute the output calculated from the item (1) and (2) to the expression (a) and (b), 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)) x 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-D Series >

Unit	MDS-D-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

7-3-5 Example for power supply unit and power supply facility capacity

< MDS-DM-V3 Series >

Axis name	Motor	Drive unit	Rated output	Maximum momentary output
X-axis	**HF223**	**(MDS-DM-V3-404040)**	2.1kW	7.5kW
Y-axis	**HF223**	**(MDS-DM-V3-404040)**	2.1kW	7.5kW
Z-axis	**HF302B**	**(MDS-DM-V3-404040)**	3.0kW	7.4kW
Spindle	**Spindle motor 22kW**	**MDS-D-SP-320 (Output coefficient 1.0)**	22kW	26.4kW
Total			0.7×(2.1×2+3.0)+22 =27.04kW < 31kW (D-CV-300)	(7.5×2+7.4)+26.4 =48.8kW < 92kW (D-CV-300)

The power supply unit satisfying the total of the rate output and the maximum momentary output is MDS-D-CV-300.
Required power supply capacity (kVA) = (27.04/30) × 43=38.8(kVA)

Appendix 1

Cable and Connector Specifications

Appendix 1-1 Selection of cable

Appendix 1-1-1 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. When manufacturing the encoder cable and battery connection cable, use the recommended 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				

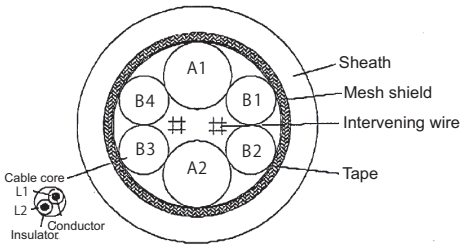
(b) General-purpose heat resistant specifications cable

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 2))	8.7mm	PVC	2 ($0.5mm^2$)	100strands/ 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 ($0.2mm^2$)	40strands/ 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. For MDS-C1/CH series, (b) or equivalent is used as the standard cable.

Compound 6-pair cable structure drawing



Core identification

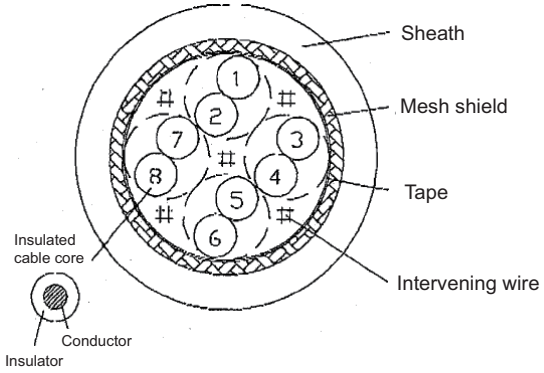
Pair No.	Insulator color	
	L1	L2
A1 ($0.5mm^2$)	Red	White
A2 ($0.5mm^2$)	Black	White
B1 ($0.2mm^2$)	Brown	Orange
B2 ($0.2mm^2$)	Blue	Green
B3 ($0.2mm^2$)	Purple	White
B4 ($0.2mm^2$)	Yellow	White

(c) HF-KP motor encoder 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
ETFE・SVP 60/ 0.08mm 4-pair shielded cable Specification No.Bangishi-17669(Note 1))	7.1mm	PVC	4 ($0.5mm^2$)	60 strands/ 0.08mm	73.0Ω/km or less	500VAC/ 1min	1500 MΩ/km or more	105°C	R200 ($70×10^4$ times or more)

(Note 1) BANDO Electric Wire (http://www.bew.co.jp/)

4-pair shielded cable structure drawing

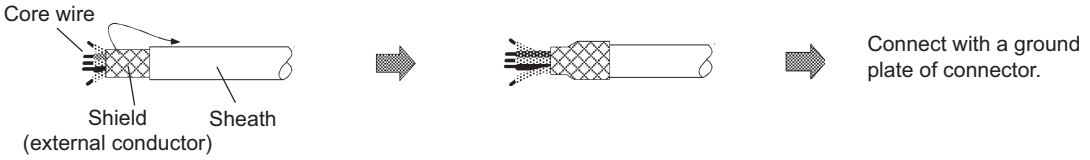


Core identification

No.	Color
1	Black
2	White
3	Red
4	Green
5	Yellow
6	Brown
7	Blue
8	Gray

(2) Cable assembly

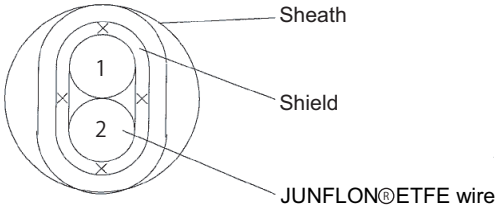
Assemble the cable with the cable shield wire securely connected to the ground plate of the connector.



(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	3.3mm	PVC	1 ($0.2mm^2$)	7strands / 0.2mm	91.2Ω/km or less	AC500V/ 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/index_e.html



Two core shield cable structure drawing

Core identification

No.	Insulator color
1	Red
2	Black

Appendix 1-2 Cable connection diagram

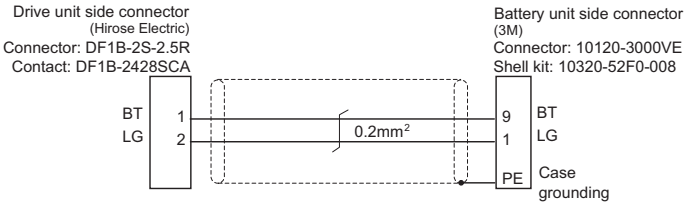
⚠CAUTION

1. Take care not to mistake the connection when manufacturing the encoder cable. Failure to observe this could lead to faults, runaway or fire.

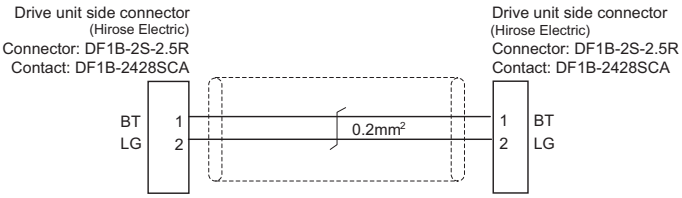
2. When manufacturing the cable, do not connect anything to pins which have no description.

Appendix 1-2-1 Battery cable

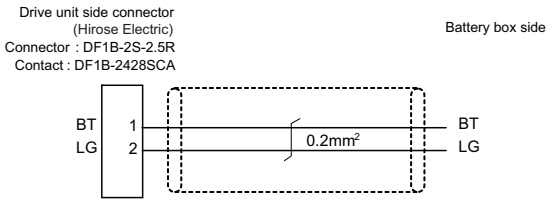
<DG21 cable connection diagram
(Connection cable between drive unit and A6BAT (MR-BAT) (MDS-BTCASE)>



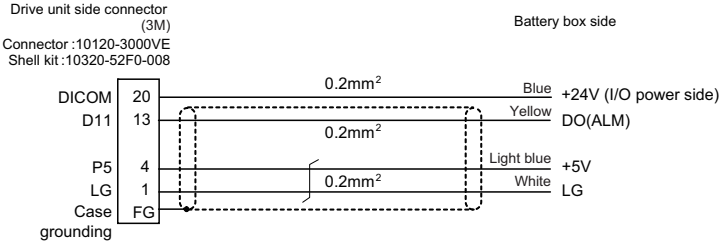
<DG22 cable connection diagram (Connection cable between drive unit and drive unit)>



<DG23 cable connection diagram (Connection cable between drive unit and MDS-BTBOX-36)>



<DG24 cable connection diagram (Connection cable for alarm output between drive unit and MDS-BTBOX-36)>

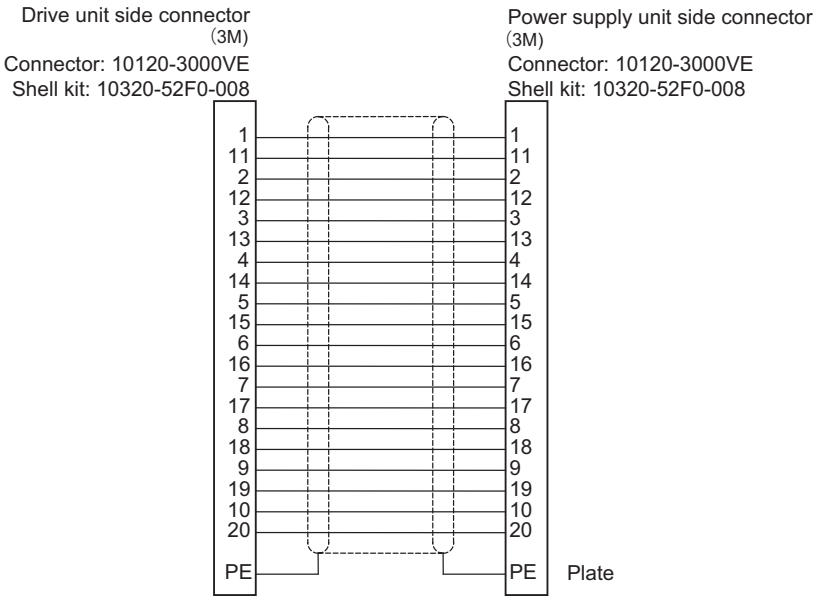


CAUTION !

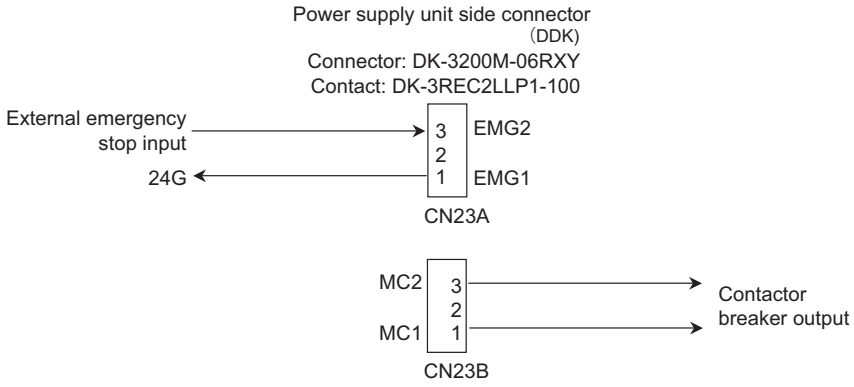
When DG24 cable is used, proximity switch or external emergency stop cannot be wired, so these functions cannot be used.

Appendix 1-2-2 Power supply communication cable and connector

<SH21 cable connection diagram>

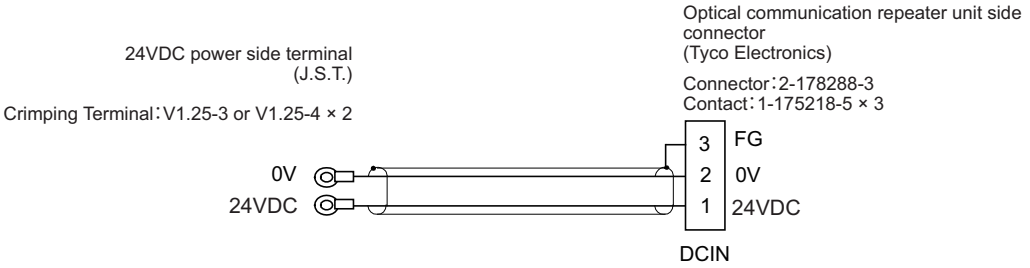


<CNU23S connector connection diagram>

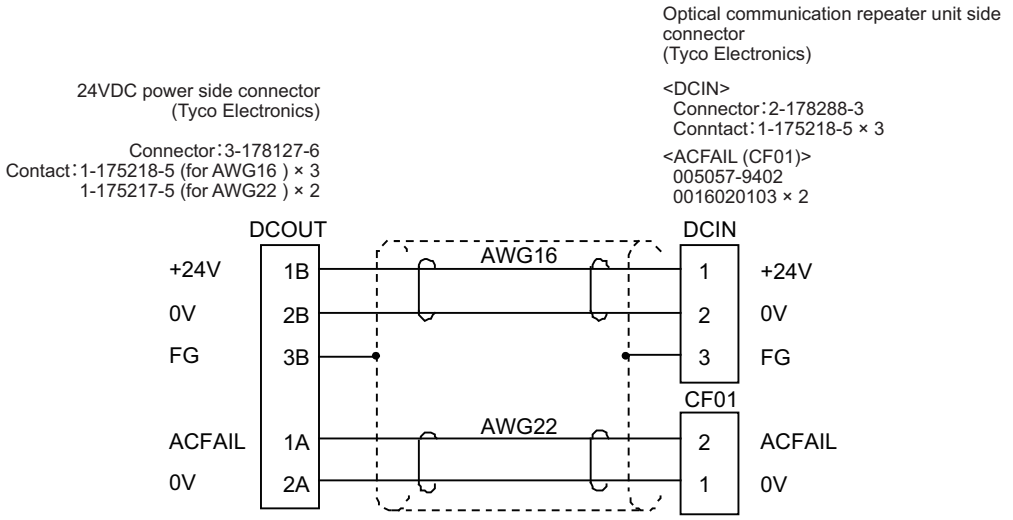


Appendix 1-2-3 Optical communication repeater unit cable

< F070 cable connection diagram >

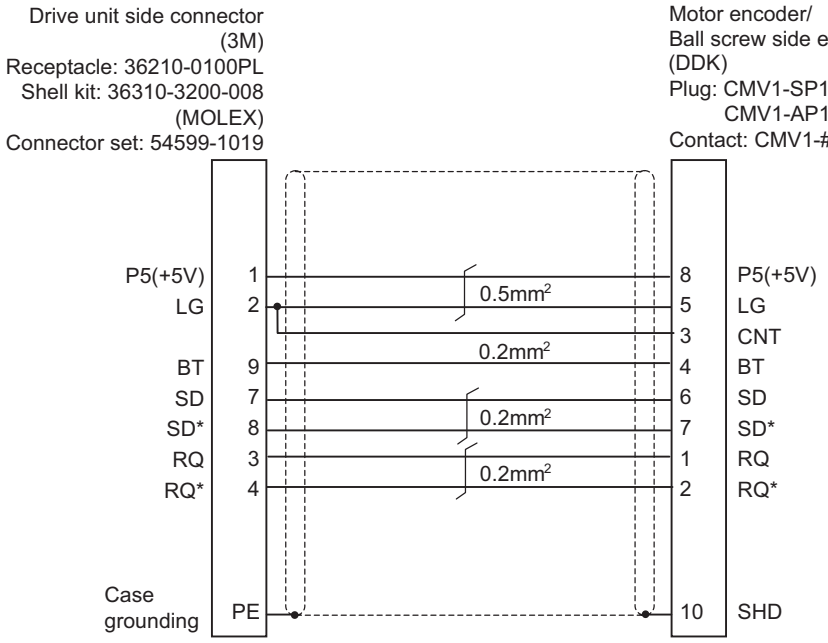


< F110 cable connection diagram >

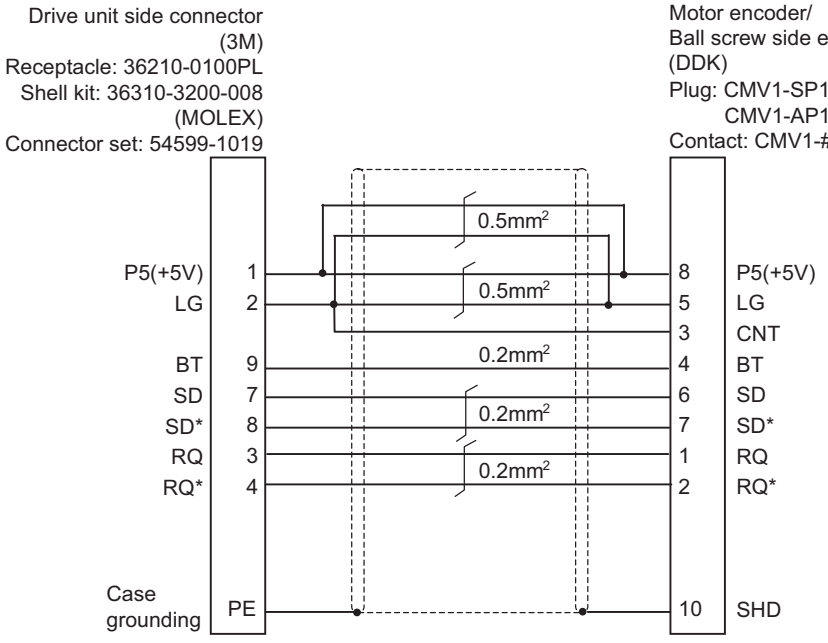


Appendix 1-2-4 Servo encoder cable

<CNV2E-8P, CNV2E-9P cable connection diagram>

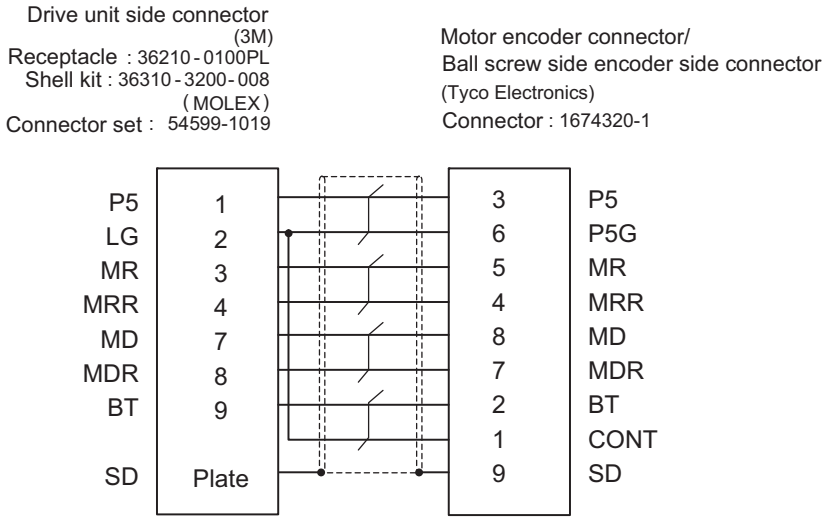


<For 15m or less>

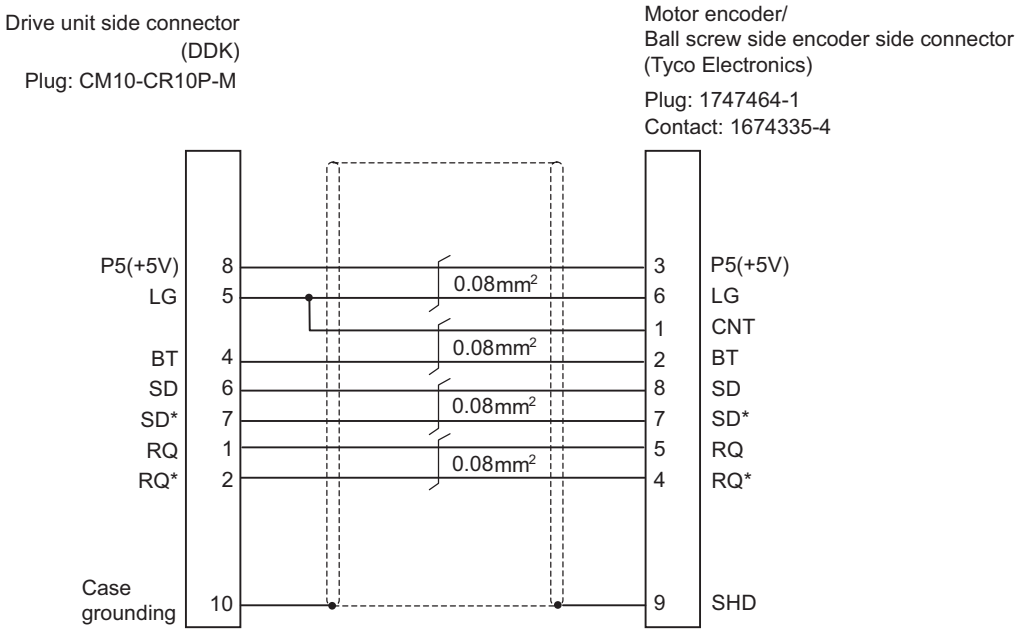


<For 15m to 30m>

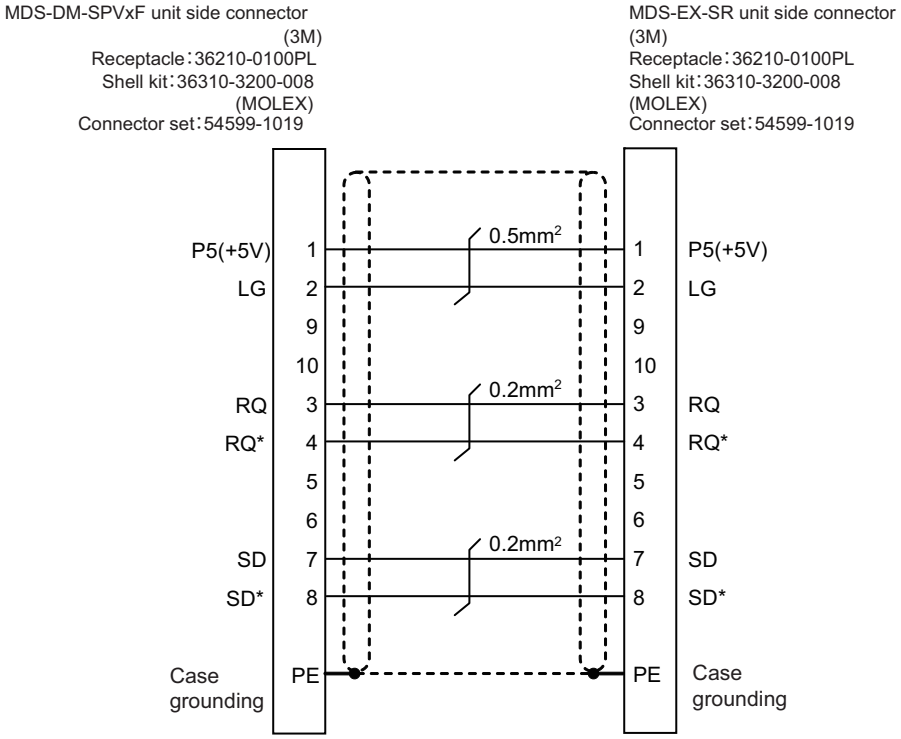
< CNV2E-K1P, CNV2E-K2P cable connection diagram (Direct connection type) >



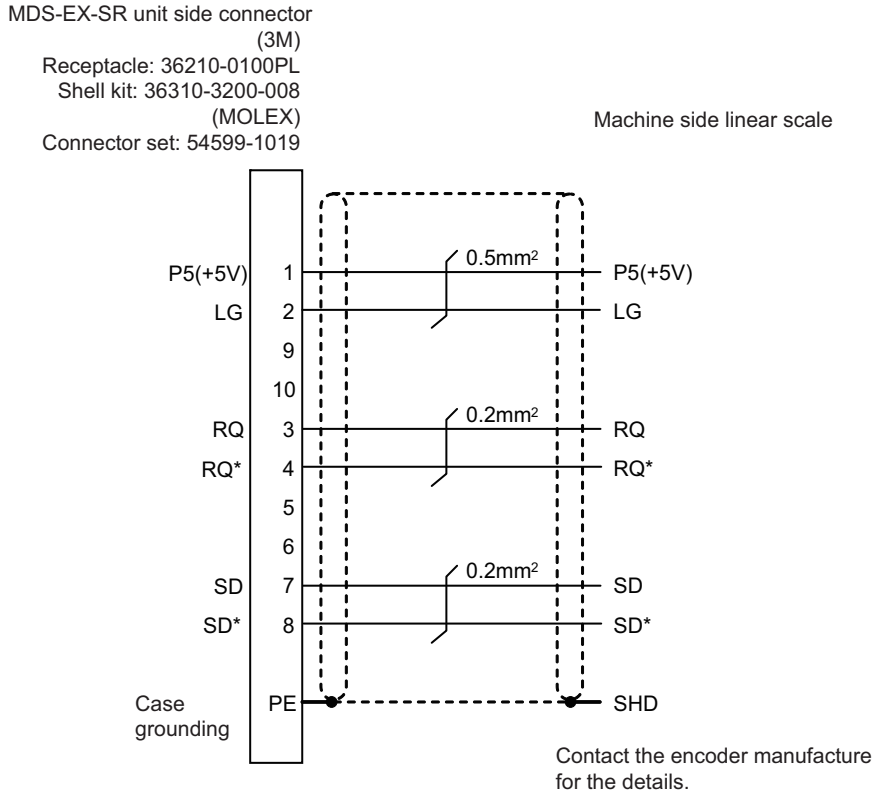
< CNV22J-K1P, CNV22J-K2P cable connection diagram (Relay type) >



<CNV2E-EX cable connection diagram (Relay type)>



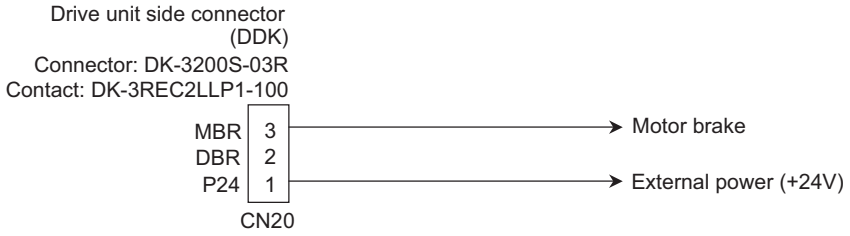
< Linear scale (Serial absolute value specifications) cable connection diagram>



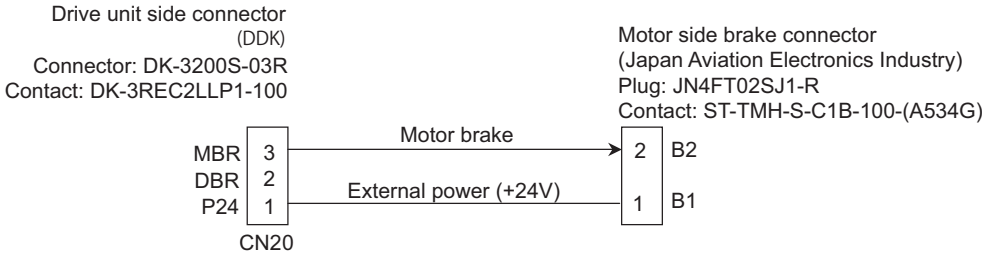
Appendix 1-2-5 Brake cable and connector

<CNU20S connector connection diagram (Brake connector for motor brake control output)>

• For MDS-DM-V3

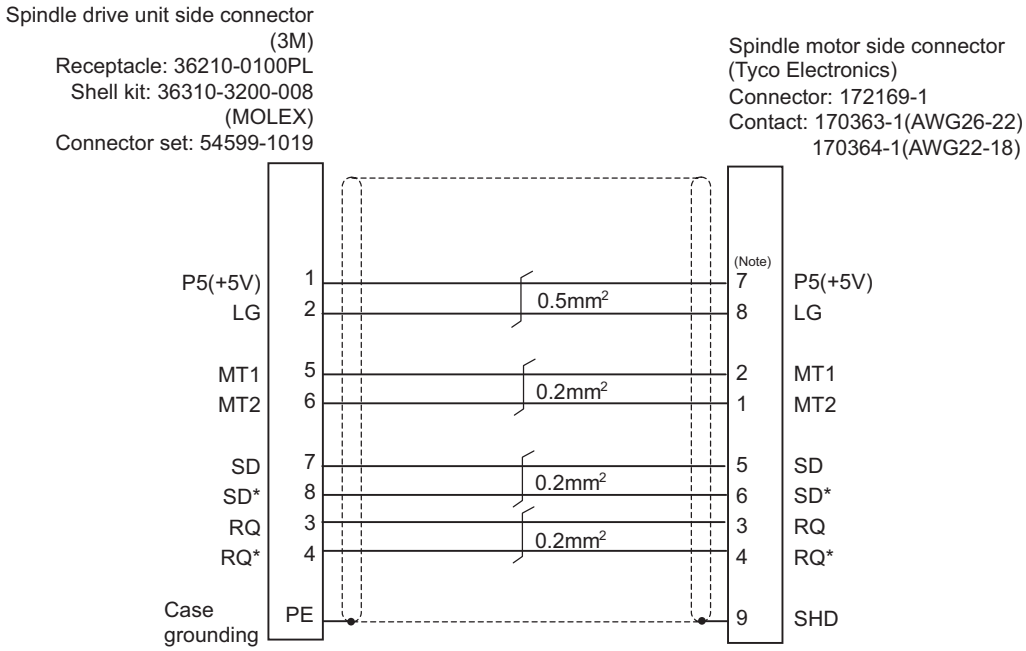


<MR-BKS1CBL ☐ M-A1-H, MR-BKS1CBL ☐ M-A2-H cable connection diagram>



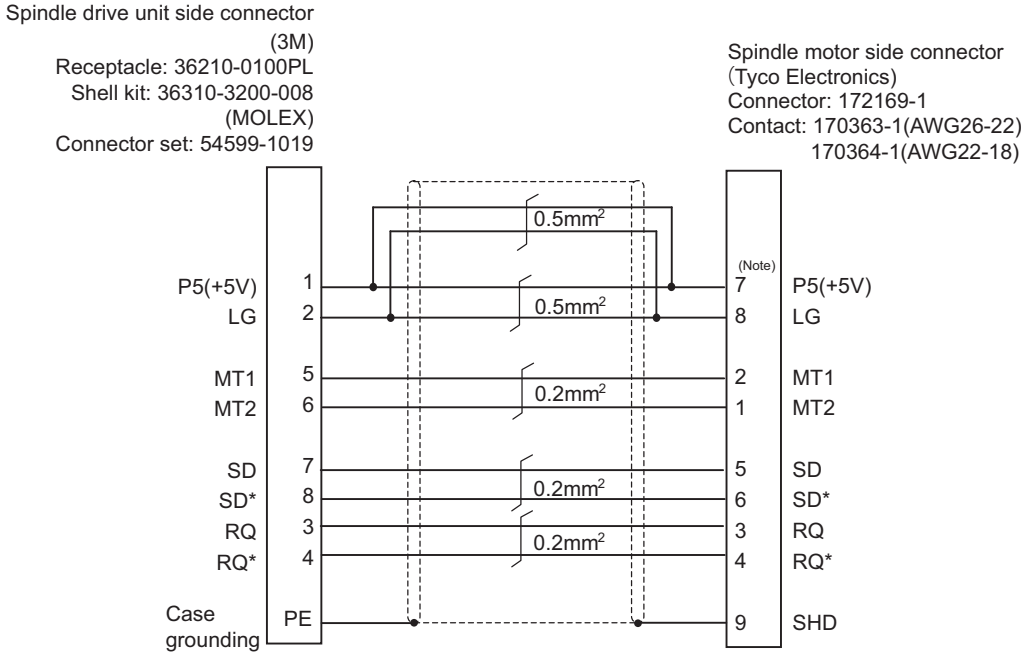
Appendix 1-2-6 Spindle encoder cable

<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".

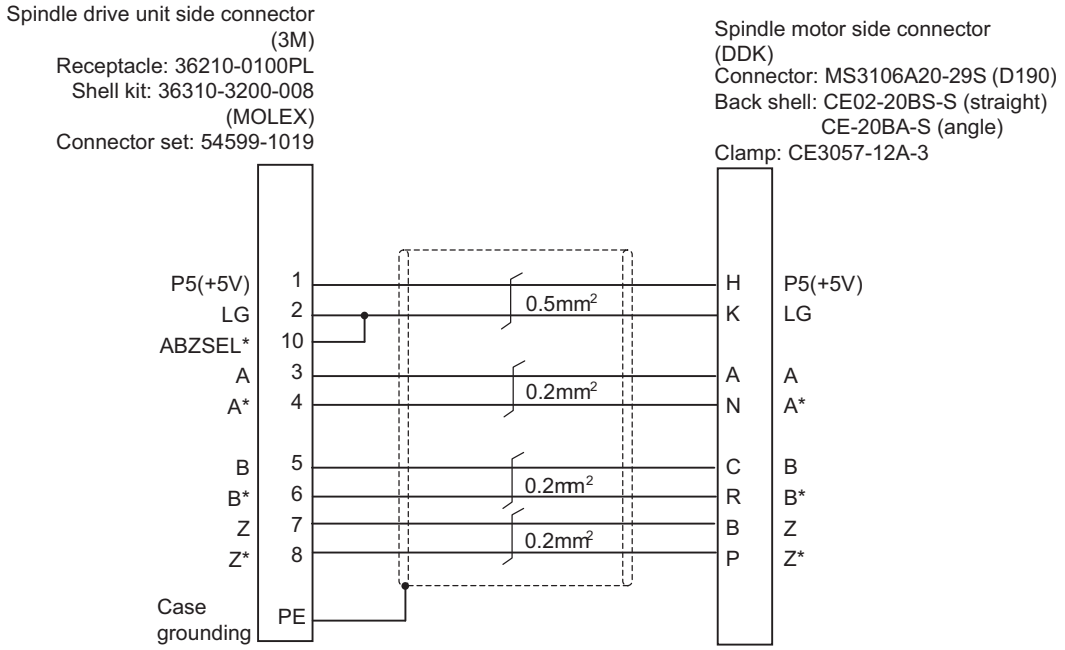
<For 15m or less>



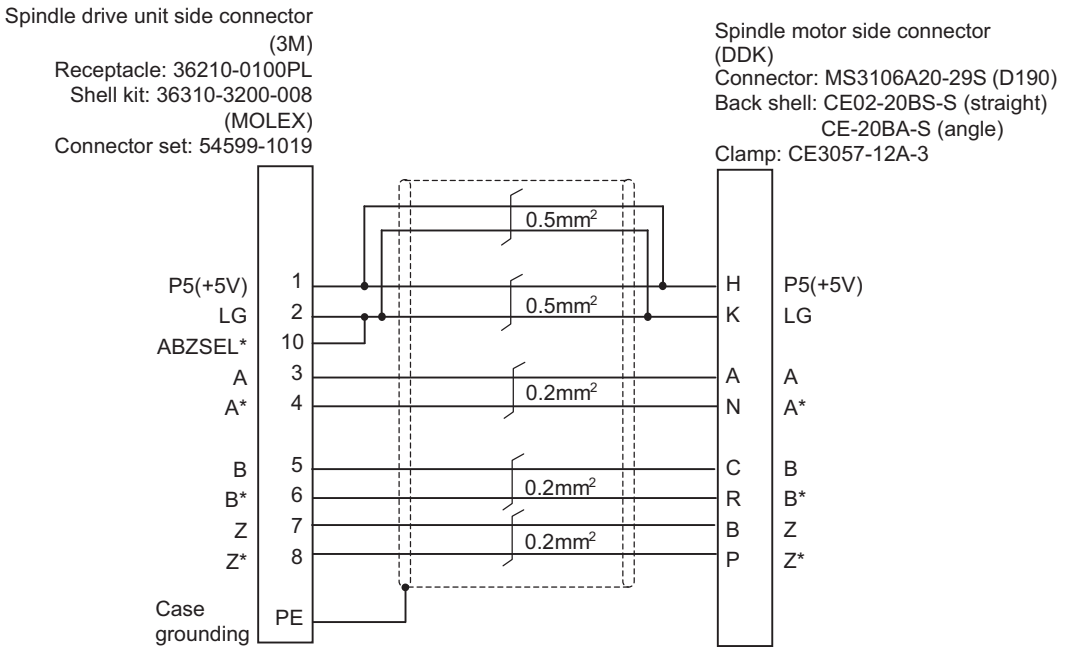
(Note) For the pin "7" or "8", use the contact "170364-1".
For the other pins, use the contact "170363-1".

<For 15m to 30m>

<CNP3EZ-2P, CNP3EZ-3P cable connection diagram>



<For 15m or less>



<For 15m to 30m>

Appendix 1-3 Main circuit cable connection diagram

The methods for wiring to the main circuit are shown below.

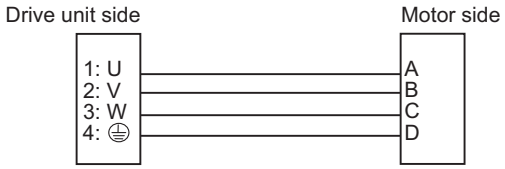
<DRSV1/DRSV2/DRSV3 cable connection diagram>

These cables are used to connect the drive unit's TE1 terminal and HF, HF-KP motor.

- DRSV1 cable:
  This is the power line for the triple-axis unit (MDS-DM-V3-) and multi axis integrated unit (MDS-DM-SPV2-, MDS-DM-SPV3-) L-axis.

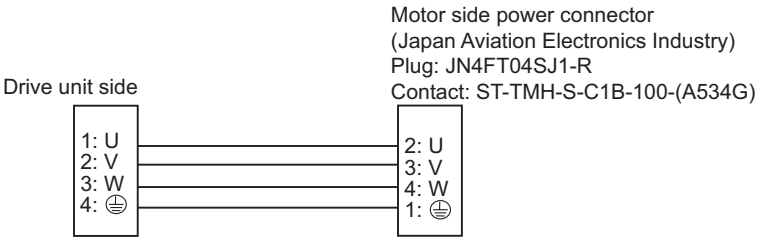
- DRSV2 cable:
  This is the power line for the triple-axis unit (MDS-DM-V3-) and multi axis integrated unit (MDS-DM-SPV2-, MDS-DM-SPV3-) M-axis.

- DRSV3 cable:
  This is the power line for the triple-axis unit (MDS-DM-V3-) and multi axis integrated unit (MDS-DM-SPV3-) S-axis.



<HF-KP motor cable connection diagram>

This cable is used to connect the drive unit's TE1 terminal and HF-KP series motor.



⚠ 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.**

Appendix 1-4 Connector outline dimension drawings

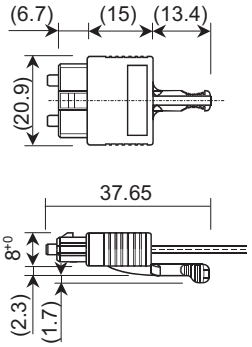
Appendix 1-4-1 Connector for drive unit

Optical communication cable connector

Optical communication connector

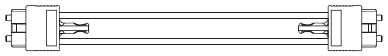
[Unit:mm]

For wiring between drive units (inside panel)
Manufacturer: Japan Aviation Electronics Industry
<Type>
Connector: PF-2D103



Cable appearance
<Type>
Connector: PF-2D103 (Japan Aviation Electronics Industry)
Optical fiber: ESKA Premium (MITSUBISHI RAYON)

(L≦0.1m)



(L≧0.2m)

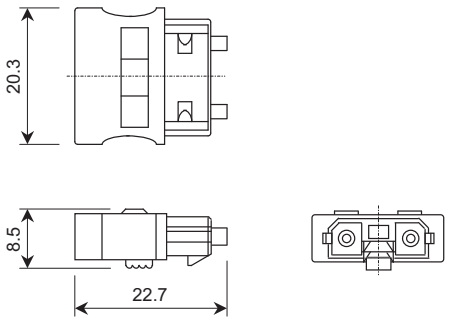
(Note 1) The POF fiber's light amount will drop depending on how the fibers are wound. So, try to avoid wiring the fibers.

(Note 2) Do not wire the optical fiber cable to moving sections.

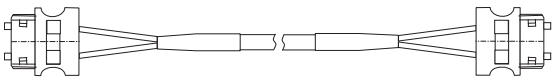
Optical communication connector

[Unit:mm]

For wiring between drive units (outside panel)
Manufacturer: Tyco Electronics
<Type>
Connector: 1123445-1



Cable appearance
<Type>
Connector: 1123445-1 (Tyco Electronics)
Optical fiber: ESKA Premium (MITSUBISHI RAYON)



(Note 1) The PCF 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.

For wiring between NC and drive unit

Refer to the instruction manual for CNC.

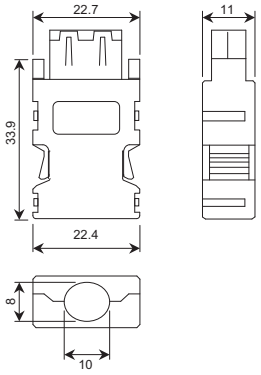
Connector for encoder cable

Spindle drive unit connector for CN2

[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

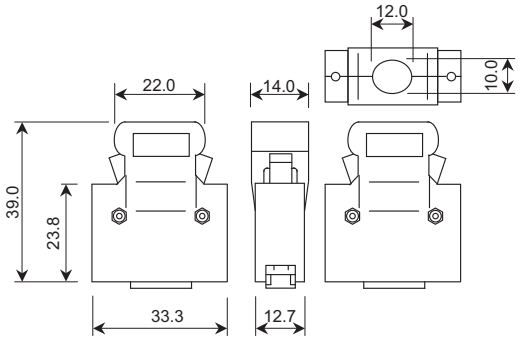


Connector for CN4/9/9A/9B

[Unit:mm]

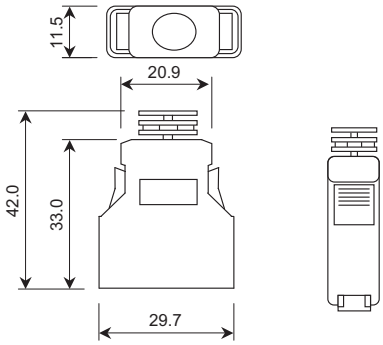
Manufacturer: 3M
<Type>
Connector: 10120-3000VE
Shell kit: 10320-52F0-008

Compatible part (Note 1)
(J.S.T.)
Connector: MS-P20-L
Shell kit: MS20-2B-28



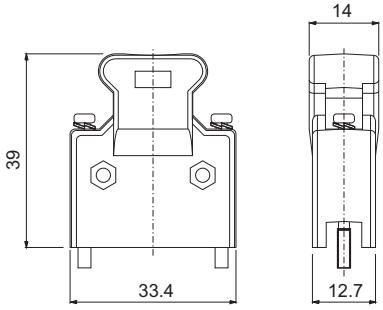
[Unit:mm]

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



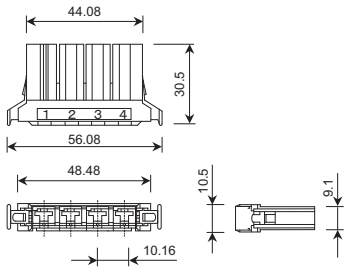
(Note 1) The names of compatible parts may be changed at the manufacturer's discretion. Contact each manufacturer for more information.

Power connector

Power connector for drive unit TE1, for MDS-DM-V3

[Unit:mm]

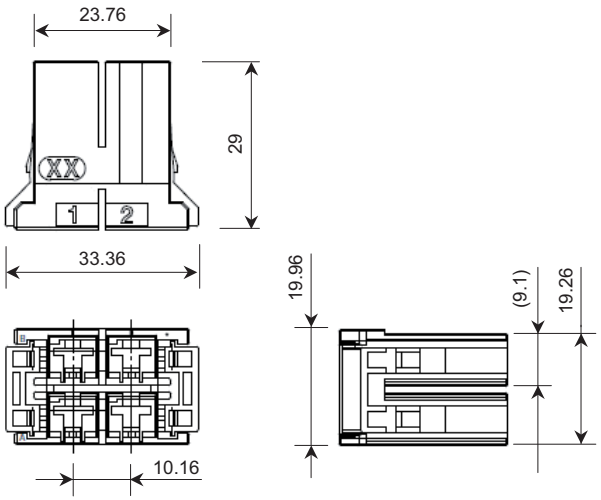
Manufacturer: DDK
<Type>
Housing: DK-5200S-04R



Power connector for drive unit CN31L/M/S, for MDS-DM-SPV Series

[Unit:mm]

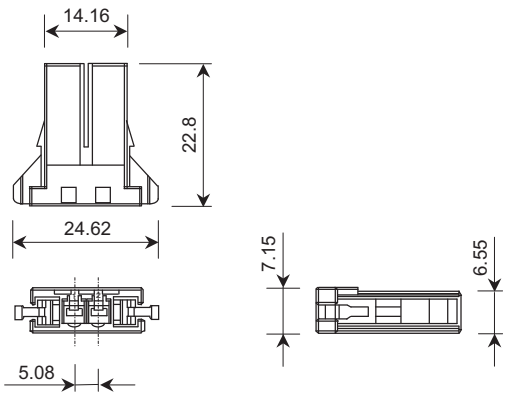
Manufacturer: DDK
<Type>
Connector: DK-5200M-04R



Control power connector for drive unit CN22, for MDS-DM-SPV Series

[Unit:mm]

Manufacturer: DDK
<Type>
Connector: DK-3200S-02R

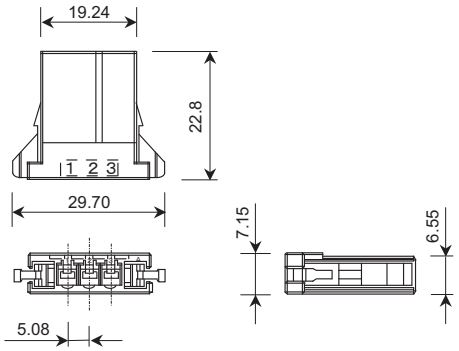


Connector for motor brake control output

Brake connector for motor brake control output

[Unit:mm]

Manufacturer: DDK
<Type>
Connector: DK-3200S-03R

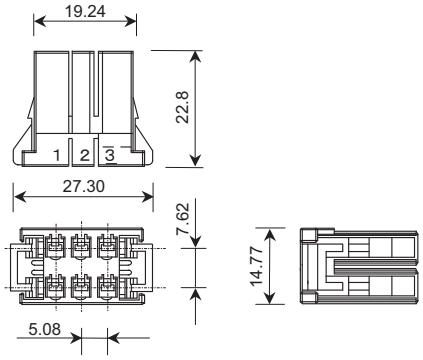


Power supply unit connector for CN23 (Contactor control output / external emergency stop)

Power supply unit connector for CN23 (Connector for contactor control output / external emergency stop)

[Unit:mm]

Manufacturer: DDK
<Type>
Connector: DK-3200M-06RXY

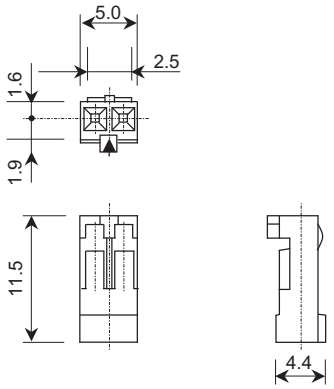


Battery power input connector

Battery connector for drive unit

[Unit:mm]

Manufacturer: Hirose Electric
<Type>
Connector: DF1B-2S-2.5R



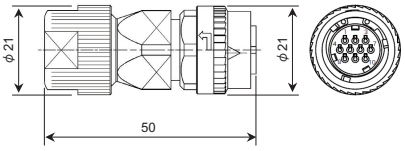
Appendix 1-4-2 Connector for servo

Motor encoder connector

Motor side encoder connector / Ball screw side encoder for connector

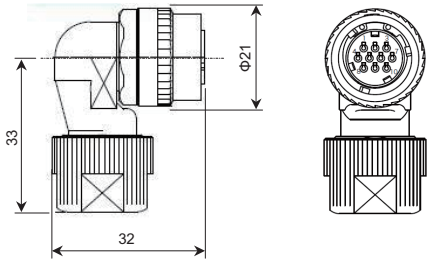
[Unit:mm]

Manufacturer: DDK
<Type>
Plug:CMV1-SP10S-M2



[Unit:mm]

Manufacturer: DDK
<Type>
Plug:CMV1-AP10S-M2

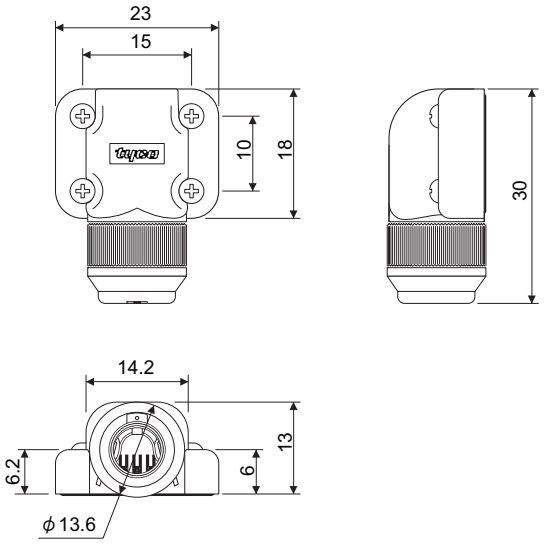


(Note) For the manufacturing method of CMV1 series connector, refer to the section "Cable and Connector Assembly" in Instruction Manual.
Contact: Fujikura Ltd. http://www.fujikura.co.jp/eng/

Motor side encoder connector

[Unit:mm]

Manufacturer: Tyco Electronics
<Type>
Assembly: 1674320-1

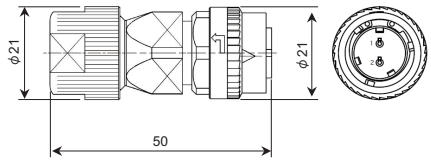


Brake connector

Brake connector

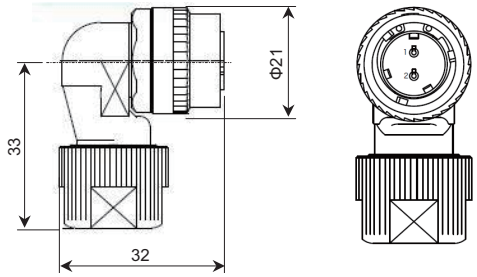
[Unit:mm]

Manufacturer: DDK
<Type>
Plug: CMV1-SP2S-S



[Unit:mm]

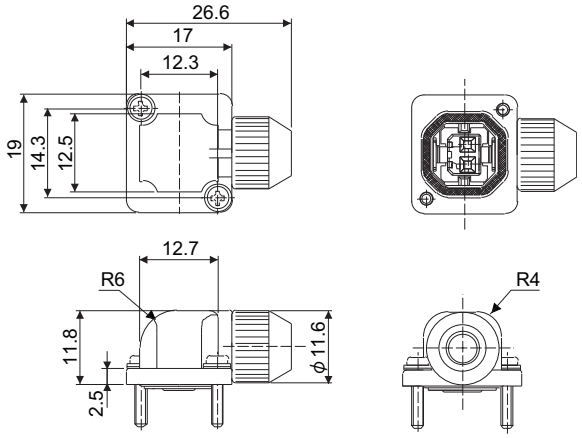
Manufacturer: DDK
<Type>
Plug: CMV1-AP2S-S



(Note) For the manufacturing method of CMV1 series connector, refer to the section "Cable and Connector Assembly" in Instruction Manual.

[Unit:mm]

Manufacturer: Japan Aviation Electronics Industry
<Type>
JN4FT02SJ1-R

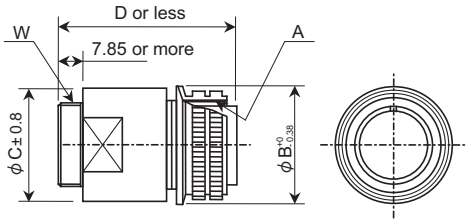


Motor power connector

Motor power connector

[Unit:mm]

Manufacturer: DDK

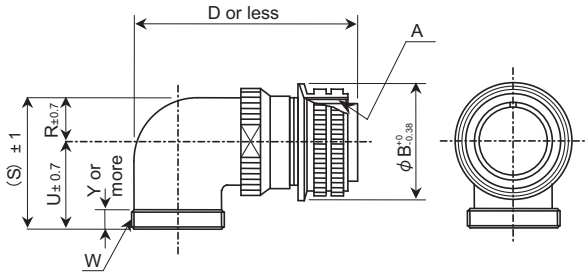


Plug:

Type	A	B +0 -0.38	C±0.8	D or less	W
CE05-6A18-10SD-C-BSS	$1^{1}/_{8}$-18UNEF-2B	34.13	32.1	57	1-20UNEF-2A
CE05-6A22-22SD-C-BSS	$1^{3}/_{8}$-18UNEF-2B	40.48	38.3	61	$1^{3}/_{16}$-18UNEF-2A
CE05-6A32-17SD-C-BSS	2-18UNS-2B	56.33	54.2	79	$1^{3}/_{4}$-18UNS-2A

[Unit:mm]

Manufacturer: DDK

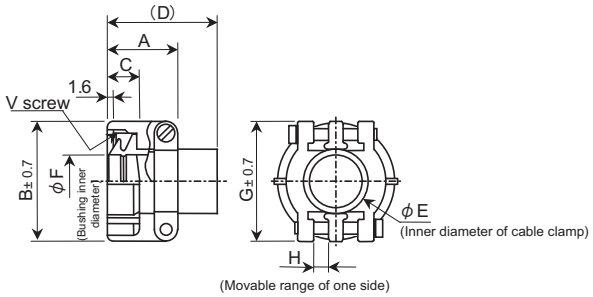


Plug:

Type	A	B +0 -0.38	D or less	W	R±0.7	U±0.7	(S)±1	Y or more
CE05-8A18-10SD-C-BAS	$1^{1}/_{8}$-18UNEF-2B	34.13	69.5	1-20UNEF-2A	13.2	30.2	43.4	7.5
CE05-8A22-22SD-C-BAS	$1^{3}/_{8}$-18UNEF-2B	40.48	75.5	$1^{3}/_{16}$-18UNEF-2A	16.3	33.3	49.6	7.5
CE05-8A32-17SD-C-BAS	2-18UNS-2B	56.33	93.5	$1^{3}/_{4}$-18UNS-2A	24.6	44.5	61.9	8.5

[Unit:mm]

Manufacturer: DDK



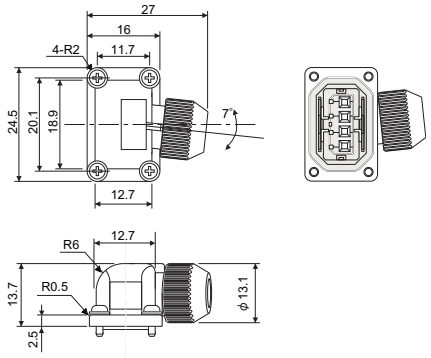
Clamp:

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(D240)	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(D240)	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(D240)	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

Motor power connector

[Unit:mm]

Manufacturer: Japan Aviation Electronics Industry
<Type>
JN4FT04SJ1-R



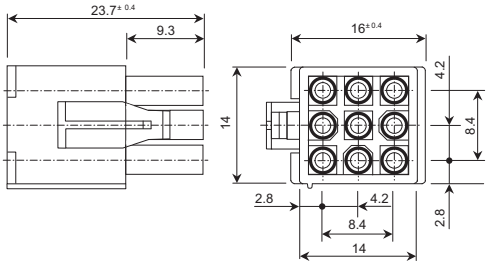
Appendix 1-4-3 Connector for spindle

Motor encoder connector

Motor side PLG (TS5690) connector

[Unit:mm]

Manufacturer: Tyco Electronics
<Type>
Plug: 172169-1

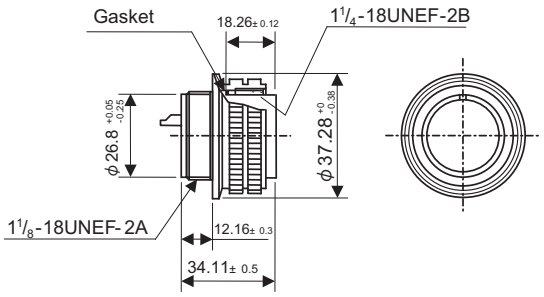


Spindle side encoder connector (for OSE-1024)

Spindle side encoder connector (for OSE-1024)

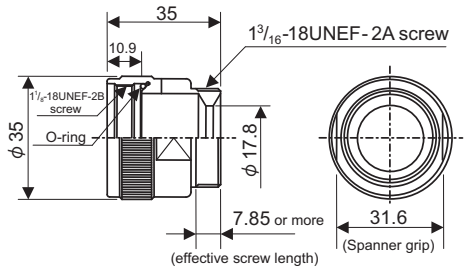
[Unit:mm]

Manufacturer: DDK
<Type>
Connector: MS3106A20-29S(D190)



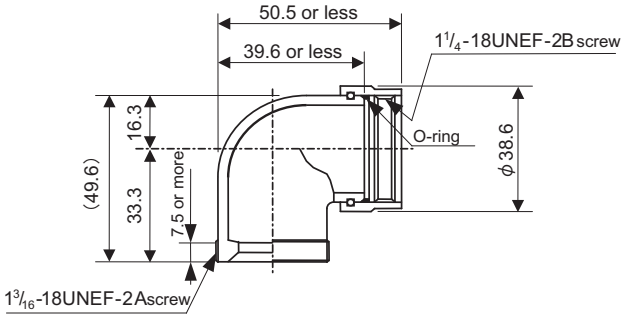
[Unit:mm]

Manufacturer: DDK
<Type>
Straight back shell: CE02-20BS-S



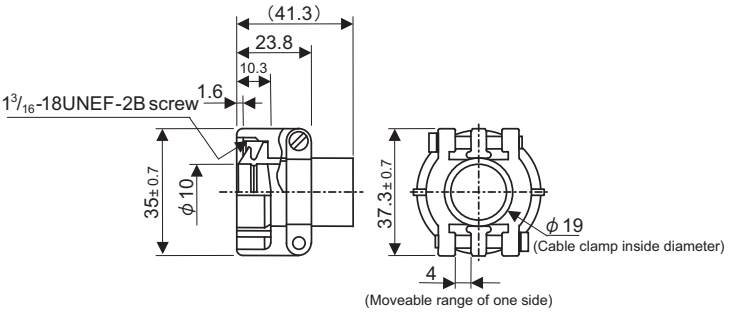
[Unit:mm]

Manufacturer: DDK
<Type>
Angle back shell: CE-20BA-S



[Unit:mm]

Manufacturer: DDK
<Type>
Cable clamp:CE3057-12A-3



Appendix 2

Restrictions for Lithium Batteries

Appendix 2-1 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	-

Appendix 2-1-1 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

Mitsubishi type (Type for arrangement)	Battery type	Lithium metal content	Number of incorporated batteries	Application (Data backup)	Battery class	Outline dimension drawing
CR2032 (for built-in battery)	CR2032	0.067g	-	For NC SRAM/	Battery cell	Refer to "Battery Option" in the specification manual for drive unit you are using for the outline dimension drawing for servo.
CR2450 (for built-in battery)	CR2450	0.173g	-	For NC SRAM		
ER6, ER6V series (for built-in battery)	ER6, ER6V	0.65g	-	For NC SRAM/ servo encoder		
A6BAT(MR-BAT)	ER17330V	0.48g	-	For servo encoder		
Q6BAT	Q6BAT	0.49g	-	For NC SRAM		
MDS-BAT6V1SET	2CR17335A	1.2g	2	For servo encoder	Battery	
MR-BAT6V1SET						

(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.

Appendix 2-1-2 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/

Appendix 2-1-3 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/

Appendix 2-2 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.

Appendix 2-3 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"

Appendix 2-4 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"

Appendix 2-5 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.

Appendix 2-5-1 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).

Appendix 2-5-2 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!

Appendix 3

EC Declaration of Conformity

Appendix 3-1 EC Declaration of conformity

Each series can respond to LVD and EMC directive. Approval from a third party certification organization has been also acquired for the Low Voltage Directive.
The declaration of conformity of each unit is shown below.

Appendix 3-1-1 Low voltage equipment

MDS-DM-V3 Series

MITSUBISHI ELECTRIC
Changes for the Better

EU DECLARATION OF CONFORMITY

EU DECLARATION OF INCORPORATION OF PARTLY COMPLETE MACHINERY

We,

Manufacturer : MITSUBISHI ELECTRIC CORPORATION

Address (Place of Declare) : TOKYO 100-8310, JAPAN

Brand Name : MITSUBISHI ELECTRIC , MITSUBISHI

declare under our sole responsibility that the product

Description : AC Servo / Spindle Drive Unit, AC Power Supply Unit

Type of Model : MDS-D-CV, -V1, -V2, -V3, -SP, -SP2, -V1S, -V2S, -SPS Series
MDS-D-SP2S, -PFU Series
MDS-DH-CV, -V1, -V2, -SP, -V1S, -V2S, -SPS, -PFU Series
MDS-DM-V3, -V3S Series
MDS-D2-CV, -V1, -V2, -V3, -SP, -SP2 Series
MDS-DH2-CV, -V1, -V2, -SP Series

Notice :

to which this declaration relates is in conformity with the following standard and directive.

Directive		Harmonized Standard	Notified Body
Low Voltage Directive	2014/35/EU	EN50178:1997	—
EMC Directive	2014/30/EU	EN 61800-3:2004/A1:2012	—
Machinery Directive	2006/42/EC	ENISO13849-1:2015 (Category 3 and performance level "d") EN62061:2005 (SIL CL 2) EN50178:1997 EN61800-5-1:2007 EN61800-5-2:2007 EN60204-1:2006 (Stop Category 0)	1

The Last Two digit of the year in which the CE marking was affixed for Low Voltage Directive is 97

This declaration is based on the conformity assessment of following Notified Body		
No.	Name and Address	Identification Number
1	TÜV SÜD Product Service GmbH,Ridlerstrasse 65 80339 Muenchen Germany	0123

Essential requirements of Machinery Directive are applied and fulfilled and the relevant technical documentation is compiled in accordance with part B of Annex VII of Machinery Directive.
If National authorities require relevant information on this product by rational reasons, we transmit its information by mail
This product must not be put into service until the final machinery into which it is to be incorporated has been declared in conformity with Machinery Directive.

Authorized representative in Europe (The person authorized to compile the Technical file or relevant Technical documentation)
Hartmut Puetz FA Product Marketing,Director,MITSUBISHI ELCTRIC EUROPE B.V., German Branch Mitsubishi-Electric-Platz 1, 40882 Ratingen, Germany

Issue Date (Date of Declaration):28 Jun. 2016
Signed for and on behalf of

(Signature) Yasushi Ikawa

[Yasushi Ikawa]
General Manager ,Drive System Dept
MITSUBISHI ELECTRIC CORPORATION

BCN-B81019-005-C

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MDS-DM-SPVx Series

MITSUBISHI ELECTRIC
Changes for the Better

EU DECLARATION OF CONFORMITY

EU DECLARATION OF INCORPORATION OF PARTLY COMPLETE MACHINERY

We,

Manufacturer : MITSUBISHI ELECTRIC CORPORATION

Address (Place of Declare) : TOKYO 100-8310, JAPAN

Brand Name : MITSUBISHI ELECTRIC , MITSUBISHI

declare under our sole responsibility that the product

Description : Multi Axis Unit

Type of Model : MDS-DM-SPV2, -SPV3, -SPV2F, -SPV3F, -SPV2S, -SPV3S Series
MDS-DM2-SPV2, SPV3, -SPHV3 Series

Notice :

to which this declaration relates is in conformity with the following standard and directive.

Directive		Harmonized Standard	Notified Body
Low Voltage Directive	2014/35/EU	EN61800-5-1:2007	—
EMC Directive	2014/30/EU	EN 61800-3:2004/A1:2012	—
Machinery Directive	2006/42/EC	ENISO13849-1:2015 (Category 3 and performance level "d") EN62061:2005 (SIL CL 2) EN50178:1997 EN61800-5-1:2007 EN61800-5-2:2007 EN60204-1:2006 (Stop Category 0)	1

The Last Two digit of the year in which the CE marking was affixed for Low Voltage Directive is 07

This declaration is based on the conformity assessment of following Notified Body

No.	Name and Address	Identification Number
1	TÜV SÜD Product Service GmbH,Ridlerstrasse 65 80339 Muenchen Germany	0123

Essential requirements of Machinery Directive are applied and fulfilled and the relevant technical documentation is compiled in accordance with part B of Annex VII of Machinery Directive.
If National authorities require relevant information on this product by rational reasons, we transmit its information by mail
This product must not be put into service until the final machinery into which it is to be incorporated has been declared in conformity with Machinery Directive.

Authorized representative in Europe
(The person authorized to compile the Technical file or relevant Technical documentation)

Hartmut Puetz
FA Product Marketing,Director,MITSUBISHI ELCTRIC EUROPE B.V., German Branch
Mitsubishi-Electric-Platz 1, 40882 Ratingen, Germany

Issue Date (Date of Declaration):28 Jun. 2016
Signed for and on behalf of

(Signature) Yasushi Ikawa

[Yasushi Ikawa]
General Manager ,Drive System Dept
MITSUBISHI ELECTRIC CORPORATION

BCN-B81019-006-C

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Appendix 4

Instruction Manual for Compliance with UL/c-UL Standard

The instructions of UL/c-UL listed products are described in this manual.
The descriptions of this manual are conditions to meet the UL/c-UL standard for the UL/c-UL listed products. To obtain the best performance, be sure to read this manual carefully before use.
To ensure proper use, be sure to read specification manual, connection manual and maintenance manual carefully for each product before use.
UL File No. E131592 (MDS-D, D2/DH, DH2/DM, DM2/DJ Series)

Appendix 4-1 Operation surrounding air ambient temperature

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

Classification	Unit name	Operation ambient temperature
AC servo/spindle system	Power supply unit, AC Reactor	0 to 55°C
	Servo, Spindle drive unit	0 to 55°C
	Multi Axis unit (Multi-Hybrid drive unit)	0 to 55°C
	Power Backup unit	0 to 55°C
	Option unit, Battery unit	0 to 55°C
	Servo motor, Spindle motor	0 to 40°C

Appendix 4-2 Notes for AC servo/spindle system

Appendix 4-2-1 Warning

It takes 15 minutes maximum to discharge the bus capacitor. (The capacitor discharge time is one minute for Models MDS-D-SVJ3-03, MDS-DJ-V1-10; two min. for Models MDS-D-SVJ3-04, MDS-DJ-V1-15, three min. for Model MDS-D-SVJ3-07, MDS-DJ-V1-30, 9 min. for Models MDS-D-SVJ3-10, -20 and -35, MDS-DJ-V1-40, -80 and -100, 10 min. for Models MDS-D, D2/DH, DH2/DM, DM2/PFU/DJ.)
When starting wiring or inspection, shut the power off and wait for more than 15 minutes to avoid a hazard of electrical shock.

Appendix 4-2-2 Installation

MDS-D, D2/DH, DH2/DM, DM2/DJ Series are UL/c-UL listed "open type" drives and must be installed into an end-use electrical enclosure. The minimum enclosure size is based on 150 percent of each MDS-D, D2/DH, DH2/DM, DM2/DJ Series combination. MDS-D, D2/DH, DH2/DM, DM2/DJ Series are installed a pollution degree 2 environment.
And also, design the enclosure so that the ambient temperature in the enclosure is 55°C (131°F) or less, refer to the specifications manual.

Appendix 4-2-3 Short-circuit ratings (SCCR)

Suitable for use in a circuit capable of delivering not more than 100kA rms symmetrical amperes, 500 volts maximum. (MDS-D2-CV, MDS-DM/DM2-SPV are suitable for use in a circuit capable of delivering 230 volts maximum, MDS-DH2-CV suitable for use in a circuit capable of delivering 480 volts maximum.)
(MDS-D/DH-PFU, MDS-D-DBU, MDS-D2-CV-550, MDS-DH2-CV-550,-750, MDS-DJ-SP-100,-120,-160, MDS-DJ-V2-3030, MDS-DJ-SP2-2020 is suitable for use in a circuit capable of delivering not more than 5kA rms symmetrical amperes.)

Appendix 4-2-4 Over-temperature protection for motor

Motor Over temperature sensing is not provided by the drive.

Appendix 4-2-5 Peripheral devices

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

Circuit Protector, Fuses, Magnetic contactor and AC Reactor

Applicable power supply unit	UL489 Circuit Protector	UL Fuse Class T	Magnetic contactor (AC3)	AC Reactor
MDS-D(*)-CV-37	20A	30A	S-N12/S-T12	D-AL-7.5K
MDS-D(*)-CV-75	40A	60A	S-N25/S-T35	D-AL-7.5K
MDS-D(*)-CV-110	60A	70A	S-N35/S-T35	D-AL-11K
MDS-D(*)-CV-185	100A	125A	S-N65/S-T65	D-AL-18.5K
MDS-D(*)-CV-300	150A	200A	S-N95/S-T80	D-AL-30K
MDS-D(*)-CV-370	200A	225A	S-N150	D-AL-37K
MDS-D(*)-CV-450	225A	250A	S-N150	D-AL-45K
MDS-D(*)-CV-550	300A	400A	S-N300	D-AL-55K
MDS-DH(*)-CV-37	10A	10A	S-N12/S-T12	DH-AL-7.5K
MDS-DH(*)-CV-75	20A	25A	S-N12/S-T12	DH-AL-7.5K
MDS-DH(*)-CV-110	30A	35A	S-N21/S-T21	DH-AL-11K
MDS-DH(*)-CV-185	50A	70A	S-N25/S-T35	DH-AL-18.5K
MDS-DH(*)-CV-300	75A	110A	S-N50/S-T50	DH-AL-30K
MDS-DH(*)-CV-370	100A	125A	S-N65/S-T65	DH-AL-37K
MDS-DH(*)-CV-450	125A	150A	S-N80/S-T80	DH-AL-45K
MDS-DH(*)-CV-550	150A	200A	S-N95/S-T80	DH-AL-55K
MDS-DH(*)-CV-750	200A	300A	S-N150	DH-AL-75K

(Note (*)) : may be followed by 2

Applicable drive unit	UL 489 Circuit Protector (240Vac)	UL Fuse Class T (300Vac)	Magnetic contactor (AC3)
MDS-D-SVJ3(#)-03(##) MDS-DJ-V1-10	5A	10A	S-N12/S-T12
MDS-D-SVJ3(#)-04(##) MDS-DJ-V1-15	5A	20A	S-N12/S-T12
MDS-D-SVJ3(#)-07(##) MDS-DJ-V1-30	5A	20A	S-N12/S-T12
MDS-D-SVJ3(#)-10(##) MDS-DJ-V1-40	10A	20A	S-N12/S-T12
MDS-D-SVJ3(#)-20(##) MDS-DJ-V1-80	15A	40A	S-N21/S-T18
MDS-D-SVJ3(#)-35(##) MDS-DJ-V1-100	20A	70A	S-N21/S-T20
MDS-D-SPJ3(#)-075(##) MDS-DJ-SP-20	5A	15A	S-N12/S-T12
MDS-D-SPJ3(#)-22(##) MDS-DJ-SP-40	15A	40A	S-N12/S-T12
MDS-D-SPJ3(#)-37(##) MDS-DJ-SP-80	30A	60A	S-N21/S-T20
MDS-D-SPJ3(#)-55(##) MDS-DJ-SP-100	40A	90A	S-N25/S-T35
MDS-D-SPJ3(#)-75(##) MDS-DJ-SP-120	50A	125A	S-N25/S-T35
MDS-D-SPJ3(#)-110(##) MDS-DJ-SP-160	75A	175A	S-N50/S-T35
MDS-DJ-V2-3030	10A	20A	S-N12/S-T12
MDS-DJ-SP2-2020	10A	15A	S-N12/S-T12

(Note (#)) : may be followed by S

(Note (##)) : may be followed by N or NA

Applicable drive unit	UL489 Circuit Protector	UL Fuse Class T (300Vac)	Magnetic contactor (AC3)	AC Reactor
MDS-DM(*)-SPV2-10080	40A	80A	S-N65/S-T65	D-AL-18.5K
MDS-DM(*)-SPV2-16080	50A	100A	S-N65/S-T65	D-AL-18.5K
MDS-DM(*)-SPV2-20080	60A	125A	S-N65/S-T65	D-AL-18.5K
MDS-DM(*)-SPV3-10080	50A	100A	S-N65/S-T65	D-AL-18.5K
MDS-DM(*)-SPV3-16080	60A	125A	S-N65/S-T65	D-AL-18.5K
MDS-DM(*)-SPV3-20080	75A	150A	S-N65/S-T65	D-AL-18.5K
MDS-DM2-SPHV3-20080	75A	150A	S-N65/S-T65	D-AL-18.5K
MDS-DM(*)-SPV3-200120	75A	150A	S-N65/S-T65	D-AL-18.5K
MDS-DM-SPV2F-10080	40A	80A	S-N65/S-T65	D-AL-18.5K
MDS-DM-SPV2F-16080	50A	100A	S-N65/S-T65	D-AL-18.5K
MDS-DM-SPV2F-20080	60A	125A	S-N65/S-T65	D-AL-18.5K
MDS-DM-SPV3F-10080	50A	100A	S-N65/S-T65	D-AL-18.5K
MDS-DM-SPV3F-16080	60A	125A	S-N65/S-T65	D-AL-18.5K
MDS-DM-SPV3F-20080	75A	150A	S-N65/S-T65	D-AL-18.5K
MDS-DM-SPV3F-200120	75A	150A	S-N65/S-T65	D-AL-18.5K
MDS-DM-SPV2S-10080	40A	80A	S-N65/S-T65	D-AL-18.5K
MDS-DM-SPV2S-16080	50A	100A	S-N65/S-T65	D-AL-18.5K
MDS-DM-SPV2S-20080	60A	125A	S-N65/S-T65	D-AL-18.5K
MDS-DM-SPV3S-10080	50A	100A	S-N65/S-T65	D-AL-18.5K
MDS-DM-SPV3S-16080	60A	125A	S-N65/S-T65	D-AL-18.5K
MDS-DM-SPV3S-20080	75A	150A	S-N65/S-T65	D-AL-18.5K
MDS-DM-SPV3S-200120	75A	150A	S-N65/S-T65	D-AL-18.5K

(Note (*)) : may be followed by 2

Applicable Power Backup Unit	UL489 Circuit Protector	Regenerative Resistance Unit
MDS-DH-PFU	10A	R-UNIT-6
MDS-D-PFU	10A	R-UNIT-7

Circuit Protector for spindle motor Fan

Select the Circuit Protector by doubling the spindle motor fan rated.

A rush current that is approximately double the rated current will flow, when the fan is started.

<Notice>

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

Appendix 4-2-6 Field wiring reference table for input and output (power wiring)

Use the UL-approved Round Crimping Terminals to wire the input and output terminals of MDS-D, D2/DH, DH2/DM, DM2-SPV/DJ Series. Crimp the terminals with the crimping tool recommended by the terminal manufacturer. Please protect terminal ring by the insulation cover.
Following described crimping terminals and tools type are examples of Japan Solderless Terminal Mfg. Co., Ltd.
This wire size is each unit maximum rating. The selection method is indicated in each specification manual.
(See Manual: No. IB-1500158, 1500875, 1500891, 1501130, 1501124 or 1501136)

(1) Power Supply Unit (MDS-D, D2/DH, DH2-CV)

Unit Type	**MDS-D(*)-CV-**	37 to 75	110 to 185	300 to 450	550	
	MDS-DH(*)-CV-	------	37 to 185	300 to 750	---	---
Terminal Screw Size	**TE2 (L+, L-)**	M6	M6	M6	M6	M10
	Torque [lb in/ N m]	35.4/4.0	35.4/4.0	35.4/4.0	35.4/4.0	97.3/11.0
	TE3 (L11, L21)	M4	M4	M4	M4	---
	Torque [lb in/ N m]	10.6/1.2	10.6/1.2	10.6/1.2	10.6/1.2	---
	TE1 (L1, L2, L3, ⏚)	M4	M5	M8	M10	---
	Torque [lb in/ N m]	10.6/1.2	17.7/2.0	53.1/6.0	97.3/11.0	---

TE2 (L+, L-)

Unit Type	**MDS-D(*)-CV-**	---	37	75	110	185	---		300 to 550
	MDS-DH(*)-CV-	37,75	---	110	185	300,370	450		550, 750
Wire Size (AWG) /Temp Rating Note 1		#14 /75°C	#12 /75°C	#10 /75°C	#8 /75°C	#4 /75°C	#2 /75°C	or Bus-bar	Bus-bar
Crimping Terminals Type		R2-6	R5.5-6	R5.5-6	R8-6	R22-6	R38-6	---	---
Crimping Tools Type		YHT-2210	YHT-2210	YHT-2210	YPT-60-21	YPT-60-21	YPT-60-21	---	---

TE3 (L11, L21)

Unit Type	**MDS-D(*)/DH(*)-CV-**	37 to 750
Wire Size (AWG)/Temp Rating Note 1		#14/75°C
Crimping Terminals Type		R2-4
Crimping Tools Type		YHT-2210

TE1 (L1, L2, L3, ⏚)

Unit Type	**MDS-D(*)-CV-**	37	---	75	110	185
	MDS-DH(*)-CV-	37, 75	110	---	185	---
Wire Size (AWG)/Temp Rating Note 1		#14/75°C	#12/75°C	#10/75°C	#8/75°C	#6/75°C
Crimping Terminals Type		R2-4	R5.5-5	5.5-S4	R8-5	R14-5
Crimping Tools Type		YHT-2210	YHT-2210	YHT-2210	YPT-60-21	YPT-60-21

Unit Type	**MDS-D(*)-CV-**	---	---	300	370, 450	550
	MDS-DH(*)-CV-	300	370, 450	550	750	---
Wire Size (AWG)/Temp Rating Note 1		#6/75°C	#4/75°C	#2/75°C	#1/0/75°C	#3/0/75°C
Crimping Terminals Type		R14-8	R22-8	38-S8	60-S8	80-10
Crimping Tools Type		YPT-60-21	YPT-60-21	YPT-60-21	YPT-60-21	YPT-150-1

(Note 1) 75 °C: Grade heat-resistant polyvinyl chloride insulated wires (HIV).
Use copper wire only.
Above listed wire are for use in the electric cabinet on machine or equipment.
(Note (*)) : may be followed by 2

(2) Spindle Drive Unit (MDS-D, D2/DH, DH2-SP/SP2, MDS-D-SPJ3, MDS-DJ)

Unit Type	MDS-D(*)-SP(#)-	160 to 200	240 to 320	400 to 640	---	---	---
	MDS-D-SPJ3(#)-	---	---	---	22, 37(##)	22(##)	55(##), 75(##), 110(##)
	MDS-DJ-SP-	---	---	---	---	20,40,80	100,120,160
	MDS-DJ-SP2-	---	---	---	---	2020	---
	MDS-DH(*)-SP(#)-	100 to 160	200 to 480	---	---	---	---
Terminal Screw Size	TE2 (L+, L-) Torque [lb in/ N m]	M6	M6	M10	---	---	---
		35.4/4.0	35.4/4.0	97.3/11.0	---	---	---
	TE3 (L11, L21) Torque [lb in/ N m]	M4	M4	M4	---	---	M3.5
		10.6/1.2	10.6/1.2	10.6/1.2	---	---	10.6/1.2
	TE1 (L1, L2, L3, ⏚) Torque [lb in/ N m]	M5	M8	M10	---	---	M4
		17.7/2.0	53.1/6.0	97.3/11.0	---	---	17.7/2.0
	CNP1 (L1,L2,L3,N,P1,P2) and CNP3 (U,V,W)) Torque [lb in/ N m]	---	---	---	---	---	---
		---	---	---	5.3/0.6	---	---

TE2 (L+, L-)

Wire size depends on the Power Supply Unit (MDS-D,D2/DH,DH2-CV Series).

TE3 or CNP2 (L11, L21)

Unit Type	MDS-D(*)/DH(*)-SP(#)-	20 to 640	---
	MDS-D-SPJ3(#)-	55(##) to 110(##)	075(##) to 37(##)
	MDS-DJ-SP-	100,120,160	20,40,80
	MDS-DJ-SP2-	---	2020
Wire Size (AWG)/Temp Rating Note 1		#14/75°C	#14/60 or 75°C
Crimping Terminals Type		R2-4	---
Crimping Tools Type		YHT-2210	---

TE1 (U, V, W, ⏚)

Unit Type	MDS-D(*)-SP(#)-	20, 40	80	---	160	200
	MDS-DH(*)-SP(#)-	20, 40	80	100	---	160
Wire Size (AWG)/Temp Rating Note 1, 2, 3		#14/75°C	#12/75°C	#10/75°C	#6/75°C	#4/75°C
Crimping Terminals Type		---	---	R5.5-5	R8-5	R14-5
Crimping Tools Type		---	---	YHT-2210	YPT-60-21	YPT-60-21

Unit Type	MDS-D(*)-SP(#)-	---	240	320	400, 640
	MDS-DH(*)-SP(#)-	200	320	---	480
Wire Size (AWG)/Temp Rating Note 1, 2, 3		#4/75°C	#2/75°C	#1/0/75°C	#3/0/75°C
Crimping Terminals Type		R22-8	38-S8	60-S8	80-10
Crimping Tools Type		YPT-60-21	YPT-60-21	YPT-60-21	YPT-150-1

CNP1 (L1, L2, L3), CNP3 (U, V, W) and ⏚

Unit Type	MDS-D-SPJ3(#)-	075(##) to 37(##)	55(##)	75(##)	110(##)
	MDS-DJ-SP-	20,40,80	100	120	160
	MDS-DJ-SP2-	2020	---	---	---
Wire Size (AWG)/Temp Rating Note 1, 2, 3		#14/60 or 75°C	#12/75°C	#10/75°C	#8/75°C
Crimping Terminals Type		---	R5.5-5	R5.5-5	R8-5
Crimping Tools Type		---	YHT-2210	YHT-2210	YPT-60-21

(Note 1) 75 °C: Grade heat-resistant polyvinyl chloride insulated wires (HIV).
Use copper wire only. Above listed wire are for use in the electric cabinet on machine or equipment.

(Note (#)) :may be followed by S

(Note (##)) :may be followed by N or NA

(Note (*)) :may be followed by 2

(Note 2) The servo motor cable can be selected in accordance with the stall current.
The spindle motor cable can be selected in accordance with the continuous rated current.

(Note 3) Select the motor so that the current value of motor become below in the current value of drive.

(3) Servo Drive Unit (MDS-D, D2/DH, DH2/DM, DM2-V1/V2/V3/D-SVJ3/DJ)

Unit Type	**MDS-D(*)-V1(#)-**	160W, 320	320W	---	---
	MDS-DH(*)-V1(#)-	160, 160W	200	---	---
	MDS-D-SVJ3(#)-	---	---	10 to 35(##)	10(##), 20(##)
	MDS-DJ-V1-	---	---	---	10, 15, 30, 40, 80, 100
	MDS-DJ-V2-	---	---	---	3030
Terminal Screw Size	**TE2 (L+, L-)**	M6	M6	---	---
	Torque [lb in/ N m]	35.4/4.0	35.4/4.0	---	---
	TE3 (L11, L21)	M4	M4	---	---
	Torque [lb in/ N m]	10.6/1.2	10.6/1.2	---	---
	TE1 (L1, L2, L3, ⏚)	M5	M8	---	---
	Torque [lb in/ N m]	17.7/2.0	53.1/6.0	---	---
	CNP1 (L1,L2,L3,N,P1,P2) and CNP3 (U,V,W))	---	---	---	---
	Torque [lb in/ N m]	---	---	5.3/0.6	---

TE2 (L+, L-)

Wire size depends on the Power Supply Unit (MDS-D, D2/DH, DH2-CV Series).

TE3 or CNP2 (L11, L21)

Unit Type	**MDS-D/DH/DM-V1(#)/V2(#)/V3(#)-**	10 to 320W	---
	MDS-D-SVJ3(#)-	---	03(##) to 35(##)
	MDS-DJ-V1-	---	10, 15, 30, 40, 80, 100
	MDS-DJ-V2-	---	3030
Wire Size (AWG)/Temp Rating Note 1		#14/75°C	#14/75°C
Crimping Terminals Type		R2-4	---
Crimping Tools Type		YHT-2210	---

TE1 (U, V, W, ⏚)

Unit Type	**MDS-D(*)-V1(#)-**	20 to 40	80	160
	MDS-DH(*)-V1(#)-	10 to 40	80	80W
Wire Size (AWG)/Temp Rating Note 1, 2, 3		#14/75°C	#12/75°C	#10/75°C

Unit Type	**MDS-D(*)-V1(#)-**	160W	320	---	320W
	MDS-DH(*)-V1(#)-	160, 160W	---	200	---
Wire Size (AWG)/Temp Rating Note 1, 2, 3		#8/75°C	#6/75°C	#4/75°C	#2/75°C
Crimping Terminals Type		R8-5	R14-5	R22-8	38-S8
Crimping Tools Type		YPT-60-21	YPT-60-21	YPT-60-21	YPT-60-21

CNP1 (L1, L2, L3), CNP3 (U, V, W) and ⏚

Unit Type	**MDS-D-SVJ3(#)-**	03(##) to 10(##)	20(##)	35(##)
	MDS-DJ-V1-	10, 15, 30, 40	80	100
	MDS-DJ-V2-	3030	---	
Wire Size (AWG)/Temp Rating Note 1, 2, 3		#14/75°C	#12/75°C	#10/75°C

(Note 1) 75 °C: Grade heat-resistant polyvinyl chloride insulated wires (HIV).
Use copper wire only.
Above listed wire are for use in the electric cabinet on machine or equipment.

(Note (#)) :may be followed by S

(Note (##)) :may be followed by N or NA

(Note (*)) :may be followed by 2

(Note 2) The servo motor cable can be selected in accordance with the stall current.
The spindle motor cable can be selected in accordance with the continuous rated current.

(Note 3) Select the motor so that the current value of motor become below in the current value of drive.

(4) Option Unit : Dynamic Brake Unit (MDS-D-DBU)

Type		MDS-D-DBU
Terminal Screw Size	U, V, W, ⏚	M4
	Torque [lb in/ N m]	10.6/1.2

TE1 (U, V, W, ⏚)

Unit Type	MDS-D-DBU
Wire Size (AWG) /Temp Rating Note 1	#10/75°C
Crimping Terminals Type	R5.5-4
Crimping Tools Type	YHT-2210

(Note 1) 75 °C: Grade heat-resistant polyvinyl chloride insulated wires (HIV).
Use copper wire only. Above listed wire are for use in the electric cabinet on machine or equipment.

(5) AC Reactor (D/DH-AL)

Type	D-AL-	7.5K, 11K	18.5K to 45K	55K
	DH-AL-	7.5K, 11K	18.5K to 75K	---
Terminal Screw Size	L11, L12, L13, L21, L22, L23	M5	M6	M10
	Torque [lb in/ N m]	17.7/2.0	35.4/4.0	97.3/11.0

Input/Output (L11, L12, L13, L21, L22, L23)

The wire connected with AC Reactor becomes same size as TE1 of the selected Power supply unit.

(6) Multi Axis Unit (Multi-Hybrid drive unit) (MDS-DM, DM2-SPV)

Unit Type	MDS-DM(*)-SPV2(###)	-10080	-16080	-20080	---
	MDS-DM(*)-SPV3(###)	-10080	-16080	-20080	-200120
	MDS-DM2-SPHV3	---	---	-20080	---
Terminal Screw Size	TE1 (L1,L2,L3,U,V,W)	M5	M5	M5	M5
	Torque [lb in/ N m]	17.7 / 2.0	17.7 / 2.0	17.7 / 2.0	17.7 / 2.0
	CN31L/M/S (U,V,W)	---	---	---	---
	Torque [lb in/ N m]	---	---	---	---
	PE (⏚)	M5	M5	M5	M5
	Torque [lb in/ N m]	17.7 / 2.0	17.7 / 2.0	17.7 / 2.0	17.7 / 2.0

TE1 (L1, L2, L3) and ⏚

Unit Type	MDS-DM(*)-SPV2(###)	-10080	-16080	-20080	---
	MDS-DM(*)-SPV3(###)	-10080	-16080	-20080	-200120
	MDS-DM2-SPHV3	---	---	-20080	---
Wire Size (AWG) /Temp Rating Note 1		#4/75°C	#4/75°C	#4/75°C	#4/75°C
Crimping Terminals Type		R22-S5	R22-S5	R22-S5	R22-S5
Crimping Tools Type		YPT-60-21	YPT-60-21	YPT-60-21	YPT-60-21

TE1 (U, V, W) and ⏚

Unit Type	MDS-DM(*)-SPV2(###)	-10080	-16080	---	-20080
	MDS-DM(*)-SPV3(###)	-10080	-16080	---	-20080 -200120
	MDS-DM2-SPHV3	---	---	-20080	---
Wire Size (AWG) /Temp Rating Note 1, 2, 3		#10/75°C	#8/75°C	#6/75°C	#4/75°C
Crimping Terminals Type Note 2		R5.5-5	R8-5	R14-5	R22-5
Crimping Tools Type		YHT-2210	YPT-60-21	YPT-60-21	YPT-60-21

CN31L/M/S (U,V,W) and ⏚

Unit Type	**MDS-DM(*)-SPV2(###)**	-10080	-16080	-20080	---
	MDS-DM(*)-SPV3(###)	-10080	-16080	-20080	-200120
	MDS-DM2-SPHV3	---	---	-20080	---
Wire Size (AWG) /Temp Rating Note 1, 2, 3		#12/75°C	#12/75°C	#12/75°C	#10/75°C

(Note (###)) :may be followed by F or S
(Note (*)) :may be followed by 2
(Note 1) 75 °C: Grade heat-resistant polyvinyl chloride insulated wires (HIV).
Use copper wire only.
Above listed wire are for use in the electric cabinet on machine or equipment.
(Note 2) The servo motor cable can be selected in accordance with the stall current.
The spindle motor cable can be selected in accordance with the continuous rated current.
(Note 3) Select the motor so that the current value of motor become below in the current value of drive.

(7) Power Backup Unit (MDS-D/DH-PFU)

Unit Type	MDS-DH-PFU / MDS-D-PFU	
Terminal Screw Size	**TE1 (L1,L2,L3)**	---
	Torque [lb in/ N m]	---
	TE2 (L+, L-))	M6
	Torque [lb in/ N m]	35.4/4.0
	TE3 (OUT-L11,OUT-L21))	M4
	Torque [lb in/ N m]	10.6/1.2
	TE4 (C+,C-))	M6
	Torque [lb in/ N m]	35.4/4.0
	TE5 (R1,R2))	M6
	Torque [lb in/ N m]	35.4/4.0
	PE(⏚)	M4
	Torque [lb in/ N m]	10.6/1.2

TE1 (L1, L2,L3)

Unit Type	MDS-DH-PFU / MDS-D-PFU
Wire Size (AWG) /Temp Rating Note 1	#14/75°C
Crimping Terminals Type	---
Crimping Tools Type	---

TE2 (L+, L-)

Unit Type	MDS-DH-PFU / MDS-D-PFU
Wire Size (AWG) /Temp Rating Note 1	#10/75°C
Crimping Terminals Type	R5.5-6
Crimping Tools Type	YHT-2210

TE3 (OUT-L11, OUT-L21)

Unit Type	MDS-DH-PFU / MDS-D-PFU
Wire Size (AWG) /Temp Rating Note 1	#14/75°C
Crimping Terminals Type	R2-4
Crimping Tools Type	YHT-2210

TE4 (C+,C-)

Unit Type	MDS-DH-PFU / MDS-D-PFU
Wire Size (AWG) /Temp Rating Note 1	#10/75°C
Crimping Terminals Type	R5.5-6
Crimping Tools Type	YHT-2210

TE5 (R1,R2)

Unit Type	MDS-DH-PFU / MDS-D-PFU
Wire Size (AWG) /Temp Rating Note 1	#10/75°C
Crimping Terminals Type	R5.5-6
Crimping Tools Type	YHT-2210

PE (⏚)

Unit Type	MDS-DH-PFU / MDS-D-PFU
Wire Size (AWG) /Temp Rating Note 1	#14/75°C
Crimping Terminals Type	R2-4
Crimping Tools Type	YHT-2210

Option Unit : R-Unit (R-UNIT-6 / R-UNIT-7)

Unit Type	R-UNIT-6 / R-UNIT-7	
Terminal Screw Size	TE1 (R1, R2) Torque [lb in/ N m]	M4
		10.6/1.2
	PE(⏚) Torque [lb in/ N m]	M4
		10.6/1.2

TE1 (R1,R2)

Unit Type	R-UNIT-6 / R-UNIT-7
Wire Size (AWG) /Temp Rating Note 1	#10/75°C
Crimping Terminals Type	R5.5-4
Crimping Tools Type	YHT-2210

PE (⏚)

Unit Type	R-UNIT-6 / R-UNIT-7
Wire Size (AWG) /Temp Rating Note 1	#10/75°C
Crimping Terminals Type	R5.5-4
Crimping Tools Type	YHT-2210

Option Unit : Capacitor Unit (MDS-D-CU / MDS-DH-CU)

Unit Type	MDS-D-CU / MDS-DH-CU	
Terminal Screw Size	TE1 (C+, C-) Torque [lb in/ N m]	M10
		97.3/11.0
	TE2 (C+, C-) Torque [lb in/ N m]	M6
		35.4/4.0
	PE(⏚) Torque [lb in/ N m]	M10
		97.3/11.0

TE1 (C+, C-)

Unit Type	MDS-D-CU / MDS-DH-CU
Wire Size (AWG) /Temp Rating Note 1	#10/75°C
Crimping Terminals Type	R5.5-10
Crimping Tools Type	YHT-2210

TE2 (C+, C-)

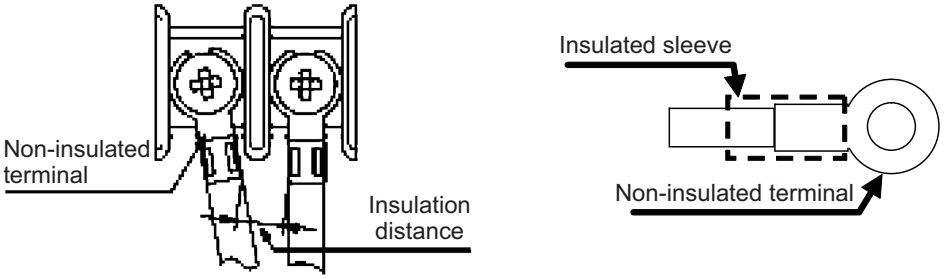
Unit Type	MDS-D-CU / MDS-DH-CU
Wire Size (AWG) /Temp Rating Note 1	#10/75°C or more
Crimping Terminals Type	R5.5-6
Crimping Tools Type	YHT-2210

PE (⏚)

Unit Type	MDS-D-CU / MDS-DH-CU
Wire Size (AWG) /Temp Rating Note 1	#10/75°C
Crimping Terminals Type	R5.5-10
Crimping Tools Type	YHT-2210

(8) Notes of Round Crimping Terminals and Terminal Block

The non-insulation ring tongue must have the insulated sleeving described below to prevent electric shock. The crimp terminal must be provided with SUMITOMO ELECTRIC FINE POLYMER INC. (File No.: E48762, Catalogue No.: SUMITUBE F(Z) or 939) per the illustration below.



Appendix 4-2-7 Motor over load protection

Spindle drive unit MDS-D, D2/DH, DH2-SP/SP2, MDS-D-SPJ3/MDS-DJ, Servo drive unit MDS-D, D2/DH, DH2/DM, DM2-V1/V2/V3/, MDS-D-SVJ3/MDS-DJ and Multi Axis unit (Multi-Hybrid drive unit) MDS-DM, DM2-SPV Series have each solid-state motor over load protection. (The motor full load current is the same as rated current.)

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

(1) MDS-D, D2/DH, DH2-SP/SP2, MDS-D-SPJ3/MDS-DJ (Spindle drive unit), MDS-DM, DM2-SPV (Multi Axis unit (Multi-Hybrid drive unit))

Parameter No.	Parameter abbr.	Parameter Name	Setting Procedure	Standard Setting Value	Setting Range
SP021	OLT*	Overload time constant	Set the time constant for overload detection. (Unit: 1 second.)	60s	0 to 15300s
SP022	OLL	Overload detection level	Set the overload current detection level with a percentage (%) of the rating.	120%	1 to 200%

(2) MDS-D, D2/DH, DH2/DM, DM2-V1/V2/V3, MDS-D-SVJ3, MDS-DJ (Servo drive unit), MDS-DM, DM2-SPV (Multi Axis unit (Multi-Hybrid drive unit))

Parameter No.	Parameter abbr.	Parameter Name	Setting Procedure	Standard Setting Value	Setting Range
SV021	OLT	Overload time constant	Set the time constant for overload detection. (Unit: 1 second.)	60s	1 to 999s
SV022	OLL	Overload detection level	Set the overload current detection level with a percentage (%) of the stall rating.	150%	110 to 500%

Appendix 4-2-8 Flange of servo motor

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

Flange size (mm)	Servo Motor
	HF, HF-H, HP, HP-H, HF-KP, HF-MP, HF-SP
150×150×6	50 to 100W
250×250×6	200 to 400W
250×250×12	0.5 to 1.5kW
300×300×20	2.0 to 7.0kW
800×800×35	9.0 to 11.0kW

Appendix 4-2-9 Spindle drive/motor combinations

Following combinations are the Standard combinations.

Drive Unit	Rating Output (kW) of Applicable Spindle Motor
	SJ, SJ-V/VL Series Note 1
MDS-D(*)-SP(#)-20	0.75
MDS-D(*)-SP(#)-40	0.75, 1.5, 2.2
MDS-D(*)-SP(#)-80	2.2, 3.7, 7.5
MDS-D(*)-SP(#)-160	7.5, 11
MDS-D(*)-SP(#)-200	11, 15, 18.5
MDS-D(*)-SP(#)-240	18.5, 22
MDS-D(*)-SP(#)-320	22, 26, 30
MDS-D(*)-SP(#)-400	30, 37, 45
MDS-D(*)-SP(#)-640	37, 45, 55
MDS-D(*)-SP2(#)-2020	0.75, 1.5 / 0.75, 1.5
MDS-D(*)-SP2(#)-8040	2.2, 3.7, 7.5 / 0.75, 1.5, 2.2
MDS-D(*)-SP2(#)-8080	2.2, 3.7, 7.5 / 2.2, 3.7, 7.5
MDS-D(*)-SP2(#)-16080	7.5, 11 / 2.2, 3.7, 7.5

Drive Unit	Rating Output (kW) of Applicable Spindle Motor
	SJ-4, SJ-4-V/VL Series Note 1
MDS-DH(*)-SP(#)-20	0.75, 1.5, 2.2, 3.7
MDS-DH(*)-SP(#)-40	2.2, 3.7, 5.5, 7.5
MDS-DH(*)-SP(#)-80	2.2, 3.7, 7.5, 11
MDS-DH(*)-SP(#)-100	7.5, 11, 15, 18.5
MDS-DH(*)-SP(#)-160	18.5, 22, 26, 30
MDS-DH(*)-SP(#)-200	26, 30, 37, 45
MDS-DH(*)-SP(#)-320	30, 37, 45, 55
MDS-DH(*)-SP(#)-480	45, 55, 60
MDS-DH(*)-SP2(#)-2020	0.75, 1.5, 2.2, 3.7 / 0.75, 1.5, 2.2, 3.7
MDS-DH(*)-SP2(#)-4040	2.2, 3.7, 5.5, 7.5 / 2.2, 3.7, 5.5, 7.5
MDS-DH(*)-SP2(#)-8040	2.2, 3.7, 7.5, 11 / 2.2, 3.7, 5.5, 7.5

Drive Unit	Spindle Motor				
	SJ-V	SJ-VL	SJ-D	SJ-DJ	HF-KP
MDS-D-SPJ3(#)-075(##) MDS-DJ-SP-20	-	SJ-VL0.75	-	-	46, 56, 96
MDS-D-SPJ3(#)-22(##) MDS-DJ-SP-40	SJ-V2.2	SJ-VL1.5, SJ-VL2.2	-	-	-
MDS-D-SPJ3(#)-37(##) MDS-DJ-SP-80	SJ-V3.7	SJ-VL2.2	3.7	-	-
MDS-D-SPJ3(#)-55(##) MDS-DJ-SP-100	SJ-V5.5	-	5.5	5.5	-
MDS-D-SPJ3(#)-75(##) MDS-DJ-SP-120	SJ-V7.5	-	7.5	7.5	-
MDS-D-SPJ3(#)-110(##) MDS-DJ-SP-160	SJ-V7.5, SJ-V11	SJ-VL11	11	11	-
MDS-DJ-SP2-2020	-	SJ-VL0.75	-	-	46, 56, 96

Drive Unit	Rating Output (kW) of Applicable Spindle Motor			
	SJ-V Series Note 1	SJ-VL Series Note 1	SJ-DJ Series Note 1	SJ-DL Series Note 1
MDS-DM(*)-SPV2(###)-10080	5.5, 7.5	-	-	-
MDS-DM(*)-SPV3(###)-10080				
MDS-DM(*)-SPV2(###)-16080	7.5, 11	11	-	-
MDS-DM(*)-SPV3(###)-16080				
MDS-DM(*)-SPV2(###)-20080	11, 15	-	-	-
MDS-DM(*)-SPV3(###)-20080			-	-
MDS-DM2-SPHV3-20080			15	3.7
MDS-DM(*)-SPV3(###)-200120			-	-

(Note1) Applicable unit depends on the range of power constant of motor.Inquire of Mitsubishi about the detail of the combinations.

(Note (#)) :may be followed by S

(Note (##)) :may be followed by N or NA

(Note (###)) :may be followed by F or S

(Note (*)) :may be followed by 2

Appendix 4-2-10 Servo drive/motor combinations

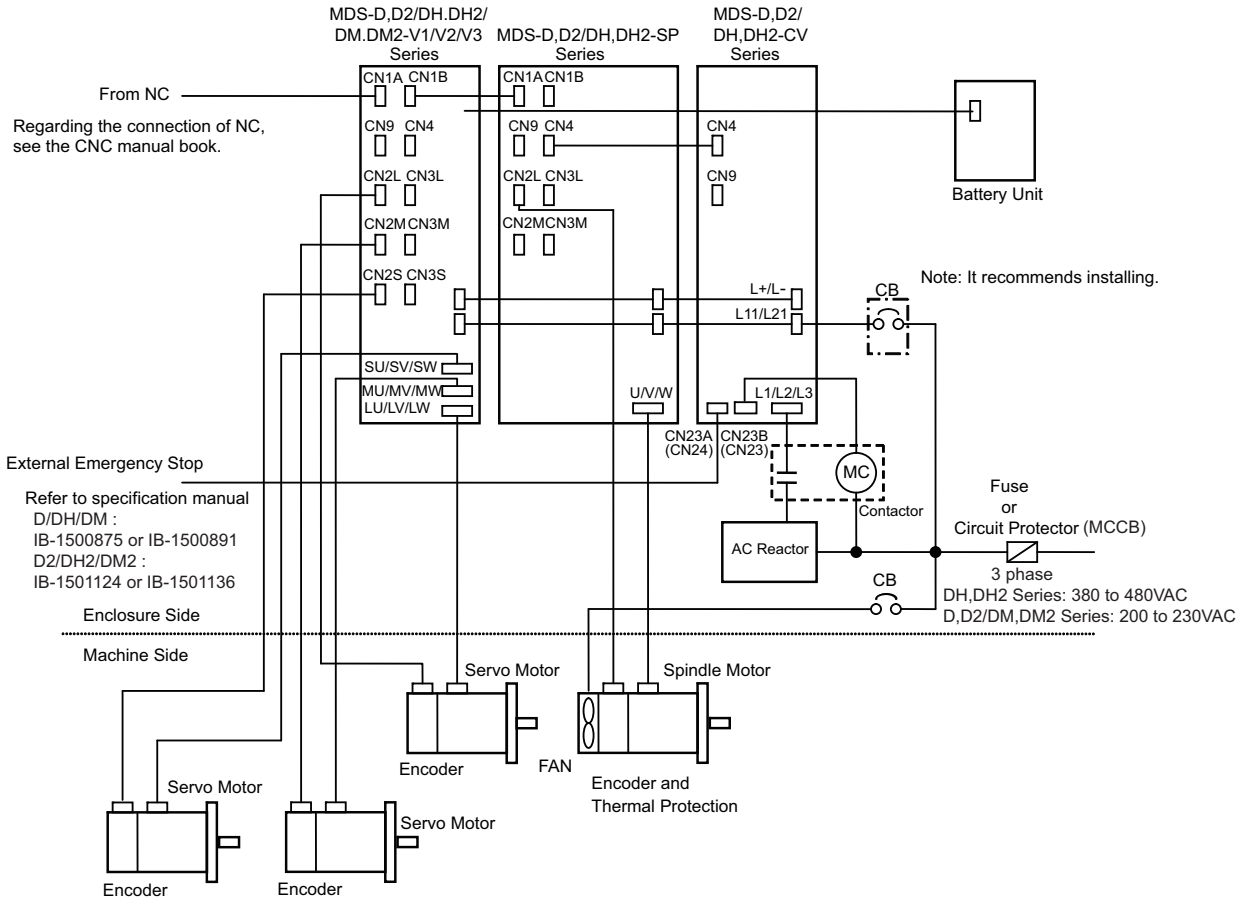
Following combinations are the Standard combinations.

Drive Unit	Servo Motor			
	HF-KP	HF-SP	HF-MP	HF
MDS-D-SVJ3(#)-03(##) MDS-DJ-V1-10	053, 13, 23	-	053, 13, 23	-
MDS-D-SVJ3(#)-04(##) MDS-DJ-V1-15	43	-	43	-
MDS-D-SVJ3(#)-07(##) MDS-DJ-V1-30	73	51, 52	73	54,75,105
MDS-D-SVJ3(#)-10(##) MDS-DJ-V1-40	-	81, 102	-	104,123,142,223, 302
MDS-D-SVJ3(#)-20(##) MDS-DJ-V1-80	-	121, 152, 201, 202	-	154, 204,224,303
MDS-D-SVJ3(#)-35(##) MDS-DJ-V1-100	-	352	-	354
MDS-DJ-V2-3030	13, 23, 43, 73	-	-	54, 75, 105
MDS-DM(*)-SPV2(###)-10080 MDS-DM(*)-SPV2(###)-16080 MDS-DM(*)-SPV2(###)-20080 MDS-DM(*)-SPV3(###)-10080 MDS-DM(*)-SPV3(###)-16080 MDS-DM(*)-SPV3(###)-20080 MDS-DM2-SPHV3-20080	-	-	-	54, 104, 154, 204, 224, 223, 303, 302
MDS-DM(*)-SPV3(###)-200120	-	-	-	154, 204, 224, 354, 303, 453

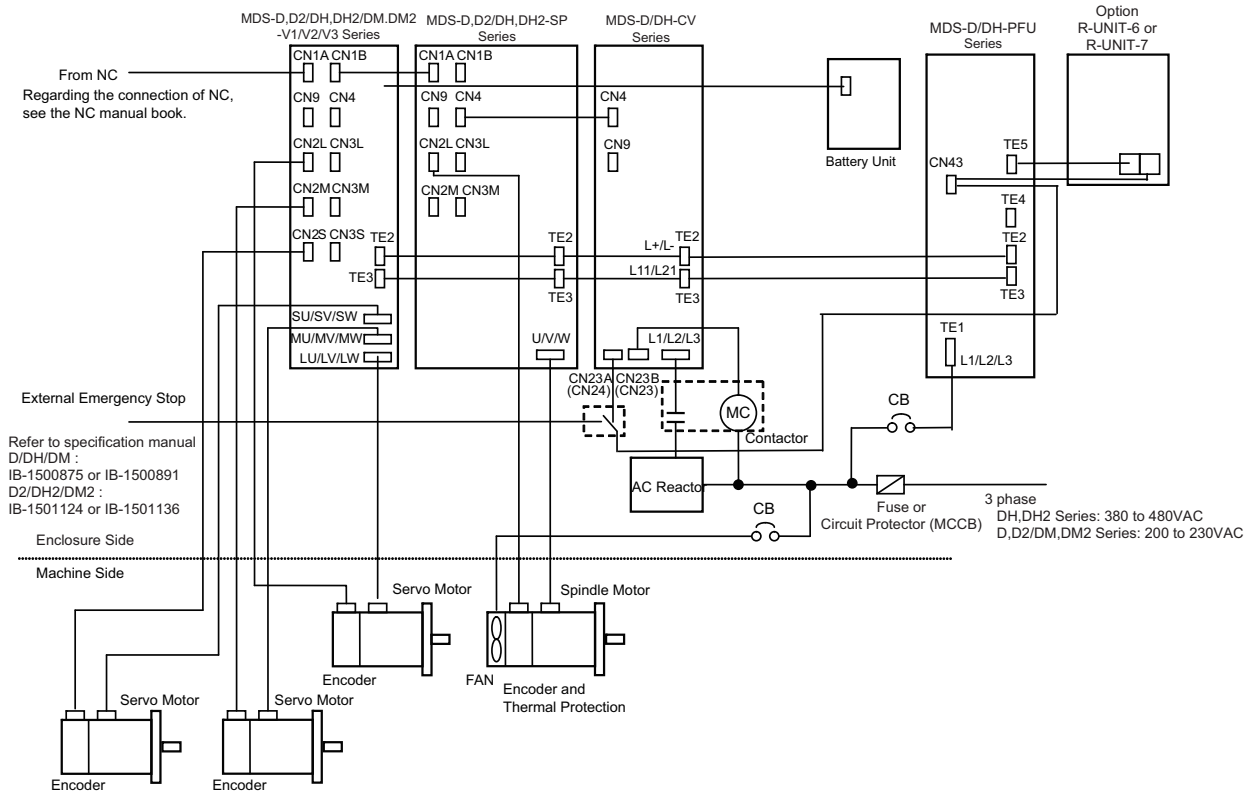
(Note (#)) :may be followed by S
(Note (##)) :may be followed by N or NA
(Note (###)) :may be followed by F or S
(Note (*)) :may be followed by 2

Appendix 4-3 AC servo/spindle system connection

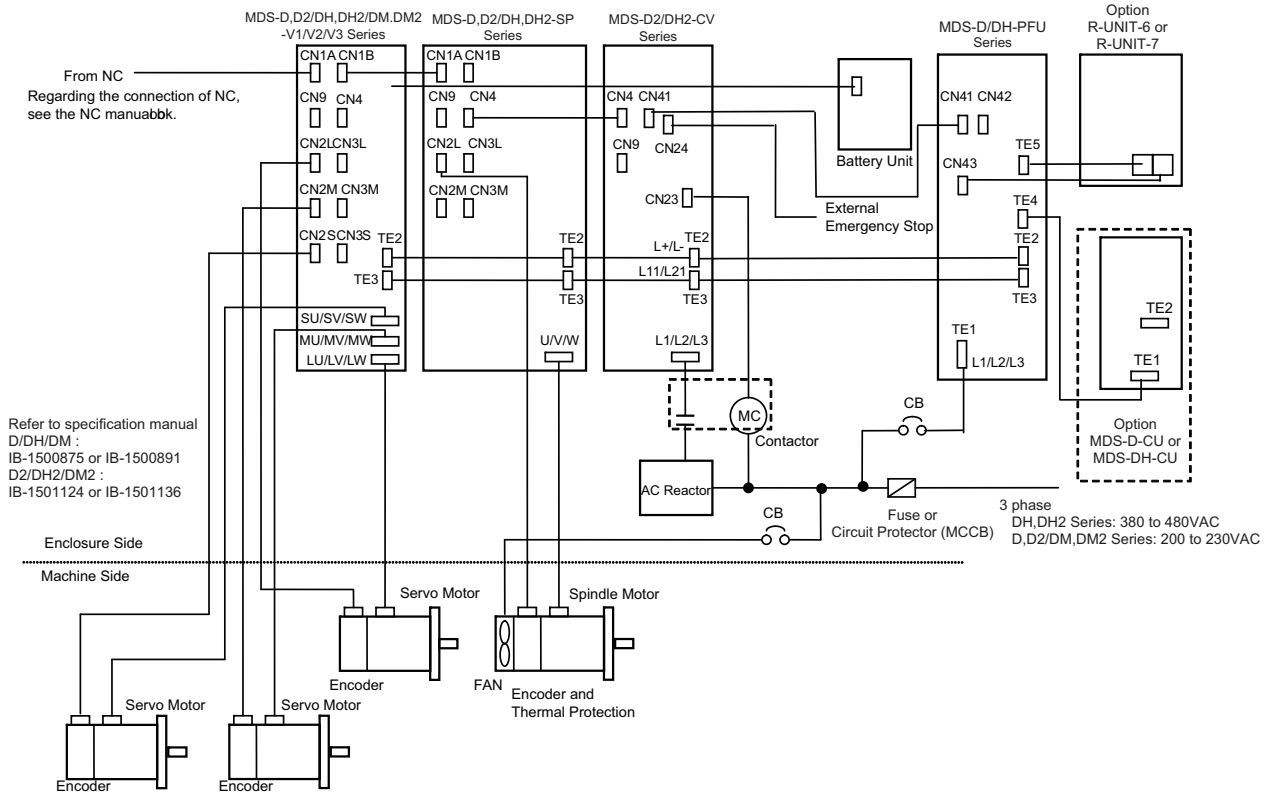
Appendix 4-3-1 MDS-D, D2/DH, DH2/DM, DM2-Vx/SP Series



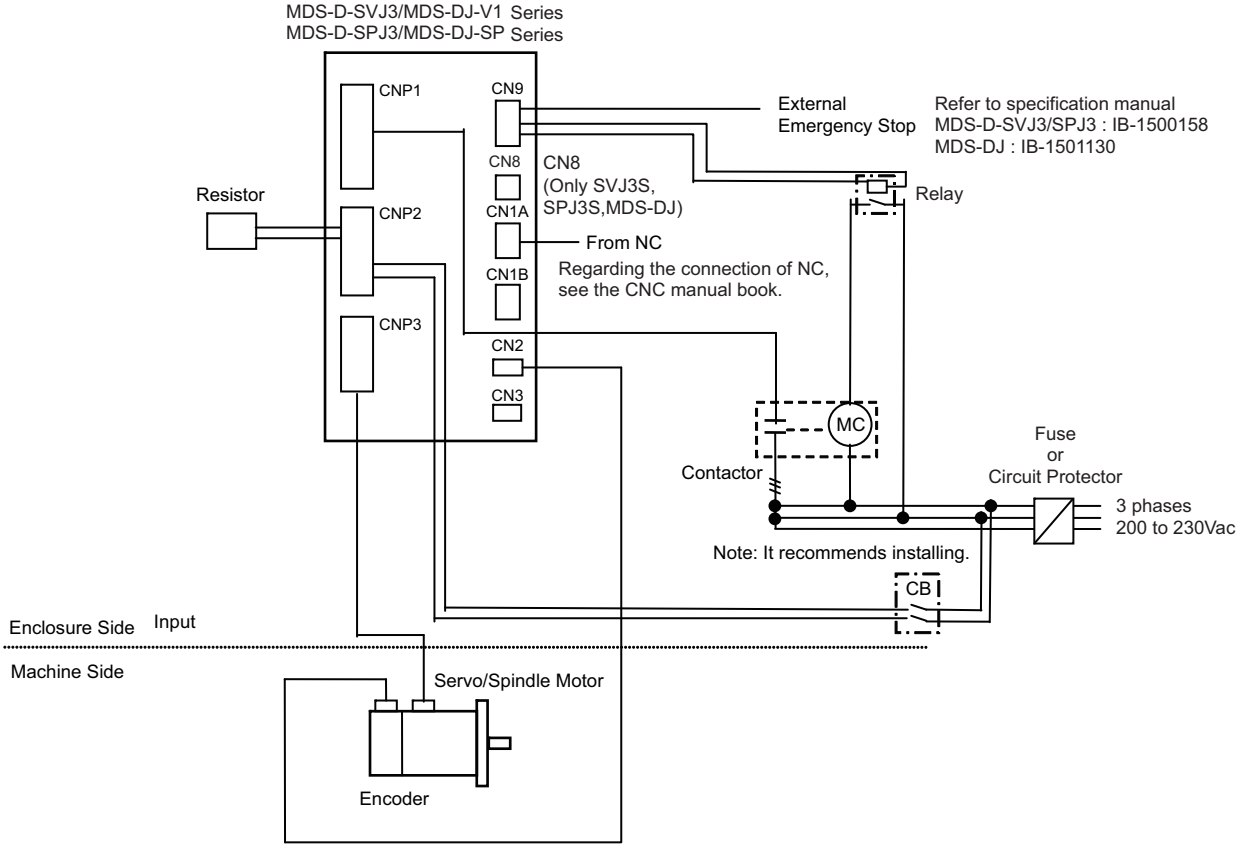
Appendix 4-3-2 MDS-D/DH-CV, D/D2-Vx/SPx, DH/DH2-Vx/SPx, DM/DM2-V3 Series with MDS-D/DH-PFU

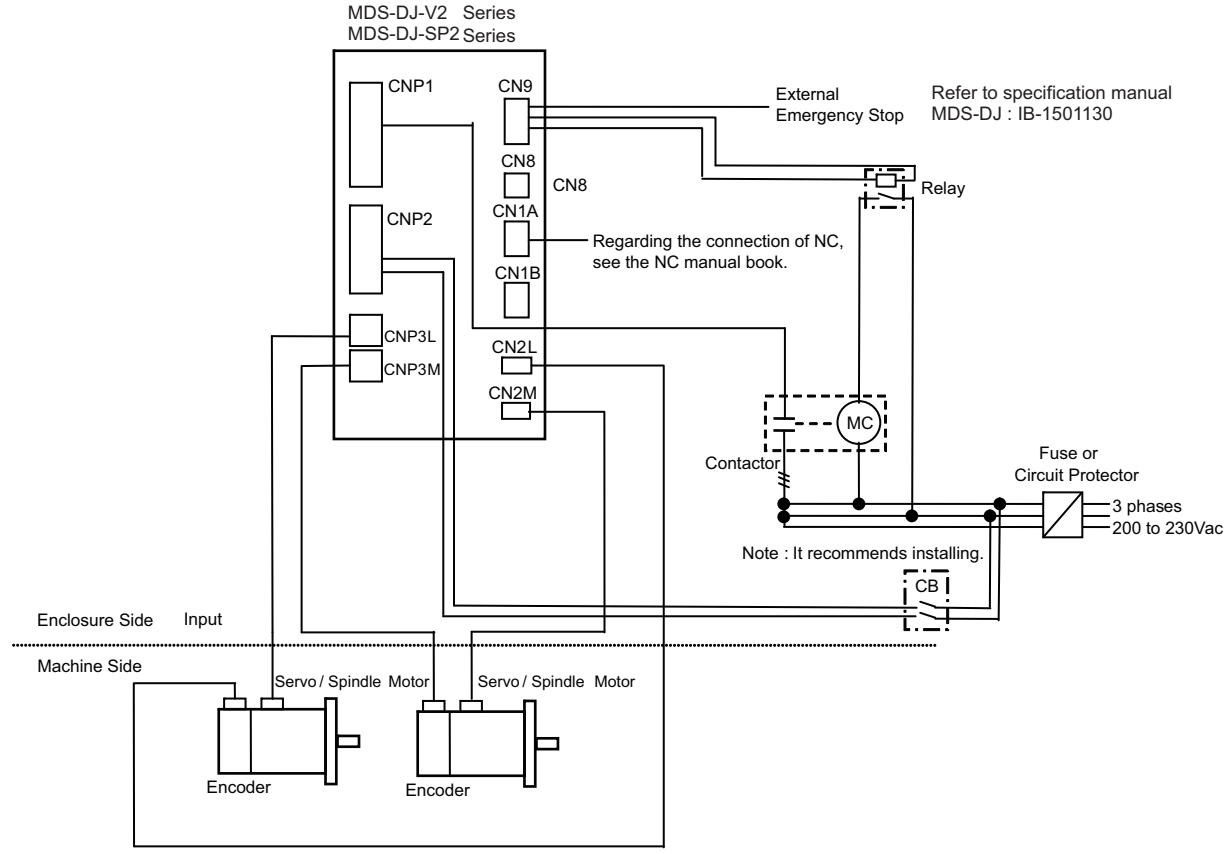


Appendix 4-3-3 MDS-D2/DH2-CV, D/D2-Vx/SPx, DH/DH2-Vx/SPx, DM/DM2-V3 Series with MDS-D/DH-PFU

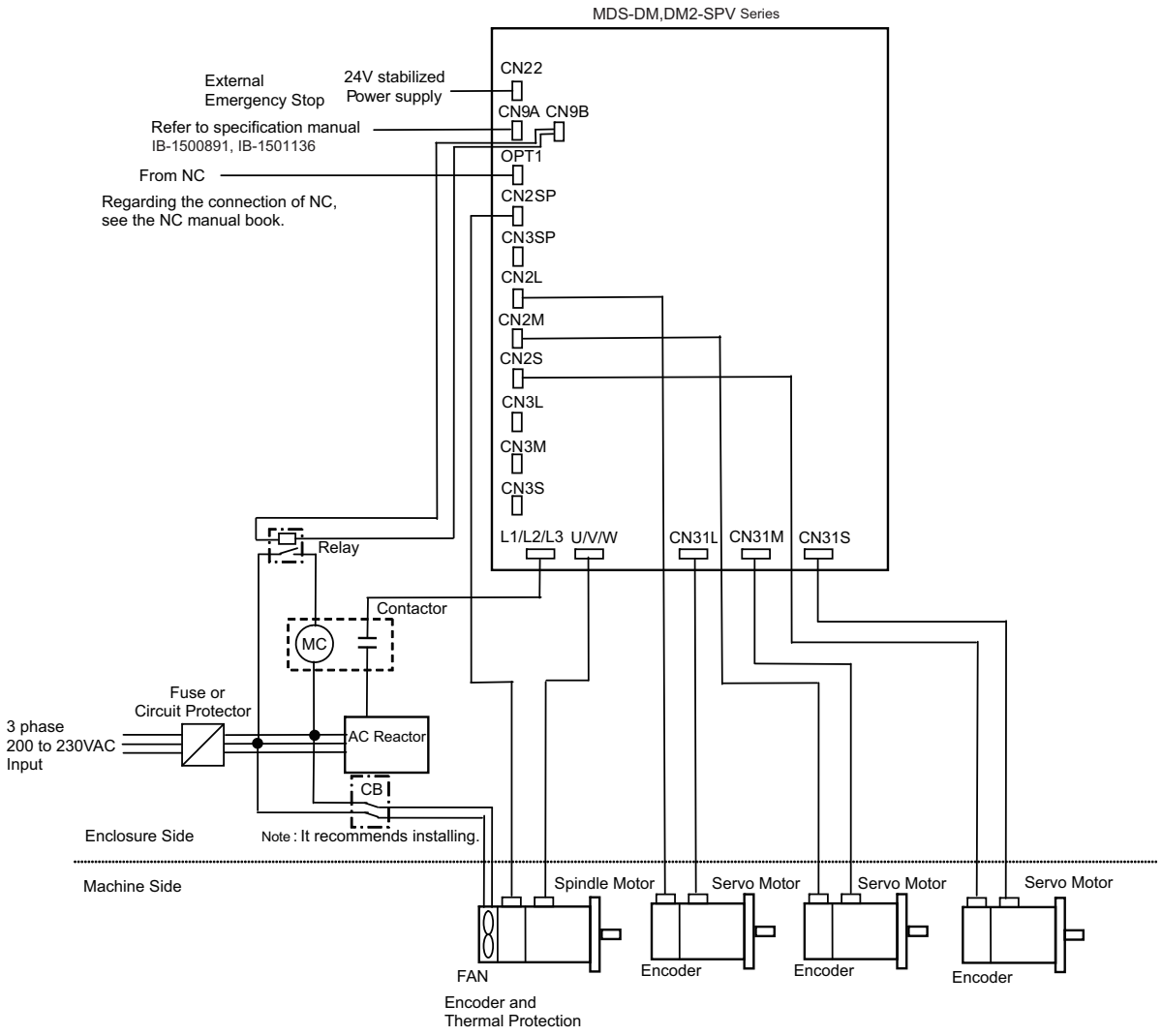


Appendix 4-3-4 MDS-D-SVJ3/SPJ3/MDS-DJ Series





Appendix 4-3-5 MDS-DM, DM2-SPV Series



Revision History

Date of revision	Manual No.	Revision details
Jun. 2008	IB(NA)1500891-B	First edition created.
Oct. 2010	IB(NA)1500891-C	- "Outline for MDS-DM Series Instruction Manual (IB-1500893-C) was added. - Corresponding to MDS-DM-SPV2F/SPV3F. - Specifications list of servo motor and spindle motor were revised. - Corresponding spindle motor was corrected. - List of servo drive unit and spindle drive unit were revised. - "Unit outline dimension drawing" was added. - "AC reactor outline dimension drawing" was added. - "D/A output specifications" was changed to "Diagnosis function". - "Function specifications" (function specifications list and explanation of each function) were added. - "Machine accuracy" and "Flange of servo motor" were added. - Power supply unit was added to the list of "Heating value". - Explanation of the system establishment in the full closed loop control was added. - "FCU6-BTBOX-36" was changed to "MDS-BTBOX-36". - The system configuration of "Converged battery option" was revised. - Notes were added to "Spindle options" and "Spindle side ABZ pulse output encoder". - The following spindle options were added. TS5690 Series, ERM280, MPCI Series - The following encoder interface units were added. MDS-EX-SR, EIB192M, EIB392M, ADB-20J Series - ERM280 and APE391M were deleted. - Optical communication repeater unit (FCU7-EX022) was added. - Each cables for battery box and for MDS-EX-SR were added. - Note was added to "Servo encoder cable and connector". - Input and output circuit diagram in "Relay" was corrected . - "Selection" was revised. - "Cable and Connector Specifications" was revised. - "Restrictions for Lithium Batteries" was revised. - "EMC Installation Guidelines" was added. - "Global Service Network" was revised. - The outline dimension drawings were deleted form this manual. For the outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK (IB-1500273(ENG))". - Miswrite is corrected.
Sep. 2012	IB(NA)1500891-D	- Corresponding to MDS-DM-SPV3F-200120. - HF354 and HF453 were added. - "OSA105-ET2" was replaced by "OSA105ET2A". - "OSA166-ET2" was replaced by "OSA166ET2NA". - "Introduction" was revised. - MDS-A-BT was deleted. - "Handling of our product" was added. - "System configuration" and "Explanation of type" were revised. - "Specifications list" and "Drive unit" were revised. - Function specifications list was revised.

Date of revision	Manual No.	Revision details
Sep. 2012	IB(NA)1500891-D	- "Power regeneration control", "Resistor regeneration control", "Fan stop detection", "Open-phase detection", "Contactor weld detection" and "Power supply voltage display function" were added in "Function specifications". - "Variable speed loop gain control", "Vertical axis drop prevention/pull-up control" and "Monitor output function" were revised. - "Machine accuracy", "Installation of servo motor", "Dynamic brake characteristics", "Spindle motor" and "Heating value" were revised. - SAM/SVAM/GAM/LAM Series were added. - "Battery option", "Spindle options", "Encoder interface unit", "Optical communication repeater unit (FCU7-EX022)" and "Cables and connectors" were revised. - "Selection of circuit protector and contactor" and "Relay" were revised. - "Selection of the servo motor" and "Selection of the power supply unit" were revised. - "Cable and Connector Specifications" was revised. - "Restrictions for Lithium Batteries" was revised. - "Compliance to EC Directives" was revised. - Miswrite is corrected.
Apr. 2017	IB(NA)1500891-E	- The words "detector" were replaced by "encoder". - "Introduction" was revised. - "Servo motor type", "Servo drive unit type" and "Spindle motor type" were revised. - Specifications lists of servo motor and spindle motor were revised. - "Output characteristics" in "Spindle motor" was revised. - "Drive unit" was revised. - Function specifications list was revised. - "Full closed loop control", "Speed command synchronous control", "High-speed synchronous tapping control (OMR-DD control)" and "Motor temperature display function" were revised. - "Shaft characteristics", "Oil / water standards" and "Installation of servo motor" in "Servo motor" were revised. - "Environmental conditions" in "Drive unit" was revised. - Manufacturer names and the contact information were updated. - "Battery option (ER6V-C119B, A6BAT, MDS-BTBOX-36)" and "Ball screw side encoder (OSA105ET2A)" were revised. - "Spindle options" was revised. - "Spindle side ABZ pulse output encoder (OSE-1024 Series)" was revised. - "Optical communication repeater unit (FCU7-EX022)" was revised. - "List of cables and connectors" was revised. - "Example of wires by unit" and "Selection of contactor" were revised. - "Surge absorber" was revised. - "Selection of the servo motor" and "Selection of the power supply unit" were revised. - "Cable and Connector Specifications" was revised. - "Restrictions for Lithium Batteries" was revised. - "EMC Installation Guidelines" and "Compliance with Restrictions in China" were deleted. - "EC Declaration of Conformity" and "Instruction Manual for Compliance with UL/c-UL Standard" were added.

Date of revision	Manual No.	Revision details
Apr. 2017	IB(NA)1500891-E	- "Global Service Network" was revised. - Miswrite is corrected.

Global Service Network

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Flexible (Service Partner)
UNIT NO.411, ALABAMG CORPORATE CENTER KM 25. WEST SERVICE ROAD
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MITSUBISHI ELECTRIC SALES MALAYSIA SDN. BHD.

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Johor Bahru Service satellite

THAILAND

MITSUBISHI ELECTRIC FACTORY AUTOMATION (THAILAND) CO.,LTD

Thailand Service Center
12TH FLOOR, SV.CITY BUILDING, OFFICE TOWER 1, NO. 896/19 AND 20 RAMA 3 ROAD,
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INDIA

MITSUBISHI ELECTRIC INDIA PVT., LTD.

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Coimbatore Service Satellite
Hyderabad Service Satellite

North India Service Center (Gurgaon)
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Panth Nagar Service Satellite
Delhi Service Satellite
Jamshedpur Service Satellite

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Rajkot Service Satellite

CHINA

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China DongGuang Service Partner

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Notice

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

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MODEL	MDS-DM Series
MODEL CODE	100-168
Manual No.	IB-1500891

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