



Changes for the Better

MITSUBISHI CNC

Specifications and Instruction Manual
Built-in Spindle Motor SJ-BG Series

A grayscale image of the Earth from space, showing continents and clouds. Overlaid on the center of the Earth is the text "MITSUBISHI CNC" in a large, white, stylized font with a slight shadow effect. The text is partially obscured by a semi-transparent, curved band that follows the curvature of the globe.

MITSUBISHI
CNC

Introduction

Thank you for selecting the Mitsubishi numerical control unit. This instruction manual describes the handling and caution points for using this AC servo/spindle. Incorrect handling may lead to unforeseen accidents, so always read this instruction manual thoroughly to ensure correct usage.

Make sure that this instruction manual is delivered to the end user. Always store this manual in a safe place.

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

Notes on Reading This Manual

- (1) Since the description of this specification manual deals with NC in general, for the specifications of individual machine tools, refer to the manuals issued by the respective machine tool builders. The "restrictions" and "available functions" described in the manuals issued by the machine tool builders have precedence to those in this manual.
- (2) This manual describes as many special operations as possible, but it should be kept in mind that items not mentioned in this manual cannot be performed.

In this manual, the following abbreviations might be used.

MTB: Machine tool builder

Precautions for Safety

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

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

DANGER


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

WARNING



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



CAUTION

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











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

The signs indicating prohibited and mandatory matters are explained below.

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

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

The meaning of each pictorial sign is as follows.

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

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

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

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

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

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

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



POINT

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













For Safe Use

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

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




 **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/SPM spindle motor, if the rotor is rotated by hand etc., voltage occurs between the terminals of lead. Take care not to get electric shocks.

 **WARNING**

2. Injury prevention

-  **When handling a motor, perform operations in safe clothing.**
-  **In the system where the optical communication with CNC is executed, do not see directly the light generated from CN1A/CN1B connector of drive unit or the end of cable. When the light gets into eye, you may feel something is wrong for eye.**
(The light source of optical communication corresponds to class1 defined in JISC6802 or IEC60825-1.)
-  **The linear servo motor, direct-drive motor and built-in IPM/SPM spindle motor uses permanent magnets in the rotor, so observe the following precautions.**

(1) Handling

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

(2) Transportation and storage







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

(3) Installation







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

CAUTION

1. Fire prevention

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

2. Injury prevention

-  Do not apply a voltage other than that specified in this manual, on each terminal. Failure to observe this item could lead to ruptures or damage, etc.
-  Do not mistake the terminal connections. Failure to observe this item could lead to ruptures or damage, etc.
-  Do not mistake the polarity (+,-). Failure to observe this item could lead to ruptures or damage, etc.
-  Do not touch the radiation fin on unit back face, regenerative resistor or motor, etc., or place parts (cables, etc.) while the power is turned ON or immediately after turning the power OFF. These parts may reach high temperatures, and can cause burns or part damage.
-  Structure the cooling fan on the unit back face, etc., so that it cannot be touched after installation. Touching the cooling fan during operation could lead to injuries.
-  Take care not to suck hair, clothes, etc. into the cooling fan.

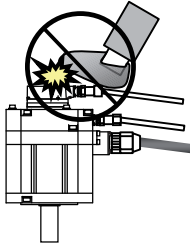
⚠ CAUTION

3. Various precautions

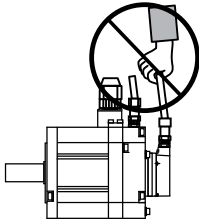
Observe the following precautions. Incorrect handling of the unit could lead to faults, injuries and electric shocks, etc.

(1) Transportation and installation

- ⚠ Correctly transport the product according to its weight.
- ❗ Use the motor's hanging bolts only when transporting the motor. 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 (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		

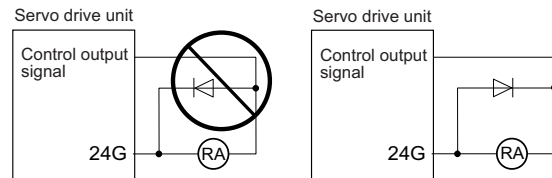
(Note) For details, confirm each unit or motor specifications in addition.

- ⚠ When disinfectants or insecticides must be used to treat wood packaging materials, always use methods other than fumigation (for example, apply heat treatment at the minimum wood core temperature of 56 °C for a minimum duration of 30 minutes (ISPM No. 15 (2009))).**
If products such as units are directly fumigated or packed with fumigated wooden materials, halogen substances (including fluorine, chlorine, bromine and iodine) contained in fumes may contribute to the erosion of the capacitors.
When exporting the products, make sure to comply with the laws and regulations of each country.
- ⚠ Do not use the products in conjunction with any components that contain halogenated flame retardants (bromine, etc). Failure to observe this may cause the erosion of the capacitors.**
- ⚠ Securely fix the servo motor to the machine. Insufficient fixing could lead to the servo motor slipping off during operation.**
- ⚠ Always install the servo motor with reduction gear in the designated direction. Failure to do so could lead to oil leaks.**
- ⚠ Structure the rotary sections of the motor so that it can never be touched during operation. Install a cover, etc., on the shaft.**
- ⚠ When installing a coupling to a servo motor shaft end, do not apply an impact by hammering, etc. The encoder could be damaged.**
- ⚠ Do not apply a load exceeding the tolerable load onto the servo motor shaft. The shaft could break.**
- ⚠ Store the motor in the package box.**
- ⚠ When inserting the shaft into the built-in IPM/SPM spindle motor, do not heat the rotor higher than 130°C. The magnet could be demagnetized, and the specifications characteristics will not be ensured.**
- ⚠ Always use a nonmagnetic tool (explosion-proof beryllium copper alloy safety tool: NGK Insulators, etc.) when installing the built-in IPM/SPM spindle motor, direct-drive motor and linear servo motor.**
- ⚠ Always provide a mechanical stopper on the end of the linear servo motor's travel path.**
- ❗ If the unit has been stored for a long time, always check the operation before starting actual operation. Please contact the Service Center, Sales Office or dealer.**
- ⚠ Install the heavy peripheral devices to the lower part in the panel and securely fix it not to be moved due to vibration.**

⚠ CAUTION

(2) Wiring

- ⚠ Correctly and securely perform the wiring. Failure to do so could lead to abnormal operation of the motor.
- ⚠ Do not install a condensing capacitor, surge absorber or radio noise filter on the output side of the drive unit.
- ⚠ Correctly connect the output side of the drive unit (terminals U, V, W). Failure to do so could lead to abnormal operation of the motor.
- ⚠ When using a power regenerative power supply unit, always install an AC reactor for each power supply unit.
- ⚠ In the main circuit power supply side of the unit, always install an appropriate circuit protector or contactor for each unit. Circuit protector or contactor cannot be shared by several units.
- ⚠ Always connect the motor to the drive unit's output terminals (U, V, W).
- ⚠ Do not directly connect a commercial power supply to the servo motor. Failure to observe this could result in a fault.
- ⚠ When using an inductive load such as a relay, always connect a diode as a noise measure parallel to the load.
- ⚠ When using a capacitance load such as a lamp, always connect a protective resistor as a noise measure serial to the load.
- ⚠ Do not reverse the direction of a diode which connect to a DC relay for the control output signals such as contractor and motor brake output, etc. to suppress a surge. Connecting it backwards could cause the drive unit to malfunction so that signals are not output, and emergency stop and other safety circuits are inoperable.



















- ⚠ Do not connect/disconnect the cables connected between the units while the power is ON.
- ⚠ Securely tighten the cable connector fixing screw or fixing mechanism. An insecure fixing could cause the cable to fall off while the power is ON.
- ⚠ When using a shielded cable instructed in the instruction manual, always ground the cable with a cable clamp, etc. (Refer to "EMC Installation Guidelines")
- ⚠ Always separate the signals wires from the power line.
- ⚠ Use wires and cables that have a wire diameter, heat resistance and flexibility that conforms to the system.

(3) Trial operation and adjustment




- ⚠ Check and adjust each program and parameter before starting operation. Failure to do so could lead to unforeseen operation of the machine.
- ⚠ Do not make remarkable adjustments and changes of parameter as the operation could become unstable.
- ⚠ The usable motor and unit combination is predetermined. Always check the combinations and parameters before starting trial operation.
- ⚠ The direct-drive motor and linear servo motor do not have a stopping device such as magnetic brakes. Install a stopping device on the machine side.
- ⚠ When using the linear servo motor for an unbalance axis, adjust the unbalance weight to 0 by installing an air cylinder, etc. on the machine side. The unbalance weight disables the initial magnetic pole adjustment.

CAUTION

(4) Usage methods









-  In abnormal state, install an external emergency stop circuit so that the operation can be stopped and power shut off immediately.
-  Turn the power OFF immediately if smoke, abnormal noise or odors are generated from the unit or motor.
-  Do not disassemble or repair this product.
-  Never make modifications.
-  When an alarm occurs, the machine will start suddenly if an alarm reset (RST) is carried out while an operation start signal (ST) is being input. Always confirm that the operation signal is OFF before carrying out an alarm reset. Failure to do so could lead to accidents or injuries.
-  Reduce magnetic damage by installing a noise filter. The electronic devices used near the unit could be affected by magnetic noise. Install a line noise filter, etc., if there is a risk of magnetic noise.
-  Use the unit, motor and regenerative resistor with the designated combination. Failure to do so could lead to fires or trouble.
-  The brake (magnetic brake) of the servo motor are for holding, and must not be used for normal braking.
-  There may be cases when holding is not possible due to the magnetic brake's life, the machine construction (when ball screw and servo motor are coupled via a timing belt, etc.) or the magnetic brake's failure. Install a stop device to ensure safety on the machine side.
-  After changing the programs/parameters or after maintenance and inspection, always test the operation before starting actual operation.
-  Do not enter the movable range of the machine during automatic operation. Never place body parts near or touch the spindle during rotation.
-  Follow the power supply specification conditions given in each specification for the power (input voltage, input frequency, 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.
-  Always turn the main circuit power of the motor OFF when an alarm occurs.
-  If an alarm occurs, remove the cause, and secure the safety before resetting the alarm.

CAUTION



(6) Maintenance, inspection and part replacement

-  Always backup the programs and parameters before starting maintenance or inspections.
-  The capacity of the electrolytic capacitor will drop over time due to self-discharging, etc. To prevent secondary disasters due to failures, replacing this part every five years when used under a normal environment is recommended. Contact the Service Center, Service Station, Sales Office or dealer for repairs or part replacement.
-  Never perform a megger test (measure the insulation resistance) of the drive unit. Failure to observe this could lead to faults.
-  If the battery low warning is issued, immediately replace the battery. Replace the batteries while applying the drive unit's control power.
-  Do not short circuit, charge, overheat, incinerate or disassemble the battery.
-  For after-purchase servicing of the built-in motor, only the servicing parts for MITSUBISHI encoder can be supplied. For the motor body, prepare the spare parts at the machine tool builders.
-  For maintenance, part replacement, and services in case of failures in the built-in motor (including the encoder), take necessary actions at the machine tool builders. For drive unit, Mitsubishi can offer the after-purchase servicing as with the general drive unit.
-  Attach the nameplate to near the motor and to a place which is easy to find for maintenance and difficult to unstick such as inside of the machine cabinet.

(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(A급) 전자파적합기기로서 판매자 또는 사용자는 이 점을 주의하시기 바라며 가정외의 지역에서 사용하는 것을 목적으로 합니다.

WARRANTY

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

1. Warranty Period and Coverage

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

[Warranty Term]

The term of warranty for this product shall be twenty-four (24) months from the date of delivery of product to the end user, provided the product purchased from us in Japan is installed in Japan (but in no event longer than thirty (30) months, including the distribution time after shipment from Mitsubishi Electric or its distributor).

Note that, for the case where the product purchased from us in or outside Japan is exported and installed in any country other than where it was purchased; please refer to "2. Service in overseas countries" as will be explained.

[Limitations]

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

2. Service in Overseas Countries

If the customer installs the product purchased from us in his/her machine or equipment, and export it to any country other than where he/she bought it, the customer may sign a paid warranty contract with our local FA center.

This falls under the case where the product purchased from us in or outside Japan is exported and installed in any country other than where it was purchased.

For details please contact the distributor from which the customer purchased the product.

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

Regardless of the gratis warranty term, Mitsubishi shall not be liable for compensation to:

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

4. Changes in Product Specifications

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

5. Product Application

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

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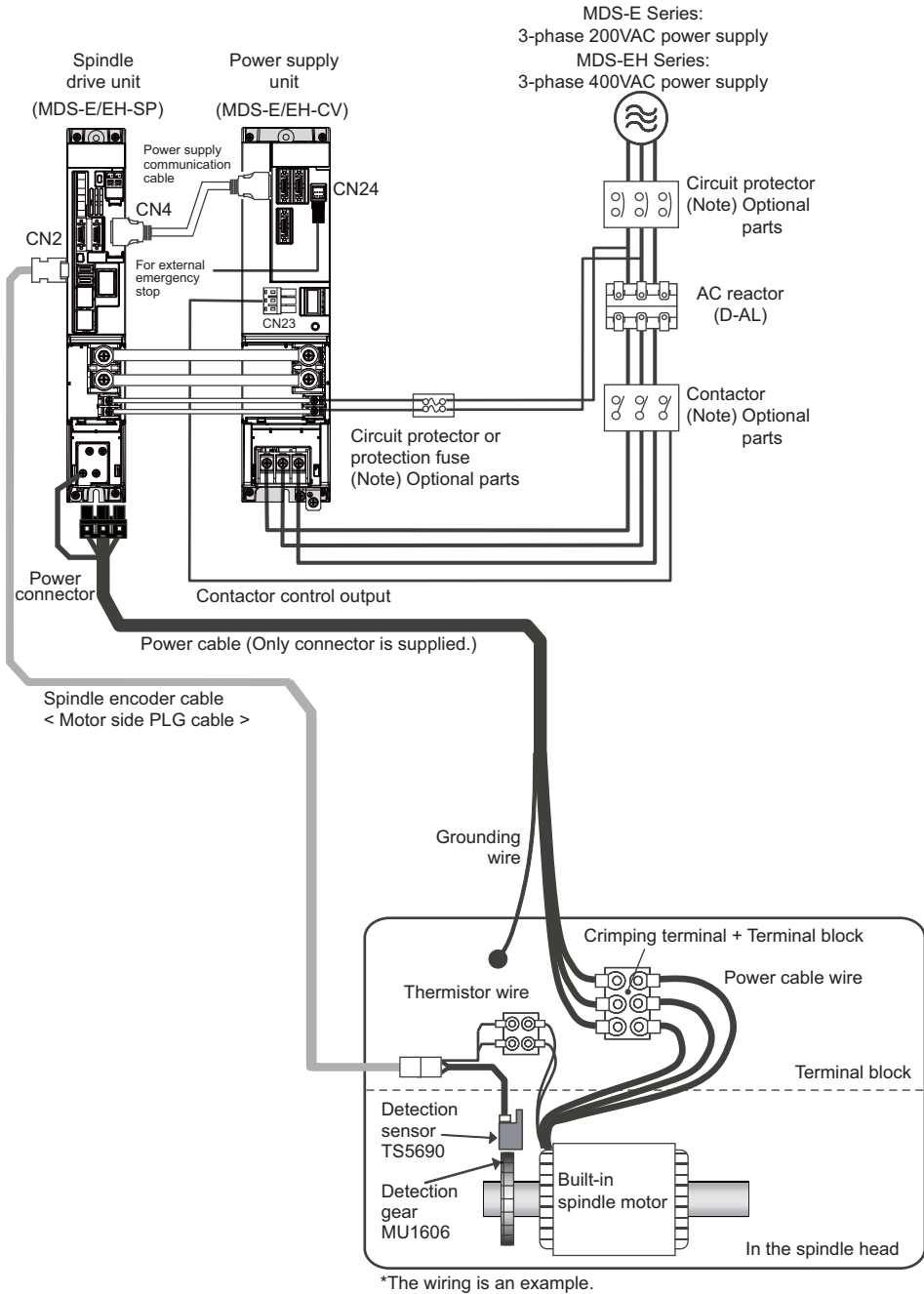
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Introduction

1.1 Spindle Drive System Configuration

1.1.1 System Configuration



For details on the drive units, refer to "MDS-E/EH Series Specifications Manual" (IB-1501226(ENG)).

⚠ CAUTION

1. Keep the detection sensor cable away from the power cable.
2. Connect the ground to the spindle head.

1.2 Explanation of Type

1.2.1 Built-in Spindle Motor Type

MITSUBISHI ELECTRIC
BUILT-IN AC SPINDLE MOTOR
MODEL: SJ-BG160D/200-011K

SI CONT	r/min	A _{max}	4 POLE
kW	3800	5500	41
11	1500	20000	82
			3 PHASES
			WIND CONNECT
			Y/Δ
			POWER FACTOR
			78
			MOTOR INPUT
			110V - 180 V
			AMP INPUT
			200-230V
			50/60Hz
			THERMAL CLASSIFICATION
			INSULF
			AMB TEMP.
			0-40°C
			FRAME
			100-110
			SERIAL
			DATE
			SPEC No.
			RESG00017+
			RESG0004-1

MITSUBISHI ELECTRIC CORPORATION
TOKYO 100-8310, JAPAN
MADE IN JAPAN

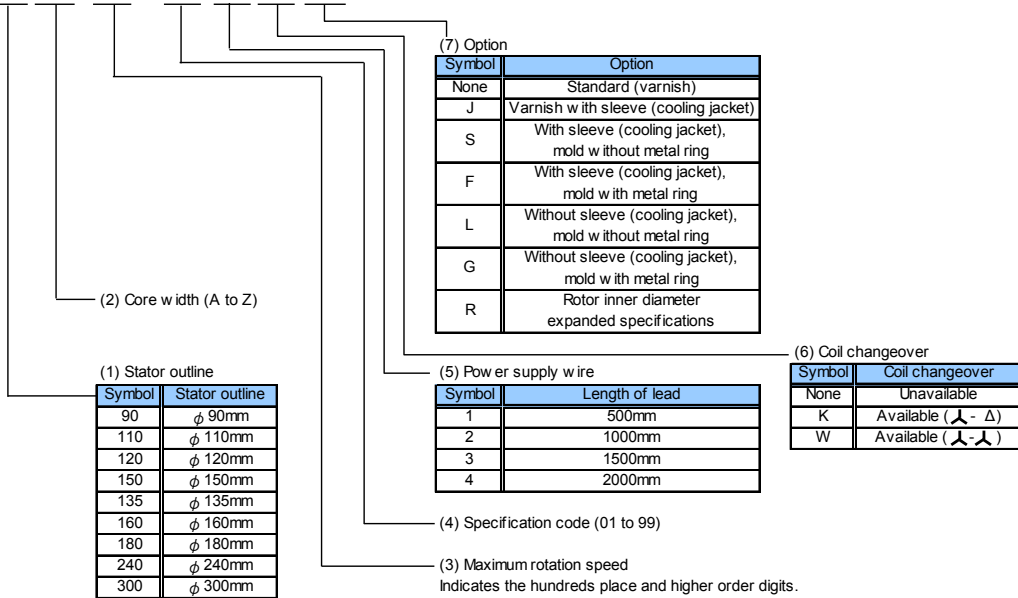
Motor type

Date of manufacture (Year-Month)

Rating nameplate

(1) Built-in IM spindle motor < SJ-BG Series >

SJ-BG (1) (2) / (3) - (4) (5) (6) (7)



CAUTION

1. Check the rating table to see whether the coil changeover specification (Δ-Δ connection, Δ-Δ connection) is included or not.
2. This explains the model name system of spindle motors, but does not mean all the combinations are available.

(2) Built-in SPM spindle motor

< SJ-BGS Series >

SJ-4BGS (1) (2) / (3) - (4) (5) (6) (7)

(1) Stator outline

Symbol	Stator outline
160	φ 160mm
210	φ 210mm
240	φ 240mm

(2) Core width (A to Z)

(5) Power supply wire

Symbol	Length of lead
1	500mm
2	1000mm
3	1500mm
4	2000mm

(4) Specification code (01 to 99)

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

(7) Option

Symbol	Option
None	Varnish
L	Without sleeve (cooling jacket), mold without metal ring
G	Without sleeve (cooling jacket), mold with metal ring
R	With rotor sleeve

(6) Coil changeover

Symbol	Coil changeover
None	Unavailable
K	Available (Δ-Δ)
W	Available (Δ-Δ)

CAUTION

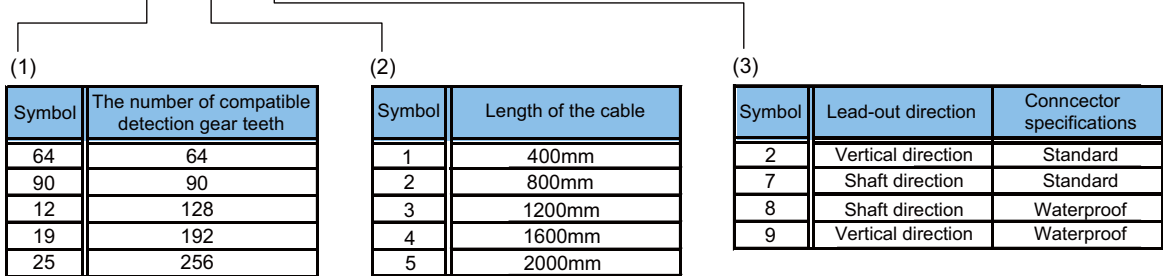
1. Check the rating table to see whether the coil changeover specification (Δ-Δ connection, Δ-Δ connection) is included or not.
2. This explains the model name system of spindle motors, but does not mean all the combinations are available.

1.2.2 Encoder Type

(1) Spindle side PLG serial output encoder (TS5690, MU1606 Series)

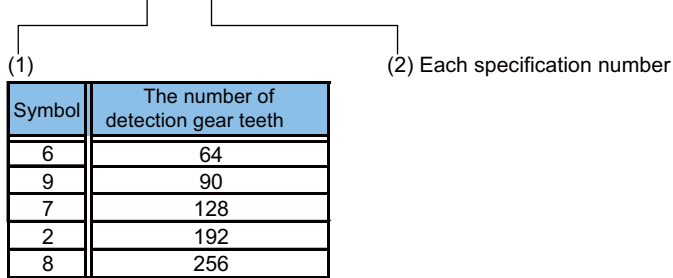
< Sensor type >

TS5690N (1) (2) (3)



< Detection gear type >

MU1606N (1) (2)



2

Specifications

2.1 Built-in Spindle Motor

2.1.1 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 (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

2.1.2 Precautions for Storage

- (1) If water, dust or foreign matters, etc., adhere or enter the parts, problems such as rust or decrease in the insulation resistivity may occur. This will prevent maintenance of satisfying quality and functions.
Always store the motor indoors, and protect the motor by covering it with a sheet, etc.
- (2) To prevent the coils from absorbing water and to prevent the steel center and other metallic parts from rusting due to water entering and internal sweating, place the entire product in a polyethylene bag, etc., insert 0.5kg/m³ of dehumidifier (silica gel), and seal the bag when storing for six months or longer. Use a dehumidifier that shows the degree of absorption, and when 50% (changes from blue to pink) is reached, replace the agent, or dry it to use again.
Remove all dehumidifiers before using the motor again.
- (3) Measure the insulation resistivity of the coils before using a stator that has been stored. Confirm that it is 10M Ω or more at room temperature (use a 500V insulation resistance tester). If the insulation resistance is less than 10M Ω , dry the stator in a dryer that does not exceed 90°C until the insulation resistance is restored.

2 Specifications

2.1.3 Specifications List

< SJ-BG Series (Normal specifications) >

Compatible spindle drive unit (Note 1)		SJ-BG090A/ 300-01 (R)	SJ-BG090B/ 300-03	SJ-BG090D/ 300-03	SJ-BG110F/ 240-01	SJ-BG120A/200-01 (R)		SJ-BG120C/ 200-01 (R)
Compatible spindle drive unit	MDS-E-SP-	20	40	160	80	80		80
	MDS-E-SP2-	20	40	16080(L)	16080(M)	16080(M)		16080(M)
Coil changeover		-	-	-	-	Low-speed coil	High-speed coil	-
Output capacity [kW]	Continuous rated output	0.75	1.2	5.5	3.0	1.5	1.5	2.2
	Short time rated output	1.1 (15%ED)	1.5 (10%ED)	9.0 (10%ED)	5.5 (15%ED)	3.7 (10%ED)	5.5 (15%ED)	3.7 (15%ED)
	Standard output during acceleration/ deceleration	1.5	1.5	9.0	5.5	3.7	5.5	3.7
	Actual acceleration/ deceleration output (Note 4)	1.8	1.8	10.8	6.6	4.4	6.6	4.4
Base rotation speed [r/min]	Continuous	8400	6000	12000	3000	2500	5500	2500
	Short time	7340	5000	12000	3000	2500	8100	1900
Maximum rotation speed		30000	30000	30000	24000	15000	20000	20000
Frame No. - Core width		50-25	50-45	50-95	63-170	71-60		71-120
Torque (Base rotation speed) [N·m]	Continuous	0.85	1.91	4.38	9.5	5.7	2.6	8.4
	Short time	1.4	2.86	7.16	17.5	14.1	6.5	18.6
Rotor GD ² [kg·m ²]		0.00086 (0.00083) (Note 6)	0.0015	0.0032	0.010	0.0063 (0.0055) (Note 6)		0.013 (0.011) (Note 6)
Rotor inertia [kg·m ²]		0.00021	0.0004	0.0008	0.0026	0.0016 (0.0014) (Note 6)		0.0032 (0.0027) (Note 6)
Mass [kg]	Stator	0.7	1.2	2.6	7.4	3.0		5.9
	Rotor	0.4	0.7	1.4	3.2	1.6 (1.3) (Note 6)		3.3 (2.5) (Note 6)
Overload capacity (for one minute)		120% of short-time rated output						
Ambient temperature [°C]		0 to 40						
Heat-resistant class		155(F)						
Tolerable vibration		Maximum stationary tolerable value 9.8m/s ² (1G), Momentary stationary tolerable value 49.0m/s ² (5G)						
Required cooling capacity (Note 2) [W]		230	360	1060	740	510		570
Cooling fluid volume [l/min (20°C)]		5	10	10	10	10		10
Motor total length [mm]		81	100	153	240	135		195
Stator outer diameter [mm] (Note 3)		φ 89.5	φ 89.5	φ 89.5	φ 109.5	φ 119.5		φ 119.5
Rotor inner diameter [mm] (Note 3)		φ 33 (φ 35) (Note 6)	φ 33	φ 33	φ 42	φ 41 (φ 52) (Note 6)		φ 41 (φ 52) (Note 6)
Motor wire size	[mm ²]	0.75	0.75	3.5	1.25	1.25		3.5
	AWG	18	18	12	16	16		12

(Note 1) Please contact your Mitsubishi Electric dealer for the special products not listed above.

(Note 2) The value for the continuous rated output is shown for the required cooling capacity. Install a cooling jacket around the stator and use fluid cooling (oil cooling).

(Note 3) These dimensions are the dimensions when shipped from the plant.

(Note 4) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

(Note 5) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

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

2 Specifications

< SJ-BG Series (Normal specifications) >

Built-in spindle motor type (Note 1)		SJ-BG135D/ 200-01		SJ-BG150D/ 150-01	SJ-BG160B/150-01 (R) (Note 6)			SJ-BG160D/ 150-01 (R) (Note 6)	SJ-BG160D/ 150-02 (R) (Note 6)
Compatible spindle drive unit	MDS-E-SP-	320		80	40	80	160	80	160
	MDS-E-SP2-	-		80 16080(M)	40	80 16080(M)	16080(L)	80 16080(M)	16080(L)
Coil changeover		Low-speed coil	High-speed coil	-	-	-	-	-	-
Output capacity [kW]	Continuous rated output	11	18.5	3.7	2.2	2.2	3.7	3.7	3.7
	Short time rated output	15 (10%ED)	26 (15%ED)	5.5 (40%ED)	3.7 (40%ED)	3.7 (40%ED)	7.5 (10%ED)	5.5 (40%ED)	7.5 (15%ED)
	Standard output during acceleration/deceleration	15	26	5.5	3.7	3.7	7.5	5.5	9.0
	Actual acceleration/deceleration output (Note 4)	18	31.2	6.6	4.44	4.44	9.0	6.6	10.8
Base rotation speed [r/min]	Continuous	3280	6000	2500	3500	1300	1770	1500	1500
	Short time	2200	5400	2500	3500	1500	1450	1500	1700
Maximum rotation speed		8000	20000	15000	15000	15000	15000	15000	15000
Frame No. - Core width		80-155		90-100	100-75	100-75	100-75	100-110	100-110
Torque (Base rotation speed) [N·m]	Continuous	32.0	29.4	14.1	6.0	16.2	20.0	23.6	23.6
	Short time	65.1	46.0	21.0	10.1	23.6	49.4	35.0	42.1
Rotor GD ² [kg·m ²]		0.018		0.023	0.019 (0.017) (Note 6)	0.019 (0.017) (Note 6)	0.019 (0.017) (Note 6)	0.028 (0.024) (Note 6)	0.028 (0.024) (Note 6)
Rotor inertia [kg·m ²]		0.0044		0.0057	0.0048 (0.0042) (Note 6)	0.0048 (0.0042) (Note 6)	0.0048 (0.0042) (Note 6)	0.0070 (0.0061) (Note 6)	0.0070 (0.0061) (Note 6)
Mass [kg]	Stator	12		8.1	7.1	7.1	7.1	11	11
	Rotor	3.3		3.7	2.9 (2.3) (Note 6)	2.9 (2.3) (Note 6)	2.9 (2.3) (Note 6)	4.2 (3.3) (Note 6)	4.2 (3.3) (Note 6)
Overload capacity (for one minute)		120% of short-time rated output							
Ambient temperature [°C]		0 to 40							
Heat-resistant class		155(F)							
Tolerable vibration		Maximum stationary tolerable value 9.8m/s ² (1G), Momentary stationary tolerable value 49.0m/s ² (5G)							
Required cooling capacity (Note 2) [W]		2990	900	920	920	1300	1160	1200	
Cooling fluid volume [l/min (20°C)]		10	10	10	10	10	10	10	
Motor total length [mm]		219	170	153	153	153	188	190	
Stator outer diameter [mm] (Note 3)		φ 134.5		φ 149.5	φ 159.5	φ 159.5	φ 159.5	φ 159.5	φ 159.5
Rotor inner diameter [mm] (Note 3)		φ 60		φ 55	φ 60 (φ 70) (Note 6)	φ 60 (φ 70) (Note 6)	φ 60 (φ 70) (Note 6)	φ 60 (φ 70) (Note 6)	φ 60 (φ 70) (Note 6)
Motor wire size	[mm ²]	14		1.25	3.5	3.5	3.5	3.5	5.5
	AWG	6		16	12	12	12	12	10

(Note 1) Please contact your Mitsubishi Electric dealer for the special products not listed above.

(Note 2) The value for the continuous rated output is shown for the required cooling capacity. Install a cooling jacket around the stator and use fluid cooling (oil cooling).

(Note 3) These dimensions are the dimensions when shipped from the plant.

(Note 4) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

(Note 5) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

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

2 Specifications

< SJ-BG Series (Normal specifications) >

Built-in spindle motor type (Note 1)		SJ-BG180B/150-01		SJ-BG180D/150-01		SJ-BG180F/150-01	
Compatible spindle drive unit	MDS-E-SP-	400		400		400	
	MDS-E-SP2-	-		-		-	
Coil changeover		Low-speed coil	High-speed coil	Low-speed coil	High-speed coil	Low-speed coil	High-speed coil
Output capacity [kW]	Continuous rated output	11	18.5	15	22	15	22
	Short time rated output	18.5 (10%ED)	30 (15%ED)	22 (10%ED)	30 (25%ED)	22 (10%ED)	37 (15%ED)
	Standard output during acceleration/ deceleration	18.5	30	22	30	22	37
	Actual acceleration/ deceleration output (Note 4)	22.2	36	26.4	36	26.4	44.4
Base rotation speed [r/min]	Continuous	2300	6000	2000	6500	1650	5700
	Short time	1350	6000	1050	6500	840	5700
Maximum rotation speed		6000	15000	6000	15000	4000	15000
Frame No. - Core width		112-115		112-180		112-225	
Torque (Base rotation speed) [N·m]	Continuous	45.7	29.4	71.6	32.3	86.8	36.9
	Short time	131	47.7	200	44.1	250	62.0
Rotor GD ² [kg·m ²]		0.047		0.074		0.092	
Rotor inertia [kg·m ²]		0.012		0.018		0.023	
Mass [kg]	Stator	14		21		27	
	Rotor	5.1		8.0		10	
Overload capacity (for one minute)		-		-		-	
Ambient temperature [°C]				0 to 40			
Heat-resistant class				155(F)			
Tolerable vibration		Maximum stationary tolerable value 9.8m/s ² (1G), Momentary stationary tolerable value 49.0m/s ² (5G)					
Required cooling capacity (Note 2) [W]		2370		3270		3220	
Cooling fluid volume [l/min (20°C)]		15		15		15	
Motor total length [mm]		212		277		322	
Stator outer diameter [mm] (Note 3)		φ 179.5		φ 179.5		φ 179.5	
Rotor inner diameter [mm] (Note 3)		φ 75		φ 75		φ 75	
Motor wire size	[mm ²]	14		14		14	
	AWG	6		6		6	

(Note 1) Please contact your Mitsubishi Electric dealer for the special products not listed above.

(Note 2) The value for the continuous rated output is shown for the required cooling capacity. Install a cooling jacket around the stator and use fluid cooling (oil cooling).

(Note 3) These dimensions are the dimensions when shipped from the plant.

(Note 4) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

(Note 5) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

2 Specifications

< SJ-BG Series (Normal specifications) >

Built-in spindle motor type (Note 1)		SJ-BG180H/150-01		SJ-BG240H/100-01		SJ-BG300L/080-01	
Compatible spindle drive unit	MDS-E-SP-	400		400		640	
	MDS-E-SP2-	-		-		-	
Coil changeover		Low-speed coil	High-speed coil	Low-speed coil	High-speed coil	Low-speed coil	High-speed coil
Output capacity [kW]	Continuous rated output	15	26	18.5	26	22	37
	Short time rated output	26 (10%ED)	37 (25%ED)	30 (15%ED)	45 (25%ED)	37 (10%ED)	55 (10%ED)
	Standard output during acceleration/deceleration	26	37	30	45	37	55
	Actual acceleration/deceleration output (Note 4)	31.2	44.4	36	54	44.4	66
Base rotation speed [r/min]	Continuous	1200	4700	700	2500	350	1800
	Short time	800	4700	460	2500	290	1400
Maximum rotation speed		6000	15000	2000	10000	1500	8000
Frame No. - Core width		112-280		160-330		180-380	
Torque (Base rotation speed) [N·m]	Continuous	119	52.8	252	99.3	600	196
	Short time	310	75.2	623	172	1218	375
Rotor GD ² [kg·m ²]		0.11		0.57		1.9	
Rotor inertia [kg·m ²]		0.029		0.14		0.48	
Mass [kg]	Stator	33		63		107	
	Rotor	12		32		63	
Overload capacity (for one minute)		-		120% of short-time rated output			
Ambient temperature [°C]		0 to 40					
Heat-resistant class		155(F)					
Tolerable vibration		Maximum stationary tolerable value 9.8m/s ² (1G), Momentary stationary tolerable value 49.0m/s ² (5G)					
Required cooling capacity (Note 2) [W]		4060		4660		7590	
Cooling fluid volume [l/min (20°C)]		15		20		20	
Motor total length [mm]		377		460		515	
Stator outer diameter [mm] (Note 3)		φ 179.5		φ 239.5		φ 299.5	
Rotor inner diameter [mm] (Note 3)		φ 75		φ 101		φ 130	
Motor wire size	[mm ²]	14		22		38	
	AWG	6		4		2	

(Note 1) Please contact your Mitsubishi Electric dealer for the special products not listed above.

(Note 2) The value for the continuous rated output is shown for the required cooling capacity. Install a cooling jacket around the stator and use fluid cooling (oil cooling).

(Note 3) These dimensions are the dimensions when shipped from the plant.

(Note 4) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

(Note 5) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

2 Specifications

< SJ-BG Series (High-speed specifications) >

Built-in spindle motor type (Note 1)		SJ-BG160D/200-03		SJ-BG180F/200-01		SJ-BG240H/130-01	
Compatible spindle drive unit	MDS-E-SP-	240		400		400	
	MDS-E-SP2-	-		-		-	
Coil changeover		Low-speed coil	High-speed coil	Low-speed coil	High-speed coil	Low-speed coil	High-speed coil
Output capacity [kW]	Continuous rated output	7.5	15	15	22	18.5	26
	Short time rated output	15 (10%ED)	22 (10%ED)	22 (10%ED)	37 (15%ED)	30 (15%ED)	45 (25%ED)
	Standard output during acceleration/ deceleration	15	22	22	37	30	45
	Actual acceleration/ deceleration output (Note 4)	18	26.4	26.4	44.4	36	54
Base rotation speed [r/min]	Continuous	2700	7500	1650	5700	700	2500
	Short time	2300	7000	840	5700	460	2500
Maximum rotation speed		5500	20000	4000	20000	2000	13000
Frame No. - Core width		100-110		112-225		160-330	
Torque (Base rotation speed) [N·m]	Continuous	26.5	19.1	86.8	36.9	252	99.3
	Short time	62.3	30.0	250	62.0	623	172
Rotor GD ² [kg·m ²]		0.025		0.092		0.58	
Rotor inertia [kg·m ²]		0.0062		0.023		0.14	
Mass [kg]	Stator	10		27		63	
	Rotor	3.4		10		32	
Overload capacity (for one minute)		120% of short-time rated output		-		120% of short-time rated output	
Ambient temperature [°C]				0 to 40			
Heat-resistant class				155(F)			
Tolerable vibration		Maximum stationary tolerable value 9.8m/s ² (1G), Momentary stationary tolerable value 49.0m/s ² (5G)					
Required cooling capacity (Note 2) [W]		2250		3380		4740	
Cooling fluid volume [l/min (20°C)]		10		15		20	
Motor total length [mm]		197		322		460	
Stator outer diameter [mm] (Note 3)		φ 159.5		φ 179.5		φ 239.5	
Rotor inner diameter [mm] (Note 3)		φ 70		φ 75		φ 101	
Motor wire size	[mm ²]	8		14		22	
	AWG	8		6		4	

(Note 1) Please contact your Mitsubishi Electric dealer for the special products not listed above.

(Note 2) The value for the continuous rated output is shown for the required cooling capacity. Install a cooling jacket around the stator and use fluid cooling (oil cooling).

(Note 3) These dimensions are the dimensions when shipped from the plant.

(Note 4) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

(Note 5) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

2 Specifications

< SJ-BGS Series (Normal specifications) >

Built-in spindle motor type (Note 1)		SJ-4BGS160B/300-01	SJ-4BGS210B/120-01		SJ-4BGS240B/120-01	
Compatible spindle drive unit	MDS-EH-SP-	600	160		320	
Coil changeover		-	Low-speed coil	High-speed coil	Low-speed coil	High-speed coil
Output capacity [kW]	Continuous rated output	65	22	22	27	27
	Short time rated output	70 (40%ED)	24 (10%ED)	24 (40%ED)	37 (10%ED)	37 (40%ED)
	Standard output during acceleration/deceleration	70	30	30	37	37
	Actual acceleration/deceleration output (Note 4)	84	36	36	44.4	44.4
Base rotation speed [r/min]	Continuous	17500	2300	5000	1600	4000
	Short time	17500	2000	5000	1500	4000
Maximum rotation speed		30000	5000	12000	4000	12000
Frame No. - Core width		100-120	132-90		160-120	
Torque (Base rotation speed) [N·m]	Continuous	35.5	91.3	42.0	161	64.5
	Short time	38.2	115	45.8	236	88.3
Rotor GD ² [kg·m ²] (Note 6)		0.0172	0.081		0.22	
Rotor inertia [kg·m ²] (Note 6)		0.0043	0.020		0.054	
Mass [kg] (Note 6)	Stator	14	18		28	
	Rotor	2.2	6.8		13	
Overload capacity (for one minute)		120% of short-time rated output				
Ambient temperature [°C]		0 to 40				
Heat-resistant class		155(F)				
Tolerable vibration		Maximum stationary tolerable value 9.8m/s ² (1G), Momentary stationary tolerable value 49.0m/s ² (5G)				
Required cooling capacity (Note 2) [W]		4420	2120		3430	
Cooling fluid volume [l/min (20°C)]		10	10		10	
Motor total length [mm]		194	180		220	
Stator outer diameter [mm] (Note 3)		φ 159.5	φ 209.5		φ 239.5	
Rotor inner diameter [mm] (Note 3)		φ 80.9	φ 84		φ 100	
Motor wire size	[mm ²]	14	8		14	
	AWG	6	8		6	

(Note 1) Please contact your Mitsubishi Electric dealer for the special products not listed above.

(Note 2) The value for the continuous rated output is shown for the required cooling capacity. Install a cooling jacket around the stator and use fluid cooling (oil cooling).

(Note 3) These dimensions are the dimensions when shipped from the plant.

(Note 4) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

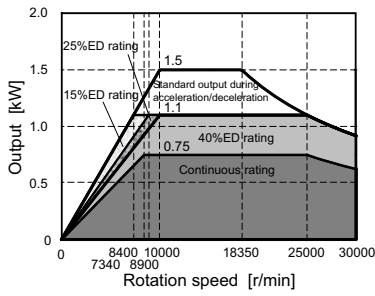
(Note 5) Only the combination designated in this manual can be used for the motor and drive unit. Always use the designated combination.

(Note 6) SJ-4BGS160B/300-01 is without rotor sleeve, and SJ-4BGS210B/120-01 and SJ-4BGS240B/120-01 are with rotor sleeves.

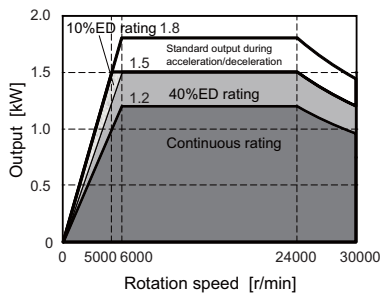
2.1.4 Characteristics

< SJ-BG Series (Normal specifications) >

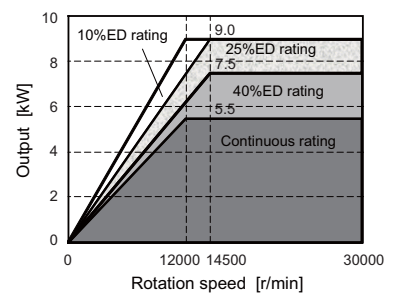
[SJ-BG090A/300-01 (R)]



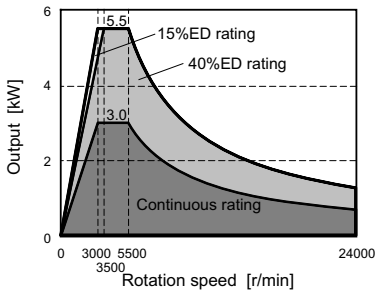
[SJ-BG090B/300-03]



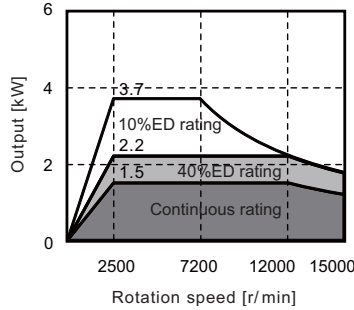
[SJ-BG090D/300-03]



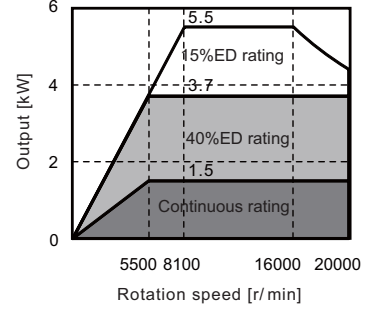
[SJ-BG110F/240-01]



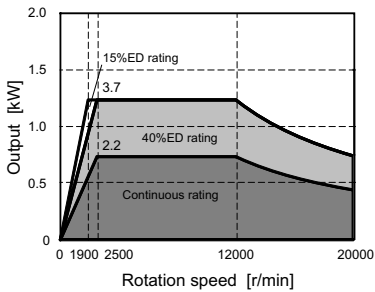
[SJ-BG120A/200-01 (R)]
(Low-speed coil)



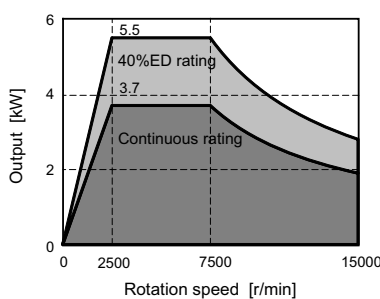
[SJ-BG120A/200-01 (R)]
(High-speed coil)



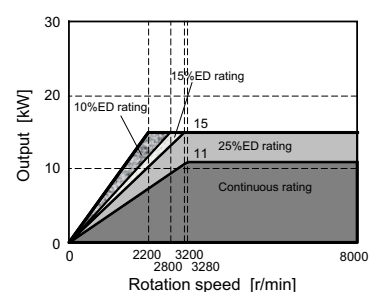
[SJ-BG120C/200-01 (R)]



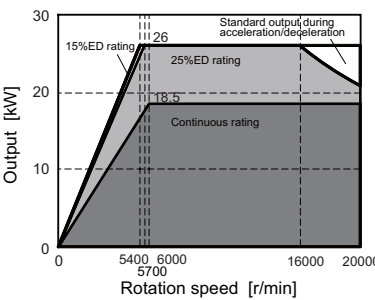
[SJ-BG150D/150-01]



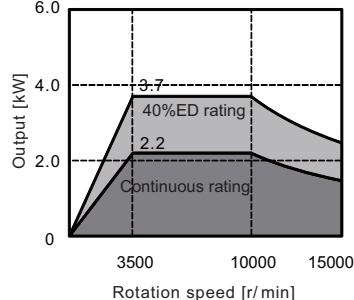
[SJ-BG135D/200-01]
(Low-speed coil)



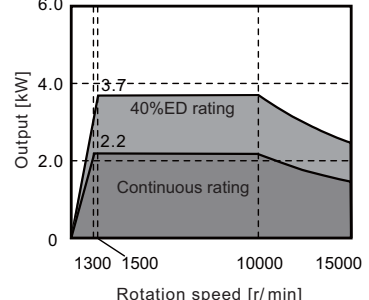
[SJ-BG135D/200-01]
(High-speed coil)



[SJ-BG160B/150-01 (R)]
(MDS-E-SP-40)

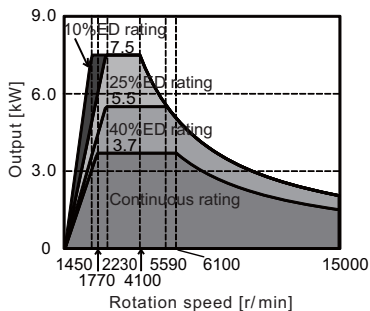


[SJ-BG160B/150-01 (R)]
(MDS-E-SP-80)

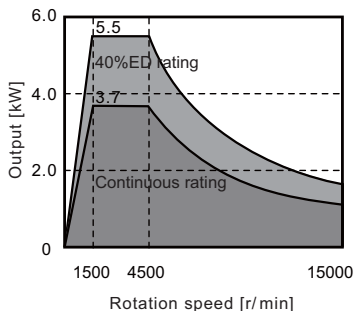


(Note) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

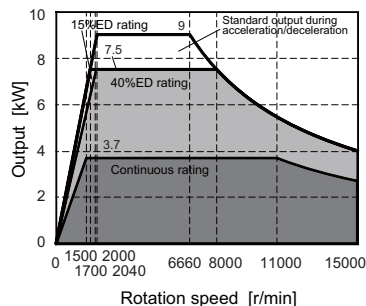
[SJ-BG160B/150-01 (R)]
 (MDS-E-SP-160)



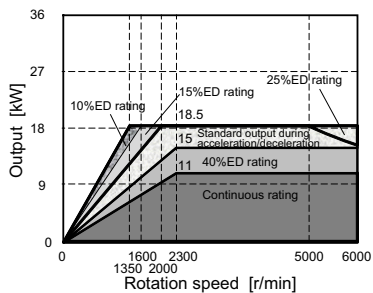
[SJ-BG160D/150-01 (R)]



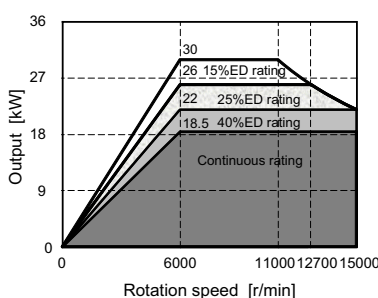
[SJ-BG160D/150-02 (R)]



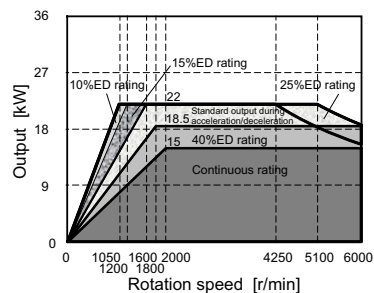
[SJ-BG180B/150-01]
 (Low-speed coil) (Note 2)



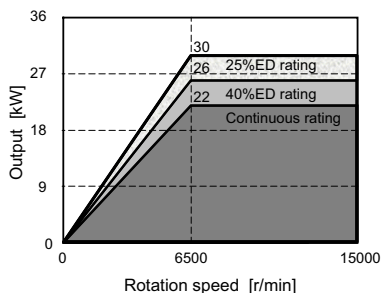
[SJ-BG180B/150-01]
 (High-speed coil)



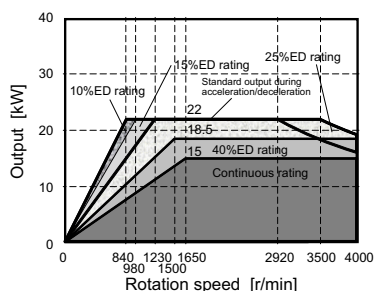
[SJ-BG180D/150-01]
 (Low-speed coil) (Note 2)



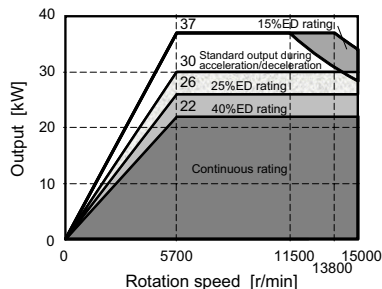
[SJ-BG180D/150-01]
 (High-speed coil)



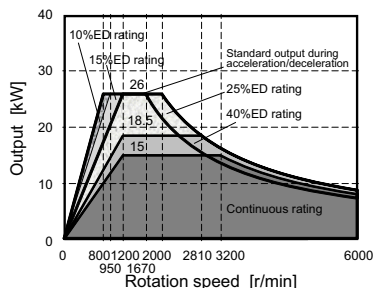
[SJ-BG180F/150-01]
 (Low-speed coil) (Note 2)



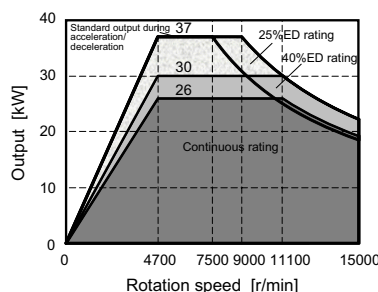
[SJ-BG180F/150-01]
 (High-speed coil)



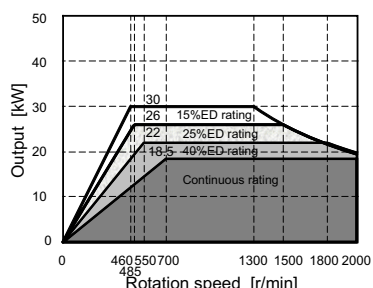
[SJ-BG180H/150-01]
 (Low-speed coil) (Note 2)



[SJ-BG180H/150-01]
 (High-speed coil) (Note 2)



[SJ-BG240H/100-01]
 (Low-speed coil) (Note 2)

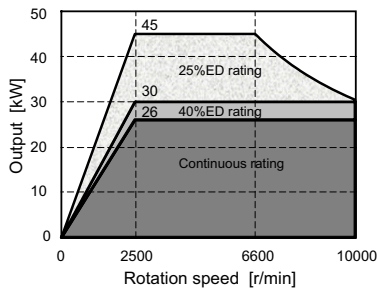


(Note 1) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

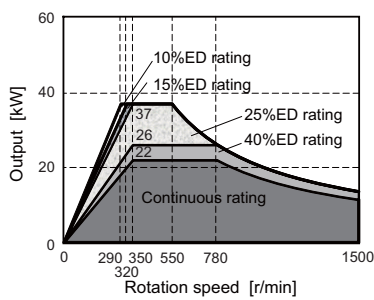
(Note 2) The cycle times for 10%ED rating, 15%ED rating, 25%ED rating (Low-speed coil), and 25%ED rating (High-speed coil) are 5 minutes.

2 Specifications

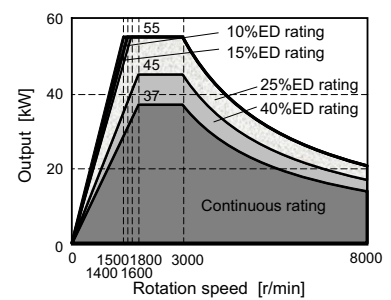
[SJ-BG240H/100-01]
(High-speed coil) (Note 2)



[SJ-BG300L/080-01]
(Low-speed coil)



[SJ-BG300L/080-01]
(High-speed coil)

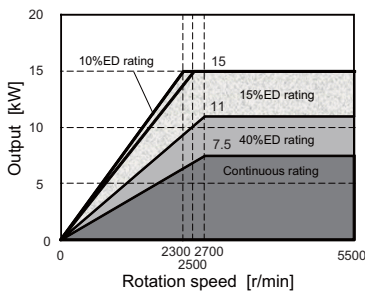


(Note 1) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

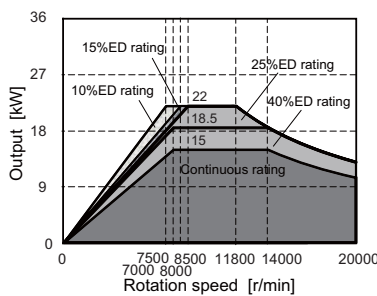
(Note 2) The cycle times for 10%ED rating, 15%ED rating, 25%ED rating (Low-speed coil), and 25%ED rating (High-speed coil) are 5 minutes.

< SJ-BG Series (High-speed specifications) >

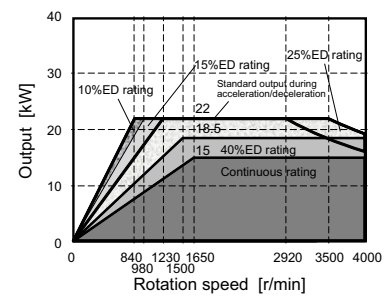
[SJ-BG160D/200-03]
(Low-speed coil)



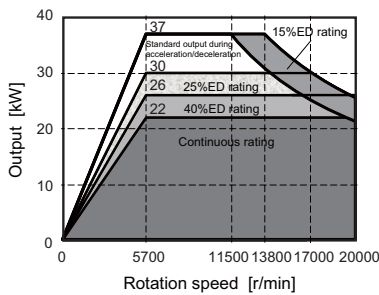
[SJ-BG160D/200-03]
(High-speed coil)



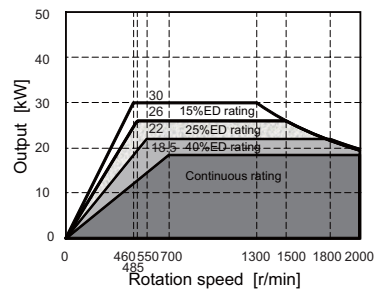
[SJ-BG180F/200-01]
(Low-speed coil) (Note 2)



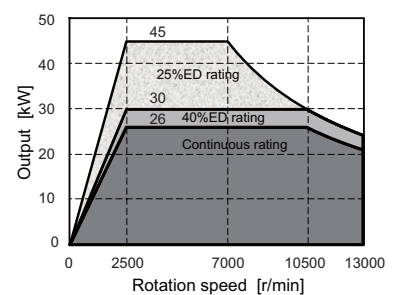
[SJ-BG180F/200-01]
(High-speed coil)



[SJ-BG240H/130-01]
(Low-speed coil) (Note 2)



[SJ-BG240H/130-01]
(High-speed coil) (Note 2)

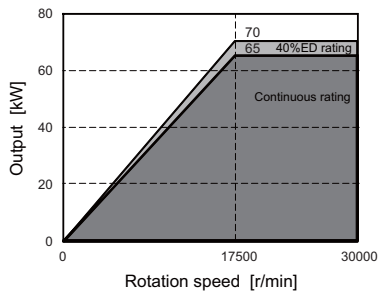


(Note 1) Actual acceleration/deceleration output is 1.2-fold of "Standard output during acceleration/deceleration" or 1.2-fold of "Short time rated output".

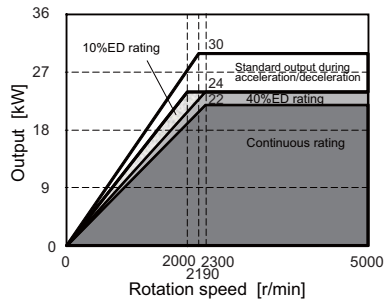
(Note 2) The cycle times for 10%ED rating, 15%ED rating, 25%ED rating (Low-speed coil), and 25%ED rating (High-speed coil) are 5 minutes.

< SJ-BGS Series (Normal specifications) >

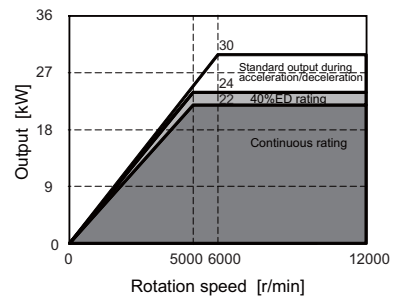
[SJ-4BGS160B/300-01]



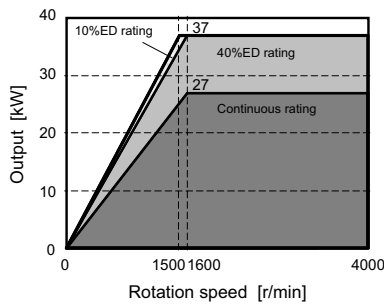
[SJ-4BGS210B/120-01]
(Low-speed coil)



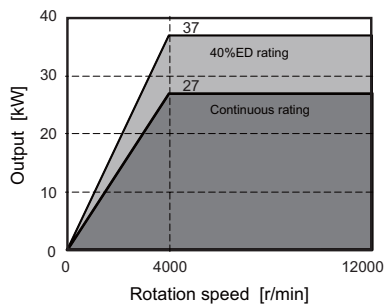
[SJ-4BGS210B/120-01]
(High-speed coil)



[SJ-4BGS240B/120-01]
(Low-speed coil)



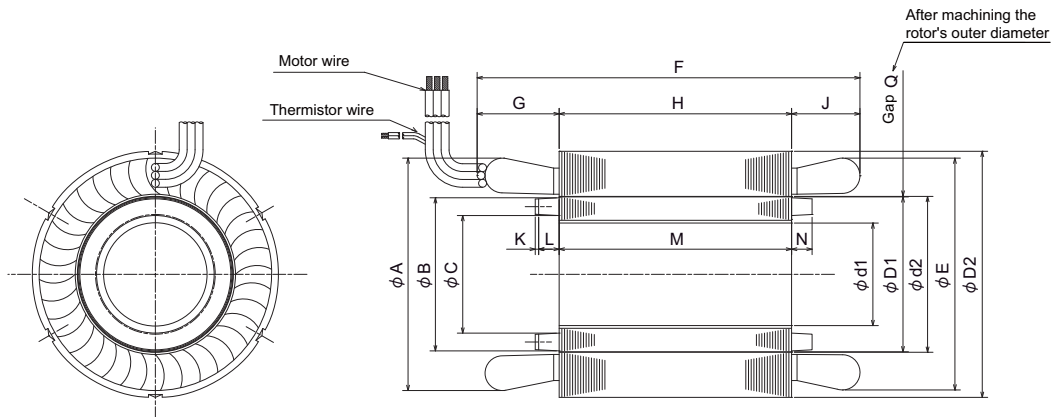
[SJ-4BGS240B/120-01]
(High-speed coil)



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

2.1.5 Outline Dimension Drawings

< SJ-BG Series (Normal specifications) >



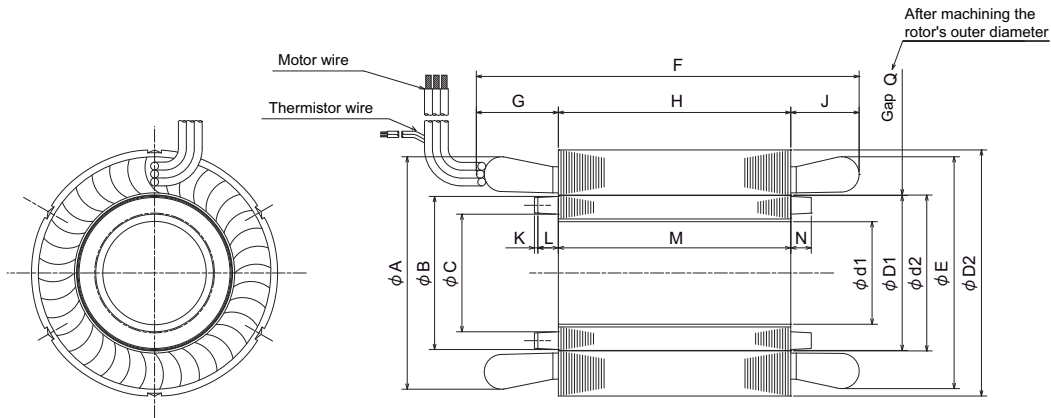
[Unit: mm]

Motor type	φA	φB	φC	Rotor		Stator			F	G	H	J	K	L	M	N	Q						
				φd1	φD1	φd2	φE	φD2															
SJ-BG090A/ 300-01	86	58	38	33	+0.025 0 (*1)	60 (*1)	60	85	89.5	0	-0.035 (*1)	81	32	25	+1.2 -1.2	24	-	7.5	25	+2 -1	7.5	0.4	
						59.2 +0.02 -0.02 (*2)																	
SJ-BG090A/ 300-01R	86	58	38	35	+0.025 0 (*1)	60 (*1)	60	85	89.5	0	-0.035 (*1)	81	32	25	+1.2 -1.2	24	-	7.5	25	+2 -1	7.5	0.4	
						59.2 +0.02 -0.02 (*2)																	
SJ-BG090B/ 300-03	86	58	38	33	+0.025 0 (*1)	60 (*1)	60	85	89.5	0	-0.035 (*1)	100	32	45	+1.2 -1.2	23	-	7.5	45	+2 -1	7.5	0.4	
						59.2 +0.02 -0.02 (*2)																	
SJ-BG090D/ 300-03	86	58	38	33	+0.025 0 (*1)	60 (*1)	60	85	89.5	0	-0.035 (*1)	153	35	95	+1.2 -1.2	23	-	7.5	95	+2 -1	7.5	0.4	
						59.2 +0.02 -0.02 (*2)																	
SJ-BG110F/ 240-01	105	67	49	42	+0.025 0 (*1)	69.4 (*1)	70	105	109.5	0	-0.035 (*1)	240	40	170		30	-	7	170	+4 0	7	0.4	5
						69.1 +0.02 -0.02 (*2)																	
SJ-BG120A/ 200-01	112	77	55	41	+0.025 0 (*1)	78.6 (*1)	79	112	119.5	0	-0.035 (*1)	135	44	60	+1.2 -1.2	31	-	8.5	60	+2 -1	8.5	0.5	
						78 +0.02 -0.02 (*2)																	
SJ-BG120A/ 200-01R	112	77	55	52	+0.030 0 (*1)	78.6 (*1)	79	112	119.5	0	-0.035 (*1)	135	44	60	+1.2 -1.2	31	-	8.5	60	+2 -1	8.5	0.5	
						78 +0.02 -0.02 (*2)																	
SJ-BG120C/ 200-01	112	77	55	41	+0.025 0 (*1)	78.6 (*1)	79	112	119.5	0	-0.035 (*1)	195	44	120	+1.4 -1.4	31	-	8.5	120	+2 -1	8.5	0.5	
						78 +0.02 -0.02 (*2)																	
SJ-BG120C/ 200-01R	112	77	55	52	+0.030 0 (*1)	78.6 (*1)	79	112	119.5	0	-0.035 (*1)	195	44	120	+1.4 -1.4	31	-	8.5	120	+2 -1	8.5	0.5	
						78 +0.02 -0.02 (*2)																	
SJ-BG150D/ 150-01	142	94	60	55	+0.030 0 (*1)	95.6 +0.1 -0.1 (*1)	96	142	149.5	0	-0.04 (*1)	170	40	100		30	-	7	100	+4 0	7	0.3	
						95.4 +0.02 -0.02 (*2)																	
SJ-BG160B/ 150-01	150	97	75	60	+0.030 0 (*1)	99.7 (*1)	100	150	159.5	0	-0.04 (*1)	153	43	75	+1.2 -1.2	35	-	10	75	+2 -1	10	0.5	
						99.0 +0.02 -0.02 (*2)																	
SJ-BG160B/ 150-01R	150	97	75	70	+0.030 0 (*1)	99.7 (*1)	100	150	159.5	0	-0.04 (*1)	153	43	75	+1.2 -1.2	35	-	10	75	+2 -1	10	0.5	
						99.0 +0.02 -0.02 (*2)																	
SJ-BG160D/ 150-01	150	97	75	60	+0.030 0 (*1)	99.7 (*1)	100	150	159.5	0	-0.04 (*1)	188	43	110	+1.4 -1.4	35	-	10	110	+2 -1	10	0.5	
						99.0 +0.02 -0.02 (*2)																	
SJ-BG160D/ 150-01R	150	97	75	70	+0.030 0 (*1)	99.7 (*1)	100	150	159.5	0	-0.04 (*1)	188	43	110	+1.4 -1.4	35	-	10	110	+2 -1	10	0.5	
						99.0 +0.02 -0.02 (*2)																	

(*1) These dimensions are the dimensions when shipped from the plant.

(*2) Apply finishing machining after carrying out shrink-fitting to the applicable shaft to realize these dimensions.
(The described values are reference values.)

< SJ-BG Series (Normal specifications) >



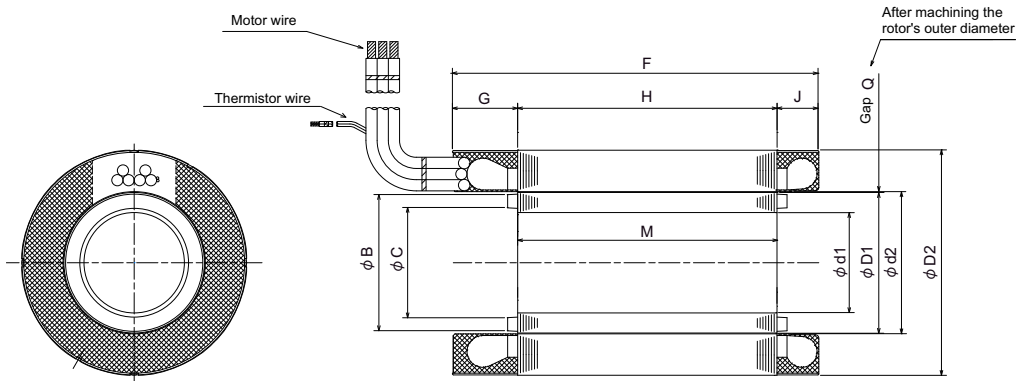
[Unit: mm]

Motor type	φA	φB	φC	Rotor		Stator			F	G	H	J	K	L	M	N	Q
				φd1	φD1	φd2	φE	φD2									
SJ-BG160D/ 150-02	150	97	75	60 ^{+0.030} ₀ (*1)	99.7 (*1)	100	150	159.5 ⁰ _{-0.04} (*1)	190	45	110 ^{+1.4} _{-1.4}	35	-	10	110 ⁺² ₋₁	10	0.5
					99.0 ^{+0.02} _{-0.02} (*2)												
SJ-BG160D/ 150-02R	150	97	75	70 ^{+0.030} ₀ (*1)	99.7 (*1)	100	150	159.5 ⁰ _{-0.04} (*1)	190	45	110 ^{+1.4} _{-1.4}	35	-	10	110 ⁺² ₋₁	10	0.5
					99.0 ^{+0.02} _{-0.02} (*2)												
SJ-BG180B/ 150-01	172	112	86	75 ^{+0.030} ₀ (*1)	113.6 (*1)	114	172	179.5 ⁰ _{-0.04} (*1)	212	58	115 ^{+1.4} _{-1.4}	39	-	15	115 ⁺² ₋₁	15	0.4
					113.2 ^{+0.02} _{-0.02} (*2)												
SJ-BG180D/ 150-01	172	112	86	75 ^{+0.030} ₀ (*1)	113.6 (*1)	114	172	179.5 ⁰ _{-0.04} (*1)	277	58	180 ^{+1.4} _{-1.4}	39	-	15	180 ⁺² ₋₁	15	0.4
					113.2 ^{+0.02} _{-0.02} (*2)												
SJ-BG180F/ 150-01	172	112	86	75 ^{+0.030} ₀ (*1)	113.6 (*1)	114	172	179.5 ⁰ _{-0.04} (*1)	322	58	225 ^{+1.7} _{-1.7}	39	-	15	225 ⁺² ₋₁	15	0.4
					113.2 ^{+0.02} _{-0.02} (*2)												
SJ-BG180H/ 150-01	172	112	86	75 ^{+0.030} ₀ (*1)	113.6 (*1)	114	172	179.5 ⁰ _{-0.04} (*1)	377	58	280 ^{+1.7} _{-1.7}	39	-	15	280 ⁺² _{-1.5}	15	0.4
					113.2 ^{+0.02} _{-0.02} (*2)												
SJ-BG240H/ 100-01	230	157	115	101 ^{+0.035} ₀ (*1)	162 (*1)	162	230	239.5 ⁰ _{-0.046} (*1)	460	75	330 ^{+2.5} _{-1.5}	55	-	18	330 ⁺⁴ _{-1.5}	18	0.6
					160.8 ^{+0.02} _{-0.02} (*2)												
SJ-BG300L/ 080-01	290	207	150	130 ^{+0.040} ₀ (*1)	210 (*1)	210	285	299.5 ⁰ _{-0.052} (*1)	515	80	380 ^{+2.5} _{-1.5}	55	-	15	380 ⁺⁴ _{-1.5}	15	0.5
					209 ^{+0.02} _{-0.02} (*2)												

(*1) These dimensions are the dimensions when shipped from the plant.

(*2) Apply finishing machining after carrying out shrink-fitting to the applicable shaft to realize these dimensions.
(The described values are reference values.)

< SJ-BG Series (Mold specifications) >

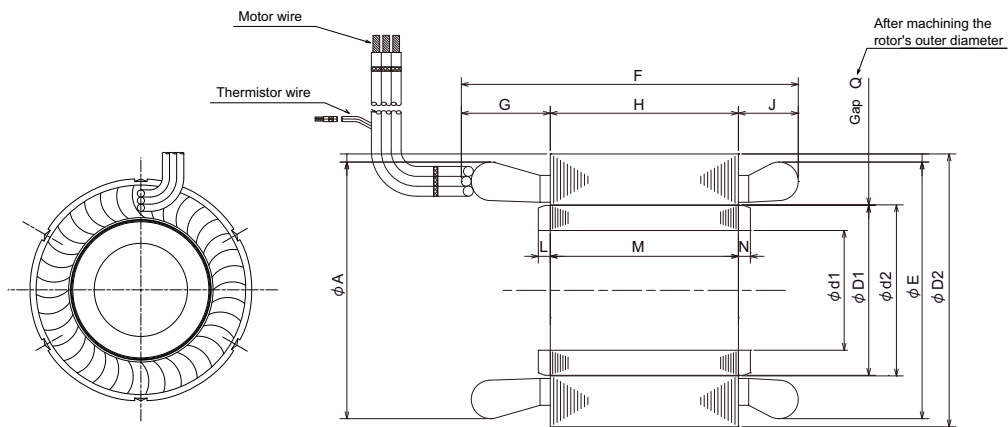


[Unit: mm]

Motor type	φ A	φ B	φ C	Rotor		Stator			F	G	H	J	K	L	M	N	Q
				φ d1	φ D1	φ d2	φ E	φ D2									
SJ-BG135D/ 200-01	-	82	65	60 +0.030 0	84 +0.020 -0.020 (*1)	85	-	134.5 0 -0.04	219 +1.0 -1.5	39	155	25 +0.5 -0.5	-	-	155 +2 -1	-	0.5

(*1) Apply finishing machining after carrying out shrink-fitting to the applicable shaft to realize these dimensions.
(The described values are reference values.)

< SJ-BG Series (High-speed specifications) >

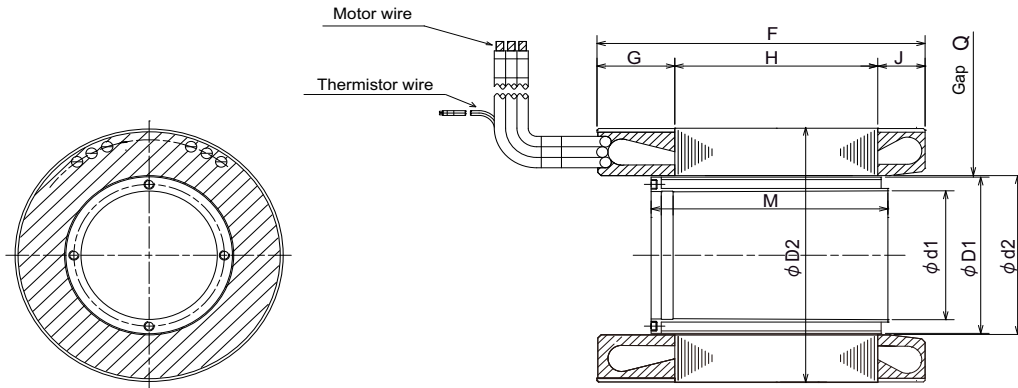


[Unit: mm]

Motor type	φ A	φ B	φ C	Rotor		Stator			F	G	H	J	K	L	M	N	Q
				φ d1	φ D1	φ d2	φ E	φ D2									
SJ-BG160D/ 200-03	150	-	-	70 (*1)	99.3 ^{+0.1} ₀ (*1)	100	150	159.5 ⁰ _{-0.04}	197	52	110 ^{+1.4} _{-1.4}	35	-	7	110	7	0.5
				70.4 to 70.5 (*2)	99 ^{+0.02} _{-0.02} (*3)												
SJ-BG180F/ 200-01	172	-	-	75 (*1)	113.2 ^{+0.05} ₀ (*1)	114	172	179.5 ⁰ _{-0.04}	322	58	225 ^{+1.7} _{-1.7}	39	-	8	225	8	0.5
				75.5 to 77 (*2)	113 ^{+0.02} _{-0.02} (*3)												
SJ-BG240H/ 130-01	230	-	-	101 (*1)	161.3 ^{+0.1} ₀ (*1)	162	230	239.5 ⁰ _{-0.046}	460	75	330 ^{+2.5} _{-1.5}	55	-	12	330	12	0.6
				101.4 to 103 (*2)	160.8 ^{+0.02} _{-0.02} (*3)												

- (*1) These dimensions are the dimensions when shipped from the plant.
- (*2) Apply finishing machining before carrying out shrink-fitting to the applicable shaft to realize these dimensions.
- (*3) Apply finishing machining after carrying out shrink-fitting to the applicable shaft to realize these dimensions.

< SJ-BGS Series (Normal specifications) >



[Unit: mm]

Motor type	φA	φB	φC	Rotor		Stator			F	G	H	J	K	L	M	N	Q
				φd1	φD1	φd2	φE	φD2									
SJ-4BGS160B/ 300-01	-	-	-	80.9	98.1 ^{+0.3} _{-0.3}	100	-	159.5 ⁰ _{-0.04} (*1)	194 ^{+1.0} _{-1.5}	46	120	28 ^{+0.5} _{-0.5}	-	-	140	-	0.7
SJ-4BGS210B/ 120-01	-	-	-	84 ^{+0.022} ₀ (*1)	133.6 ^{+0.4} _{-0.4}	135	-	209.5 ⁰ _{-0.046}	180	54	90	36	-	-	115	-	0.7
SJ-4BGS240B/ 120-01	-	-	-	100 ^{+0.022} ₀ (*1)	160.2 ^{+0.5} _{-0.5}	162	-	239.5 ⁰ _{-0.046}	220	58	120	42	-	-	145	-	0.9

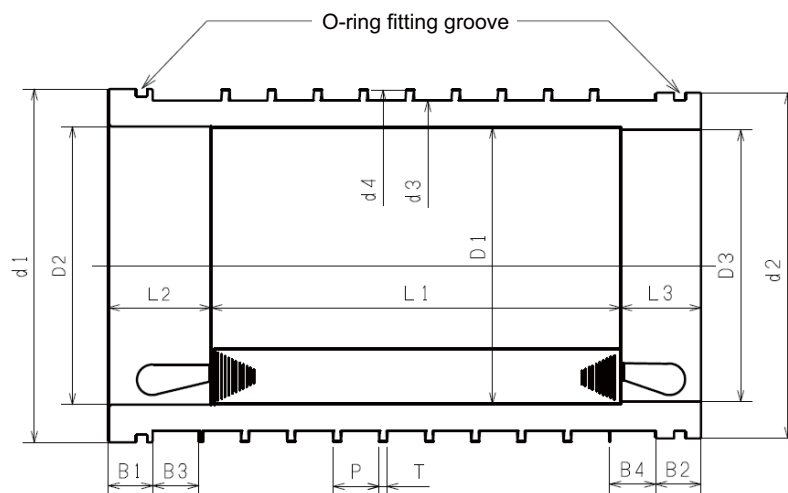
(*1) These dimensions are the dimensions when shipped from the plant.

2 Specifications

< Cooling jacket dimension example >

The tolerance is not included to the dimensions in the table.

Set an appropriate tolerance by referring to "4.2 Stator Assembly".



[Unit:mm]

Motor type	φ D1	φ D2	φ D3	φ d1	φ d2	φ d3	φ d4	L1	L2	L3	B1	B2	B3	B4	P	T
SJ-BG090A/300-01 (R)	89.5	91	88.5	110	103	99	104.8	35	42	25	18	12	21	21	16.5	3
SJ-BG090B/300-03	89.5	91	88.5	110	103	99	104.8	55	23	24	18	12	21	21	16.5	3
SJ-BG090D/300-03	89.5	91	88.5	110	103	99	104.8	105	23	27	18	12	21	21	27	3
SJ-BG110F/240-01	109.5	112	108	152	145	124	146.8	171	42	32	25	15	20	20	14	3
SJ-BG120A/200-01 (R)	119.5	120	118.5	145	135	127.5	137.5	70	44	36	25	15	13	13	14.5	3
SJ-BG120C/200-01 (R)	119.5	120	118.5	145	135	127.5	137.5	130	44	36	25	15	14	14	14.5	3
SJ-BG150D/150-01	149.5	151	148	180	175	161	179.8	110	35	35	27	22	18	18	25	5
SJ-BG160B/150-01	159.5	160	158.5	190	180	170	183	165	88	37	29	16	27	27	23	3
SJ-BG160D/150-01 (150-02)	159.5	160	158.5	190	180	170	183	200	53	37	29	16	27	27	23	3
SJ-BG180B/150-01	179.5	180	178.5	210	200	189.5	203.5	125	61	44	32	16.5	25	23.5	18	3
SJ-BG180D/150-01	179.5	180	178.5	210	200	189.5	203.5	190	61	44	32	16.5	25	23.5	18	3
SJ-BG180F/150-01	179.5	180	178.5	210	200	189.5	203.5	235	61	44	32	16.5	25	23.5	18	3
SJ-BG180H/150-01	179.5	180	178.5	210	200	189.5	203.5	290	61	44	32	16.5	25	23.5	18	3
SJ-BG240H/100-01	239.5	240	238.5	270	265	254	269.8	340	94	60	35.5	32.5	28	28	30	5
SJ-BG300L/080-01	239.5	300	298.5	345	335	319.5	339	390	85	60	40	18	26	26	20	5
SJ-BG160D/200-03	159.5	160	158.5	190	180	169.5	183	203	55	38	29	16	27	27	20	3
SJ-BG180F/200-01	179.5	180	178.5	210	200	189.5	203.5	235	61	44	32	16.5	25	23.5	18	3
SJ-BG240H/130-01	239.5	240	238.5	270	265	254	269.8	340	94	60	35.5	32.5	28	28	30	5

CAUTION

1. The output or performance as specified is not obtained if the cooling capacity is insufficient.
2. Use a built-in motor of fluid cooling type.
3. The required cooling capability differs depending on the motor type. Select an appropriate cooling device by referring to the specifications list in chapter 2 or Spindle Motor Spec.
4. Create a structure that will prevent the refrigerant from entering the motor side by attaching packing such as O-rings at the both ends of the jacket.
5. Use ferrous materials such as steel and cast iron for the jacket.

2.2 PLG Serial Output Encoder (TS5690, MU1606 Series)

2.2.1 Specifications List

Sensor	Series type		TS5690N64xx									
	xx (The end of the type name)	Standard connector	12	22	32	42	52	17	27	37	47	57
		Waterproof connector	19	29	39	49	59	18	28	38	48	58
	Length of lead [mm]		400±10	800±20	1200±20	1600±30	2000±30	400±10	800±20	1200±20	1600±30	2000±30
	Lead-out direction of lead		Vertical direction					Axis direction				
Detection gear	Type		MU1606N601									
	The number of teeth		64									
	Outer diameter [mm]		Φ52.8									
	Inner diameter [mm]		Φ40H5									
	Thickness [mm]		12									
Notched fitting section	Outer diameter [mm]		Φ59.4									
	Outer diameter tolerance [mm]		-0.070 to -0.030									
The number of output pulse	A/B phase		64									
	Z phase		1									
Detection resolution [p/rev]		2 million										
Absolute accuracy at stop		150"										
Tolerable speed [r/min]		40,000										
Signal output		Mitsubishi high-speed serial										

Sensor	Series type		TS5690N90xx									
	xx (The end of the type name)	Standard connector	12	22	32	42	52	17	27	37	47	57
		Waterproof connector	19	29	39	49	59	18	28	38	48	58
	Length of lead [mm]		400±10	800±20	1200±20	1600±30	2000±30	400±10	800±20	1200±20	1600±30	2000±30
	Lead-out direction of lead		Vertical direction					Axis direction				
Detection gear	Type		MU1606N906									
	The number of teeth		90									
	Outer diameter [mm]		Φ73.6									
	Inner diameter [mm]		Φ60H5									
	Thickness [mm]		12									
Notched fitting section	Outer diameter [mm]		Φ79.2									
	Outer diameter tolerance [mm]		-0.040 to 0									
The number of output pulse	A/B phase		90									
	Z phase		1									
Detection resolution [p/rev]		2.88 million										
Absolute accuracy at stop		105"										
Tolerable speed [r/min]		30,000										
Signal output		Mitsubishi high-speed serial										

Sensor	Series type		TS5690N12xx									
	xx (The end of the type name)	Standard connector	12	22	32	42	52	17	27	37	47	57
		Waterproof connector	19	29	39	49	59	18	28	38	48	58
	Length of lead [mm]		400±10	800±20	1200±20	1600±30	2000±30	400±10	800±20	1200±20	1600±30	2000±30
	Lead-out direction of lead		Vertical direction					Axis direction				
Detection gear	Type		MU1606N709									
	The number of teeth		128									
	Outer diameter [mm]		Φ104.0									
	Inner diameter [mm]		Φ80H5									
	Thickness [mm]		12									
Notched fitting section	Outer diameter [mm]		Φ108.8									
	Outer diameter tolerance [mm]		-0.015 to +0.025									
The number of output pulse	A/B phase		128									
	Z phase		1									
Detection resolution [p/rev]		4 million										
Absolute accuracy at stop		100"										
Tolerable speed [r/min]		20,000										
Signal output		Mitsubishi high-speed serial										

2 Specifications

Sensor	Series type		TS5690N19xx									
	xx (The end of the type name)	Standard connector	12	22	32	42	52	17	27	37	47	57
		Waterproof connector	19	29	39	49	59	18	28	38	48	58
	Length of lead [mm]		400±10	800±20	1200±20	1600±30	2000±30	400±10	800±20	1200±20	1600±30	2000±30
	Lead-out direction of lead		Vertical direction					Axis direction				
Detection gear	Type		MU1606N203									
	The number of teeth		192									
	Outer diameter [mm]		Φ155.2									
	Inner diameter [mm]		Φ125H5									
	Thickness [mm]		12									
Notched fitting section	Outer diameter [mm]		Φ159.4									
	Outer diameter tolerance [mm]		-0.035 to +0.005									
The number of output pulse	A/B phase		192									
	Z phase		1									
Detection resolution [p/rev]		6 million										
Absolute accuracy at stop		97.5"										
Tolerable speed [r/min]		15,000										
Signal output		Mitsubishi high-speed serial										

Sensor	Series type		TS5690N25xx									
	xx (The end of the type name)	Standard connector	12	22	32	42	52	17	27	37	47	57
		Waterproof connector	19	29	39	49	59	18	28	38	48	58
	Length of lead [mm]		400±10	800±20	1200±20	1600±30	2000±30	400±10	800±20	1200±20	1600±30	2000±30
	Lead-out direction of lead		Vertical direction					Axis direction				
Detection gear	Type		MU1606N802									
	The number of teeth		256									
	Outer diameter [mm]		Φ206.4									
	Inner diameter [mm]		Φ160									
	Thickness [mm]		15.8									
Notched fitting section	Outer diameter [mm]		Φ210.2									
	Outer diameter tolerance [mm]		0.0 to +0.040									
The number of output pulse	A/B phase		256									
	Z phase		1									
Detection resolution [p/rev]		8 million										
Absolute accuracy at stop		95"										
Tolerable speed [r/min]		10,000										
Signal output		Mitsubishi high-speed serial										

 **CAUTION**

1. Selected encoders must be able to tolerate the maximum rotation speed of the motor.
2. Please contact your Mitsubishi Electric dealer for the special products not listed above.

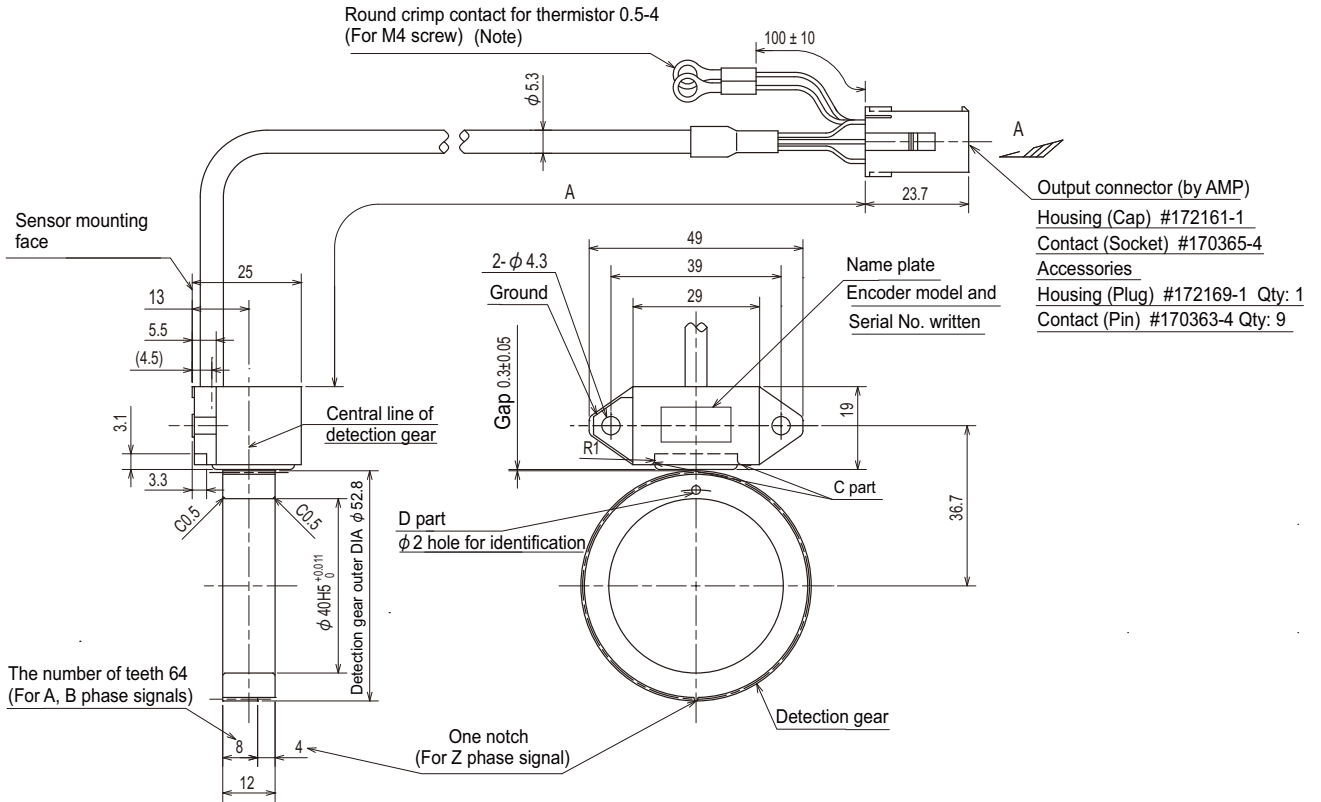
2.2.2 Outline Dimension Drawings

CAUTION

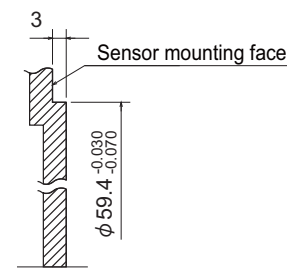
Always apply the notched fitting section machining with the specified dimensions to the sensor installation surface.

< TS5690N64x2 + MU1606N601 >

[Unit: mm]

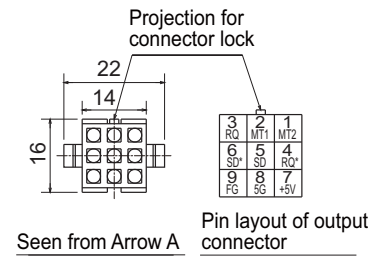


(Note) The thermistor contact is not used when the encoder is used as a spindle side encoder. Insulate the terminal.



Encoder mounting face of machine side

Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N6412	400±10	Vertical direction	MU1606N601
TS5690N6422	800±20		
TS5690N6432	1200±20		
TS5690N6442	1600±30		
TS5690N6452	2000±30		

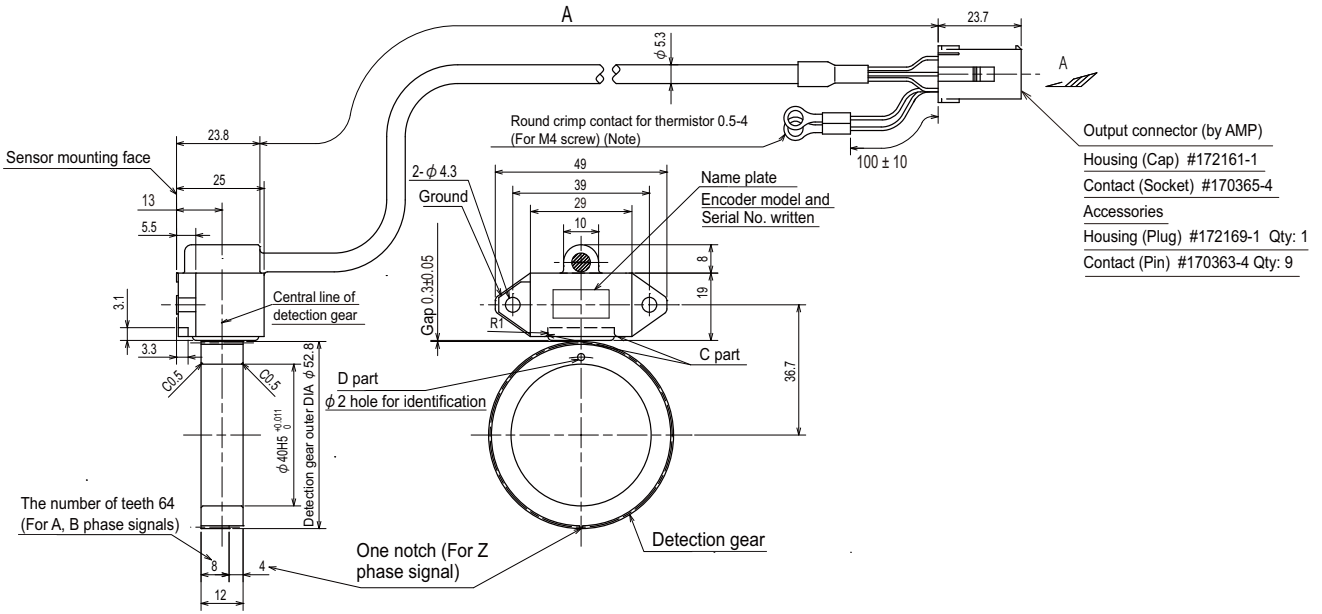


Seen from Arrow A Pin layout of output connector

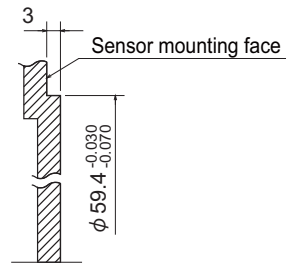
2 Specifications

< TS5690N64x7 + MU1606N601 >

[Unit: mm]

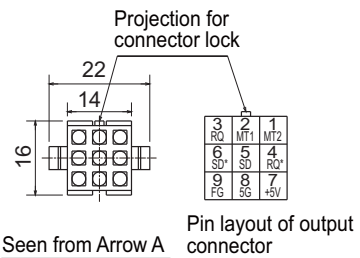


(Note) The thermistor contact is not used when the encoder is used as a spindle side encoder. Insulate the terminal.



Encoder mounting face of machine side

Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N6417	400±10	Axis direction	MU1606N601
TS5690N6427	800±20		
TS5690N6437	1200±20		
TS5690N6447	1600±30		
TS5690N6457	2000±30		

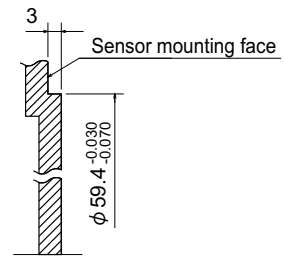
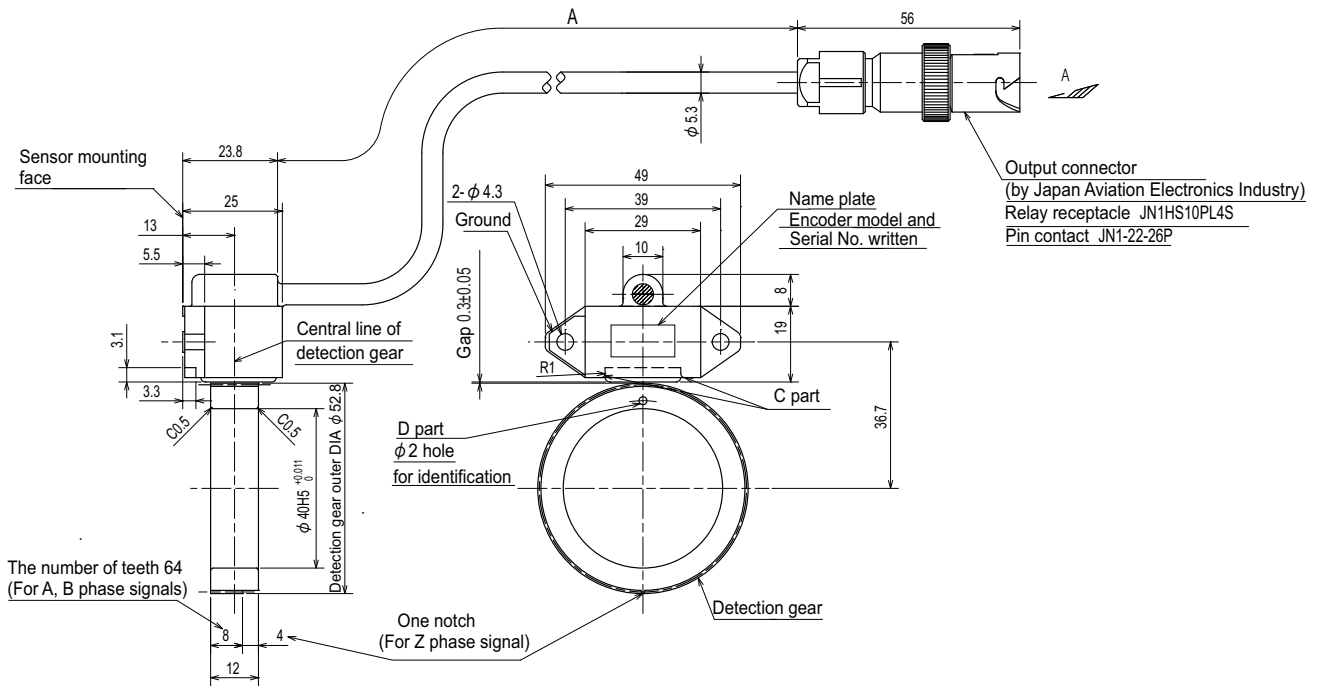


Seen from Arrow A

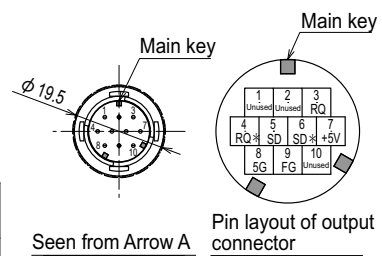
Pin layout of output connector

< TS5690N64x8 + MU1606N601 >

[Unit: mm]



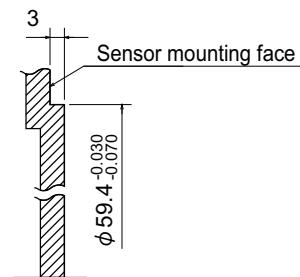
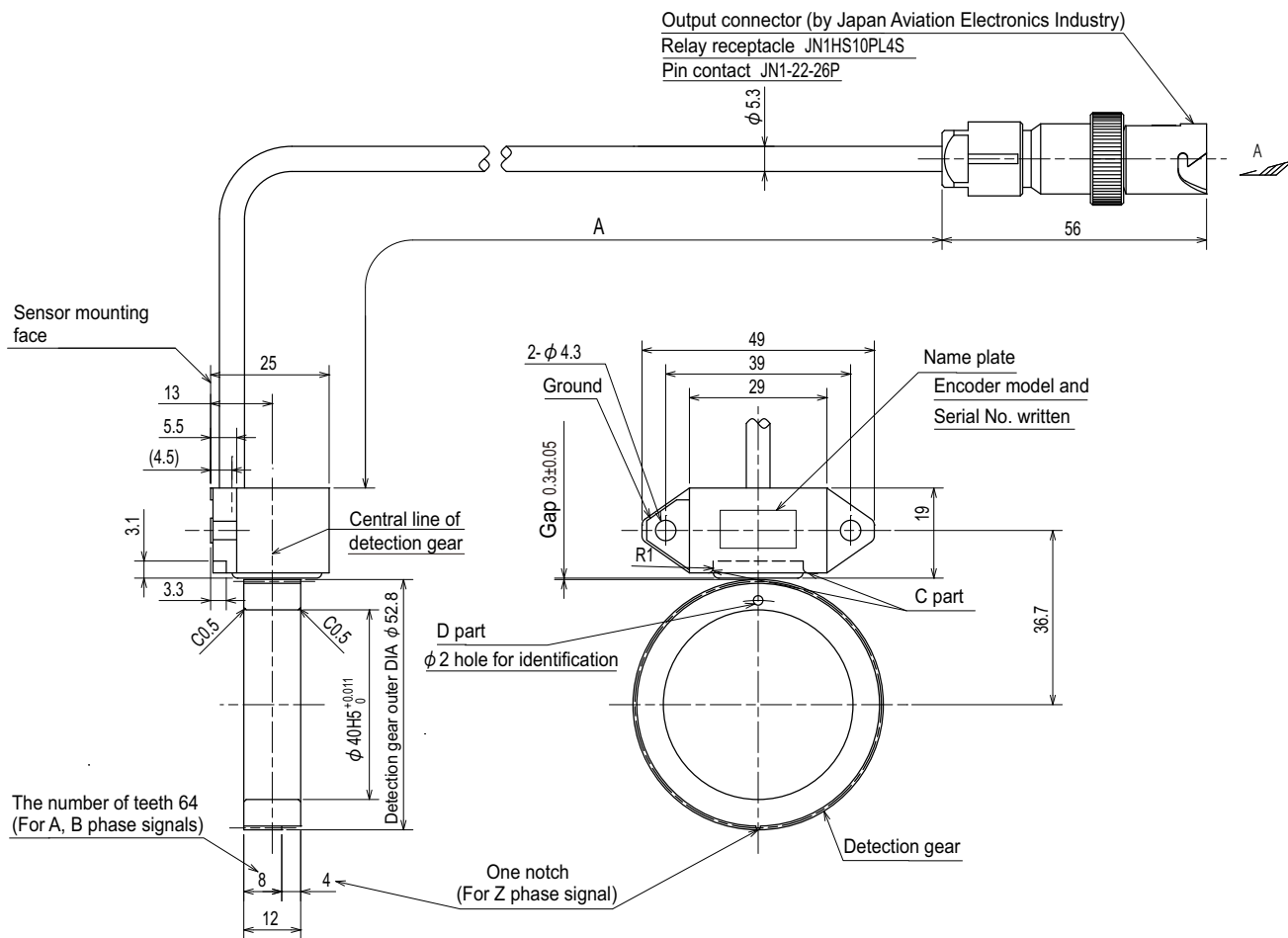
Encoder mounting face of machine side



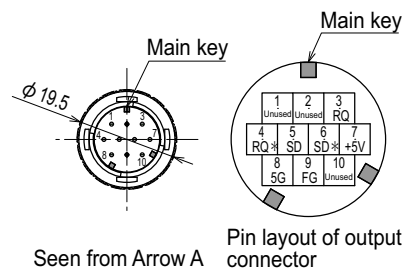
Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N6418	400±10	Axis direction	MU1606N709
TS5690N6428	800±20		
TS5690N6438	1200±20		
TS5690N6448	1600±30		
TS5690N6458	2000±30		

< TS5690N64x9 + MU1606N601 >

[Unit: mm]



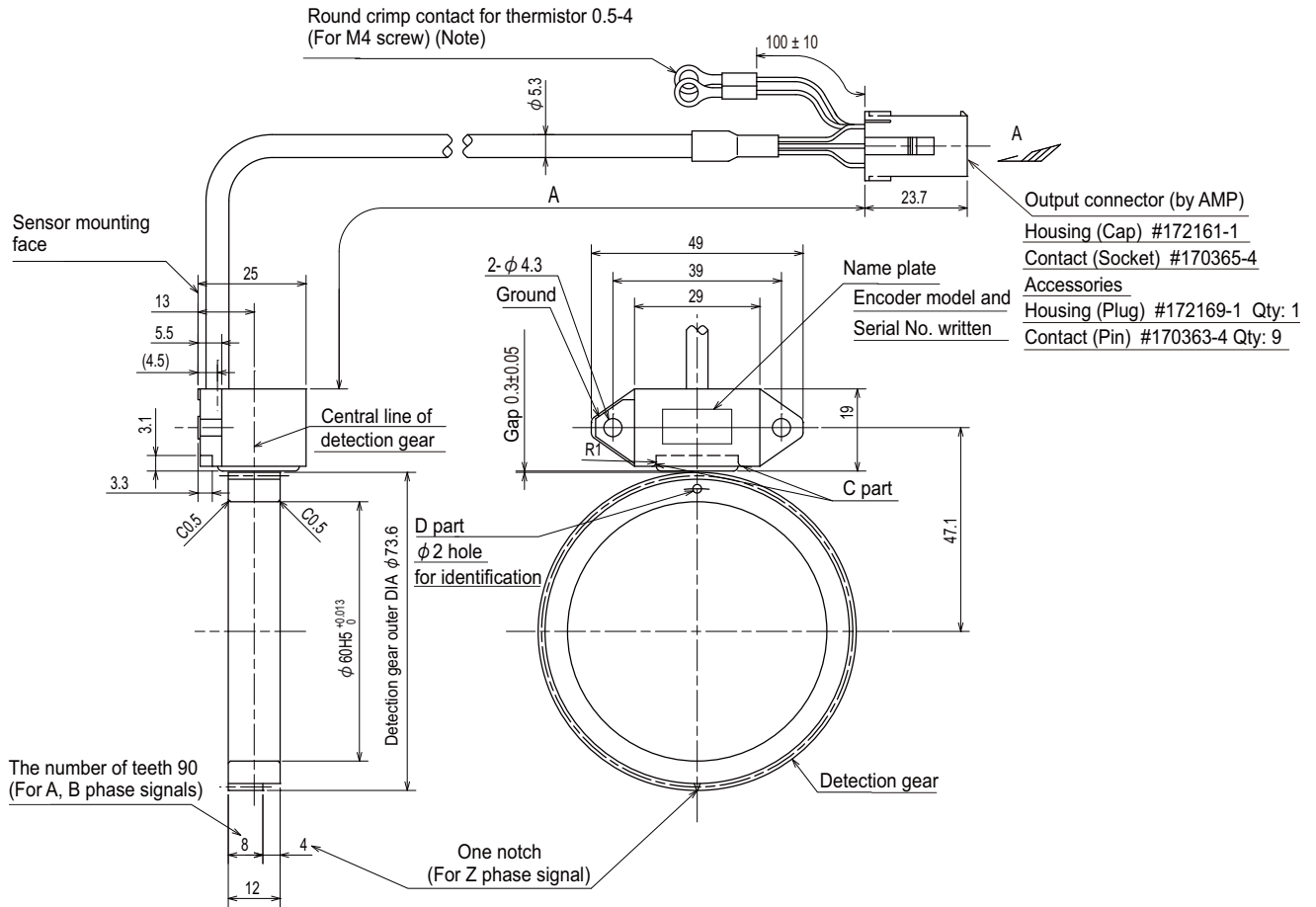
Encoder mounting face of machine side



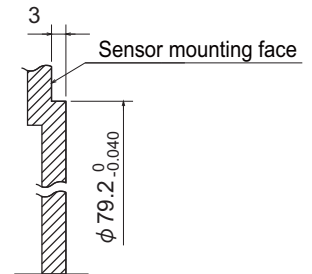
Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N6419	400±10	Vertical direction	MU1606N709
TS5690N6429	800±20		
TS5690N6439	1200±20		
TS5690N6449	1600±30		
TS5690N6459	2000±30		

< TS5690N90x2 + MU1606N906 >

[Unit: mm]

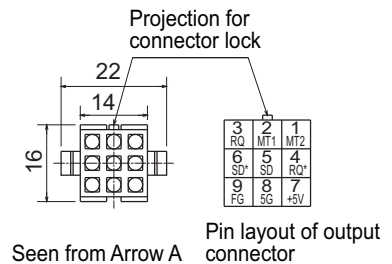


(Note) The thermistor contact is not used when the encoder is used as a spindle side encoder. Insulate the terminal.



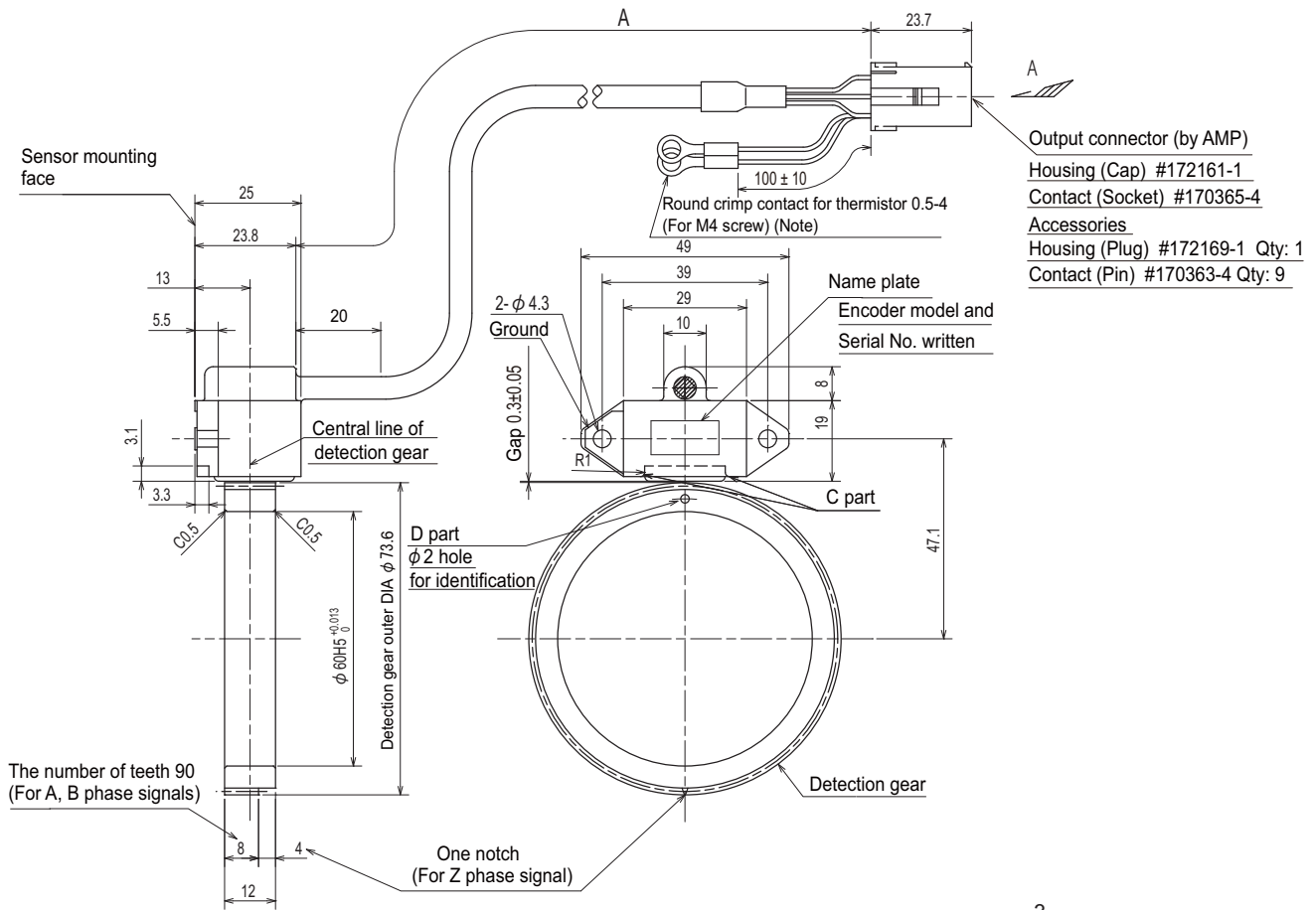
Encoder mounting face of machine side

Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N9012	400±10	Vertical direction	MU1606N906
TS5690N9022	800±20		
TS5690N9032	1200±20		
TS5690N9042	1600±30		
TS5690N9052	2000±30		

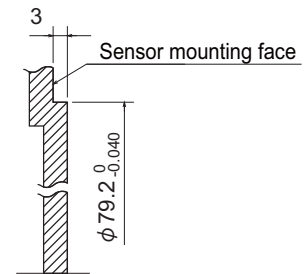


< TS5690N90x7 + MU1606N906 >

[Unit: mm]

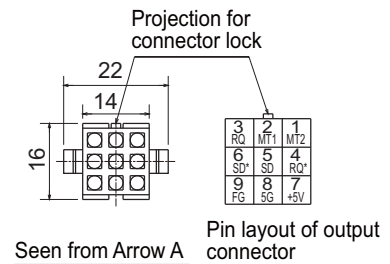


(Note) The thermistor contact is not used when the encoder is used as a spindle side encoder. Insulate the terminal.



Encoder mounting face of machine side

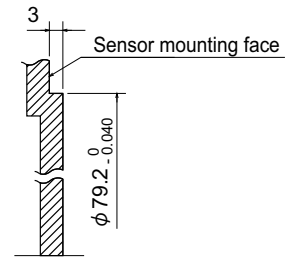
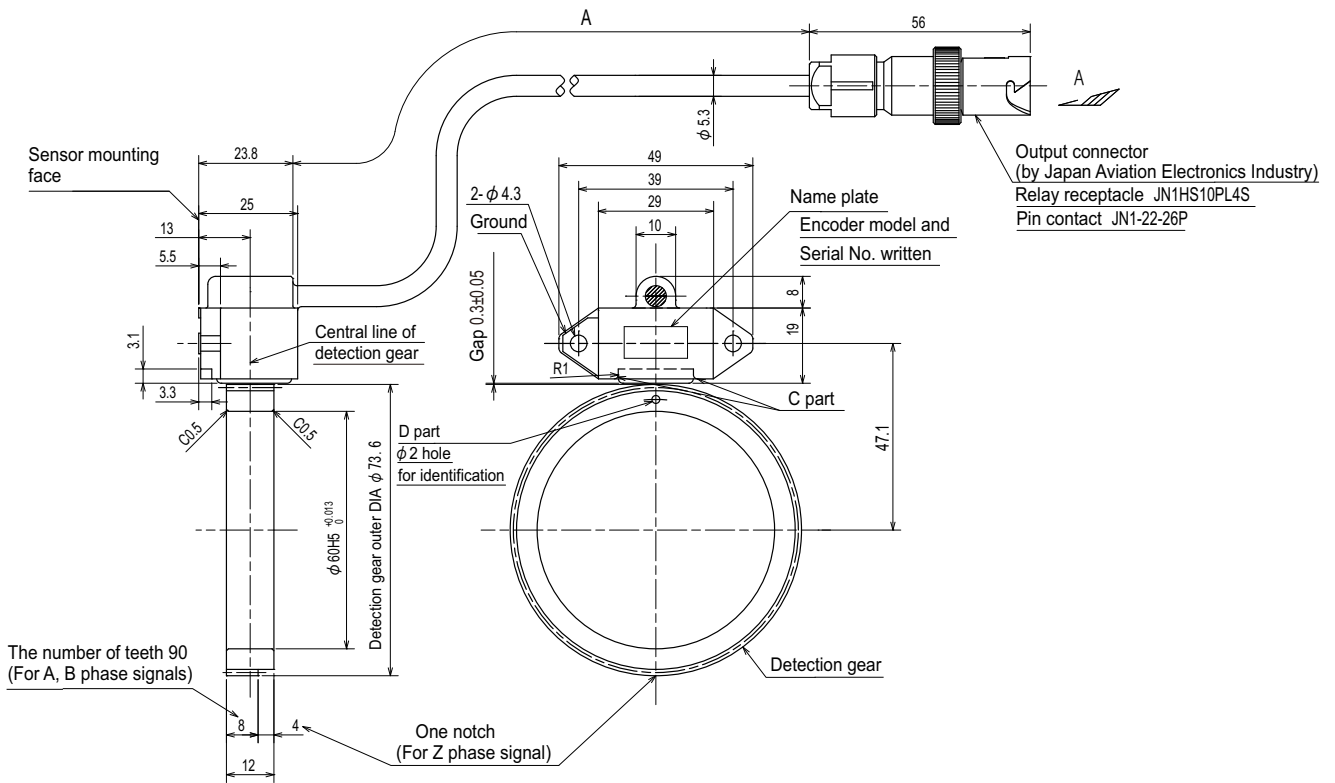
Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N9017	400±10	Axis direction	MU1606N906
TS5690N9027	800±20		
TS5690N9037	1200±20		
TS5690N9047	1600±30		
TS5690N9057	2000±30		



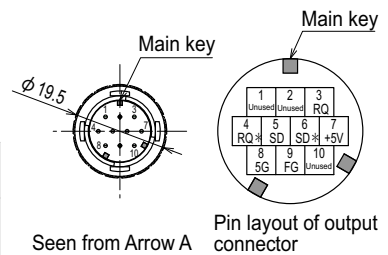
Seen from Arrow A Pin layout of output connector

< TS5690N90x8 + MU1606N906 >

[Unit: mm]



Encoder mounting face of machine side



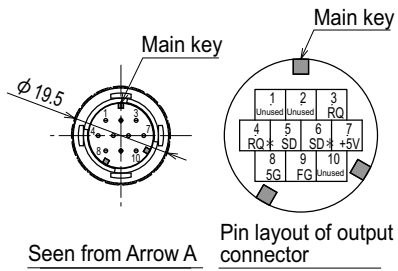
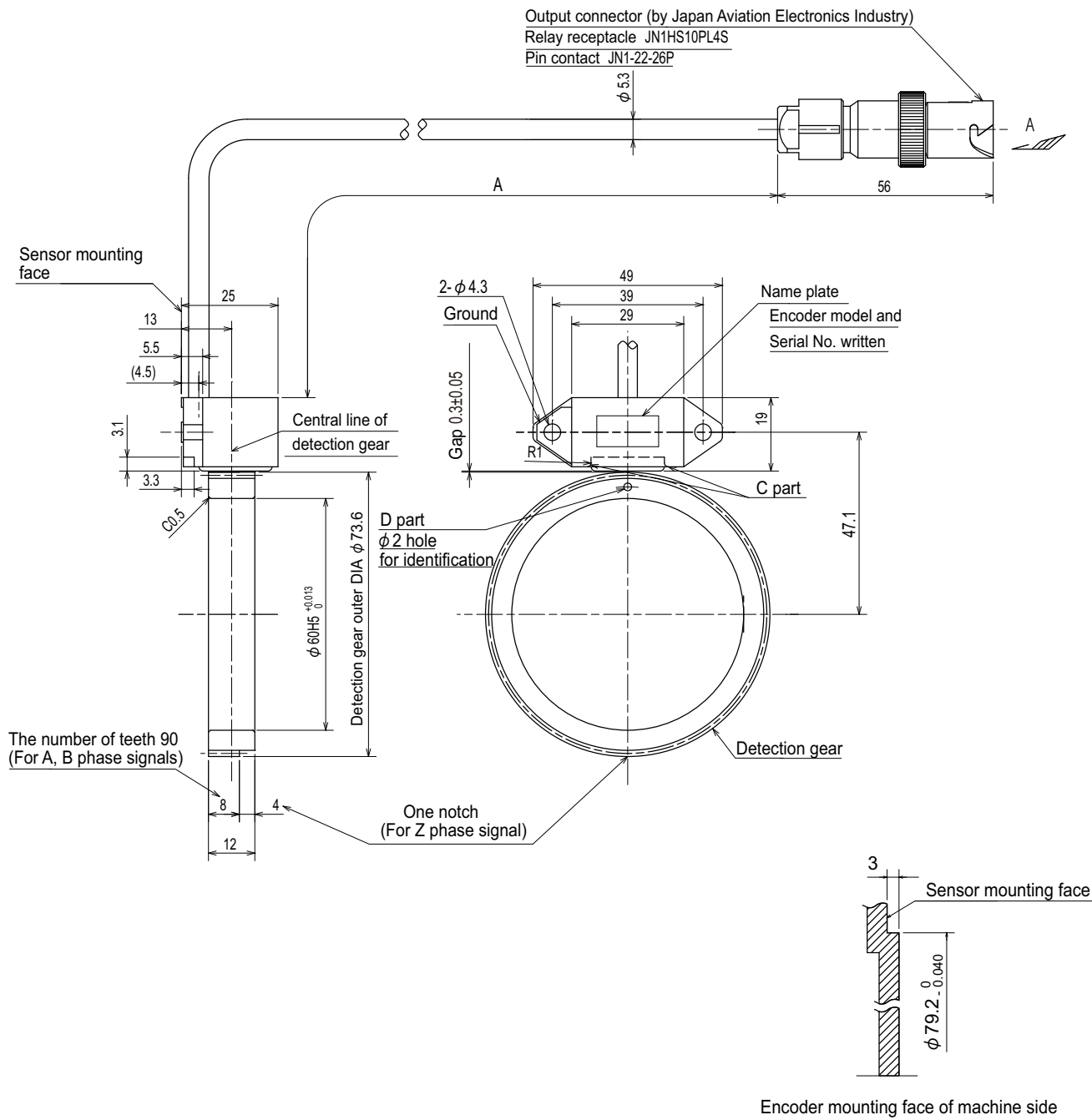
Seen from Arrow A

Pin layout of output connector

Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N9018	400±10	Axis direction	MU1606N906
TS5690N9028	800±20		
TS5690N9038	1200±20		
TS5690N9048	1600±30		
TS5690N9058	2000±30		

< TS5690N90x9 + MU1606N906 >

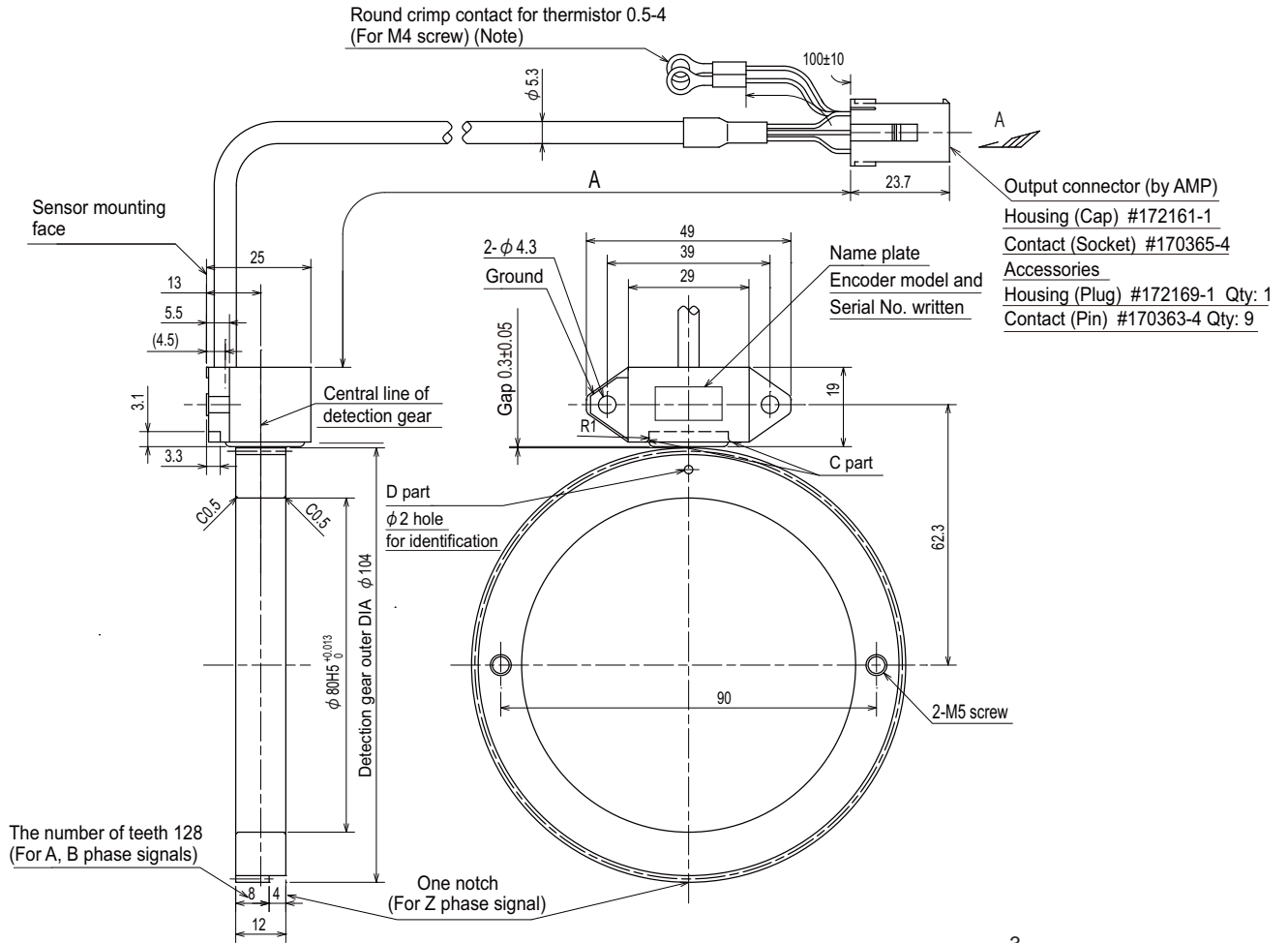
[Unit: mm]



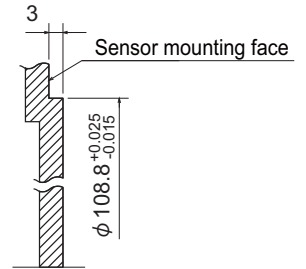
Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N9019	400±10	Vertical direction	MU1606N906
TS5690N9029	800±20		
TS5690N9039	1200±20		
TS5690N9049	1600±30		
TS5690N9059	2000±30		

< TS5690N12x2 + MU1606N709 >

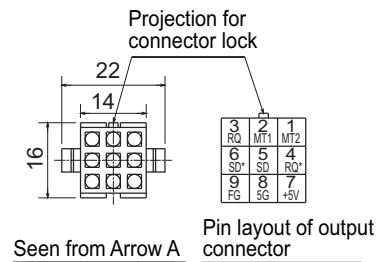
[Unit: mm]



(Note) The thermistor contact is not used when the encoder is used as a spindle side encoder. Insulate the terminal.



Encoder mounting face of machine side



Seen from Arrow A

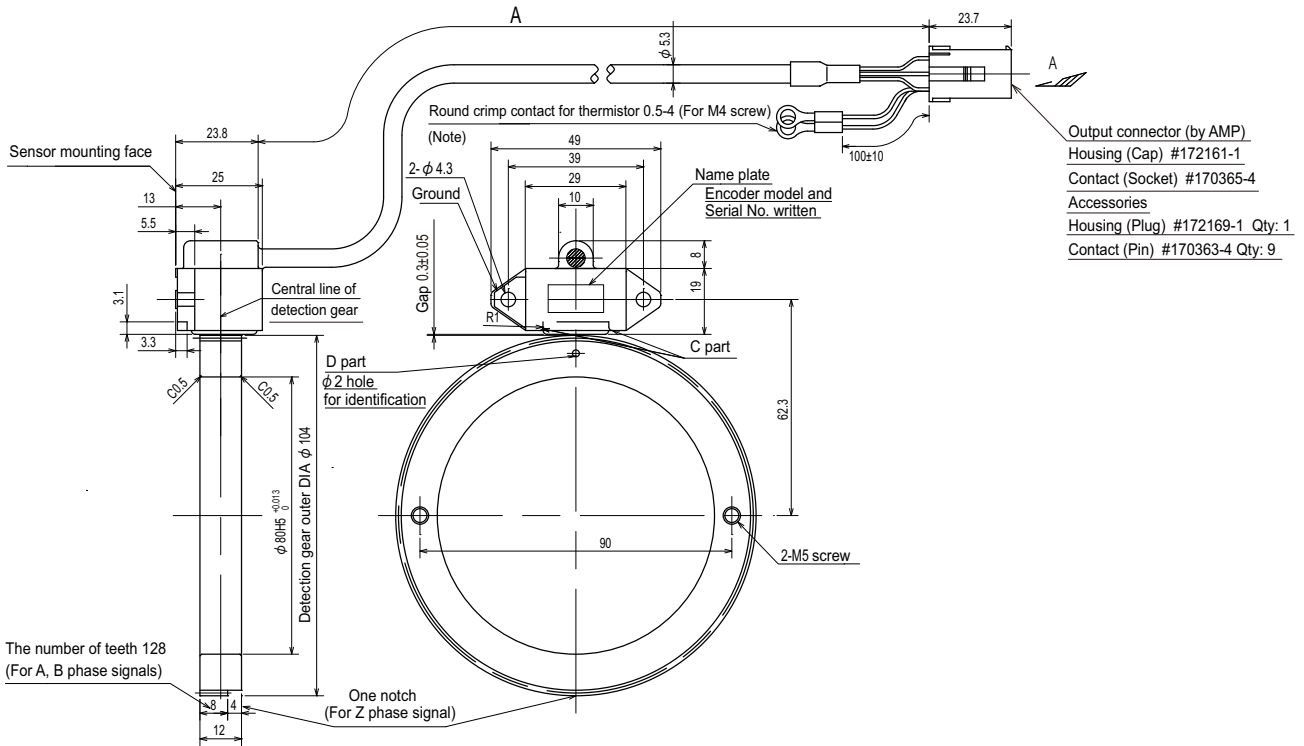
Pin layout of output connector

Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N1212	400±10	Vertical direction	MU1606N709
TS5690N1222	800±20		
TS5690N1232	1200±20		
TS5690N1242	1600±30		
TS5690N1252	2000±30		

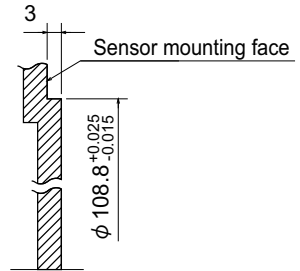
2 Specifications

< TS5690N12x7 + MU1606N709 >

[Unit: mm]

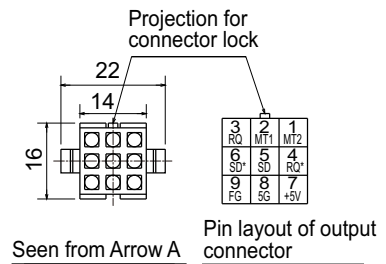


(Note) The thermistor contact is not used when the encoder is used as a spindle side encoder. Insulate the terminal.



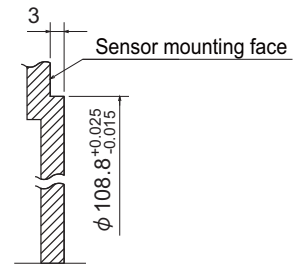
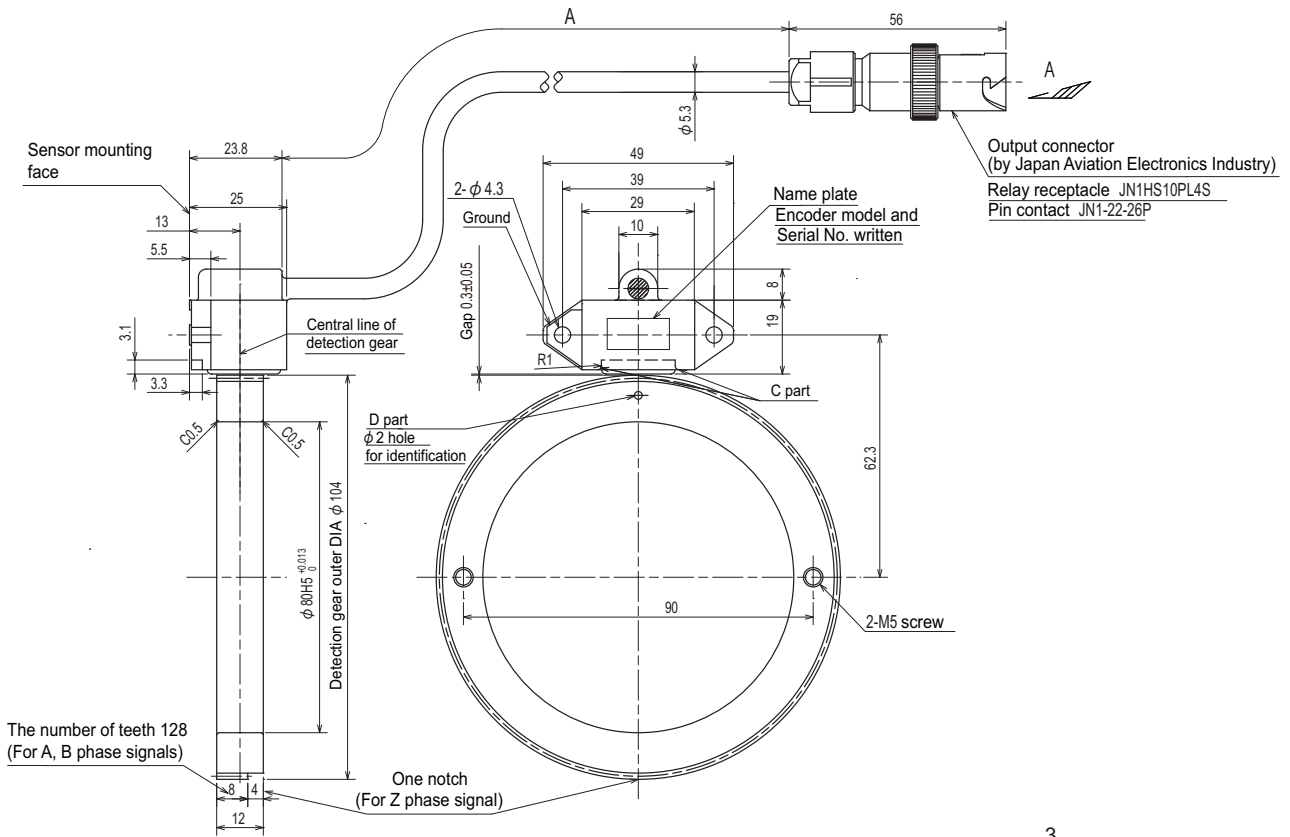
Encoder mounting face of machine side

Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N1217	400 \pm 10	Axis direction	MU1606N709
TS5690N1227	800 \pm 20		
TS5690N1237	1200 \pm 20		
TS5690N1247	1600 \pm 30		
TS5690N1257	2000 \pm 30		

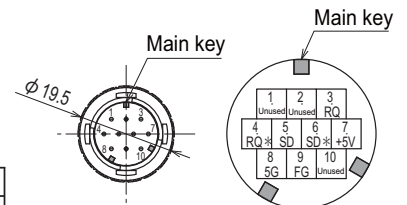


< TS5690N12x8 + MU1606N709 >

[Unit: mm]



Encoder mounting face of machine side



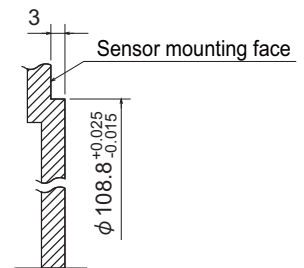
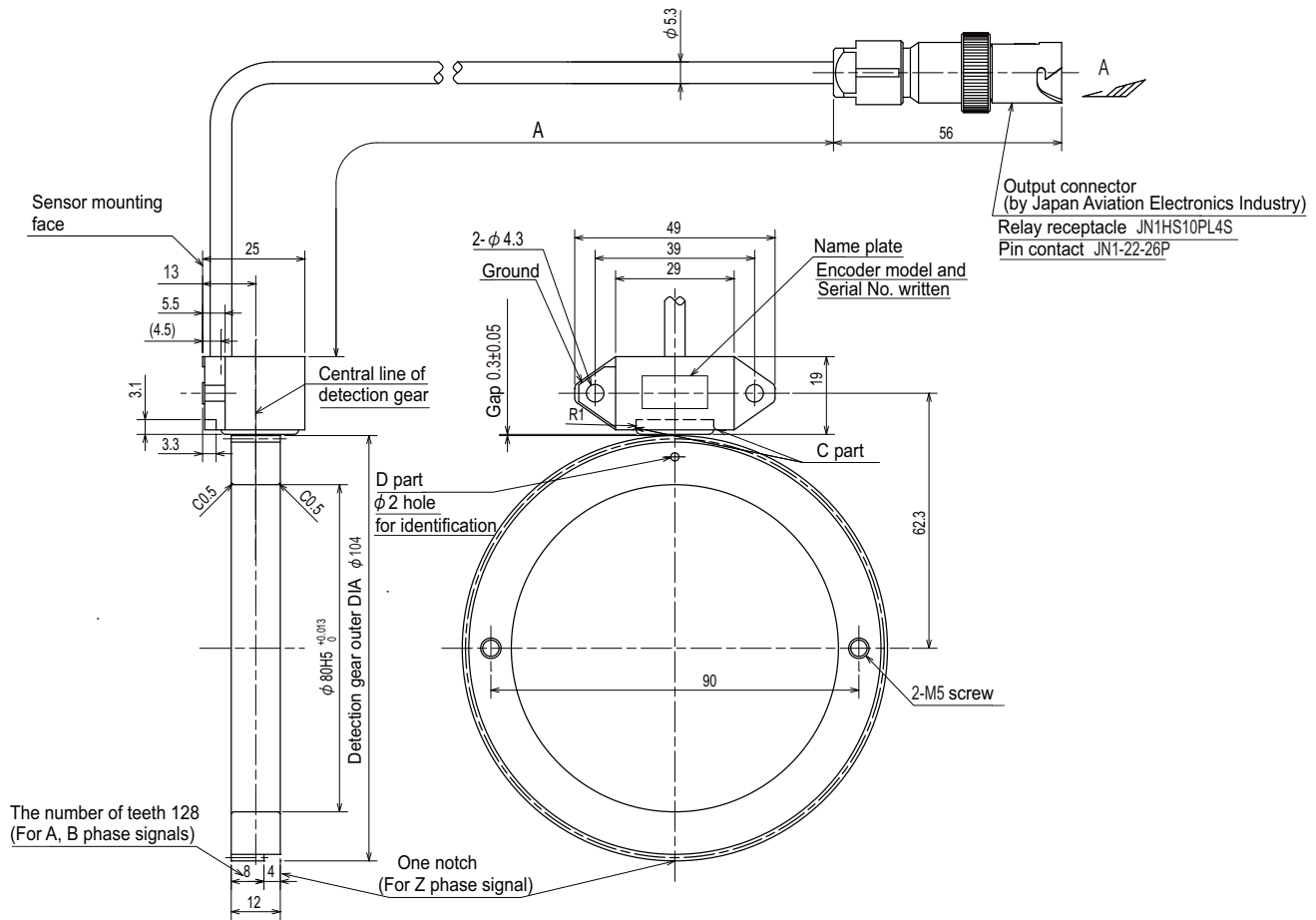
Seen from Arrow A

Pin layout of output connector

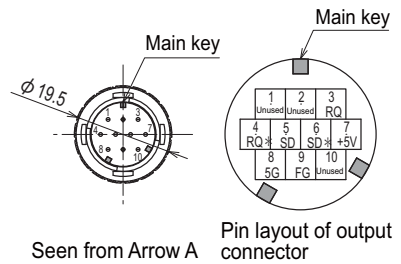
Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N1218	400 \pm 10	Axis direction	MU1606N906
TS5690N1228	800 \pm 20		
TS5690N1238	1200 \pm 20		
TS5690N1248	1600 \pm 30		
TS5690N1258	2000 \pm 30		

< TS5690N12x9 + MU1606N709 >

[Unit: mm]



Encoder mounting face of machine side



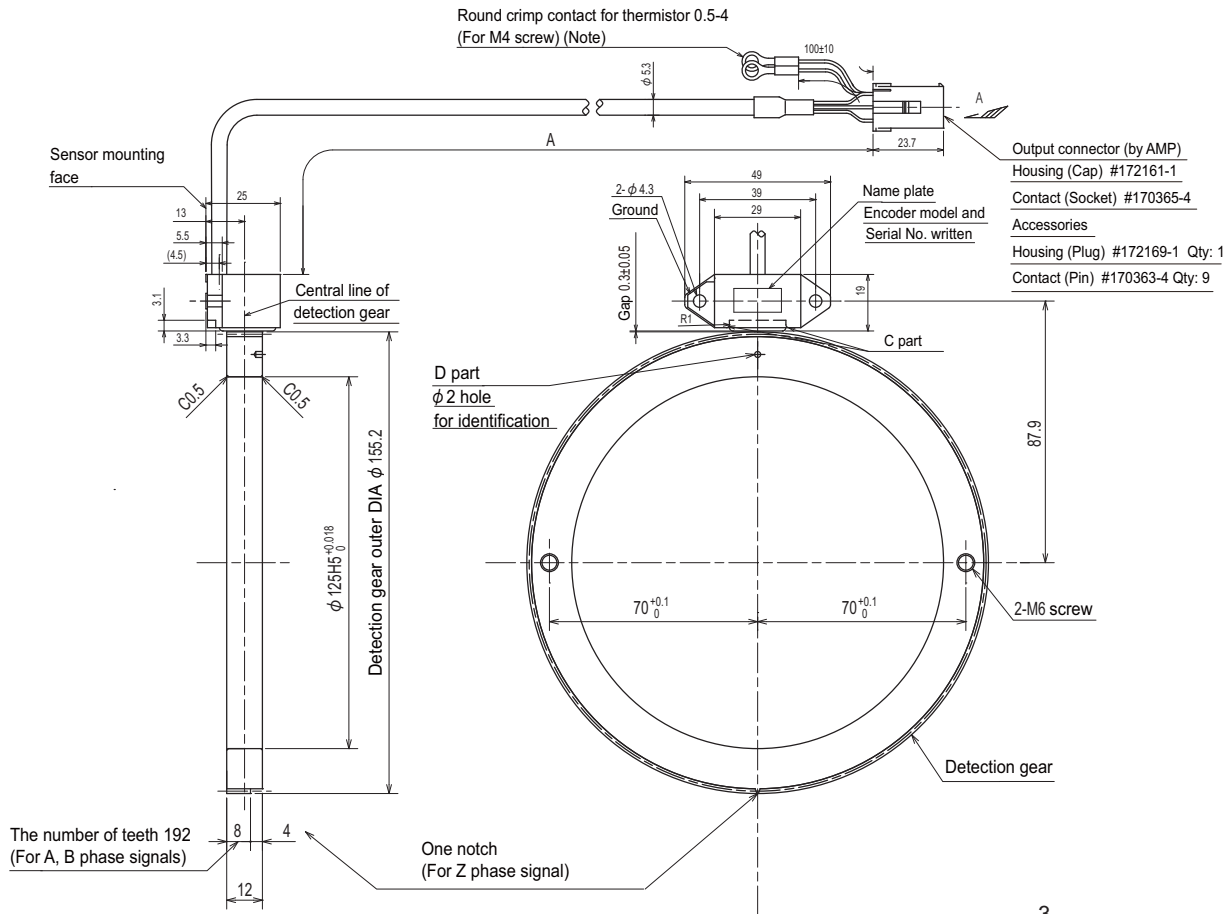
Seen from Arrow A

Pin layout of output connector

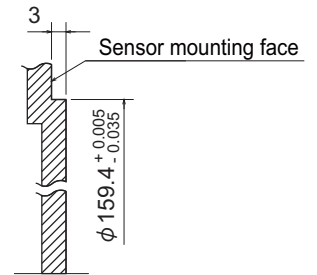
Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N1219	400±10	Vertical direction	MU1606N709
TS5690N1229	800±20		
TS5690N1239	1200±20		
TS5690N1249	1600±30		
TS5690N1259	2000±30		

< TS5690N19x2 + MU1606N203 >

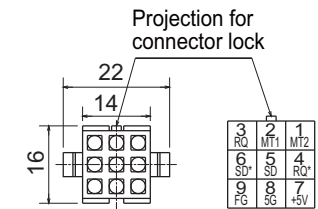
[Unit: mm]



(Note) The thermistor contact is not used when the encoder is used as a spindle side encoder.
Insulate the terminal.



Encoder mounting face of machine side



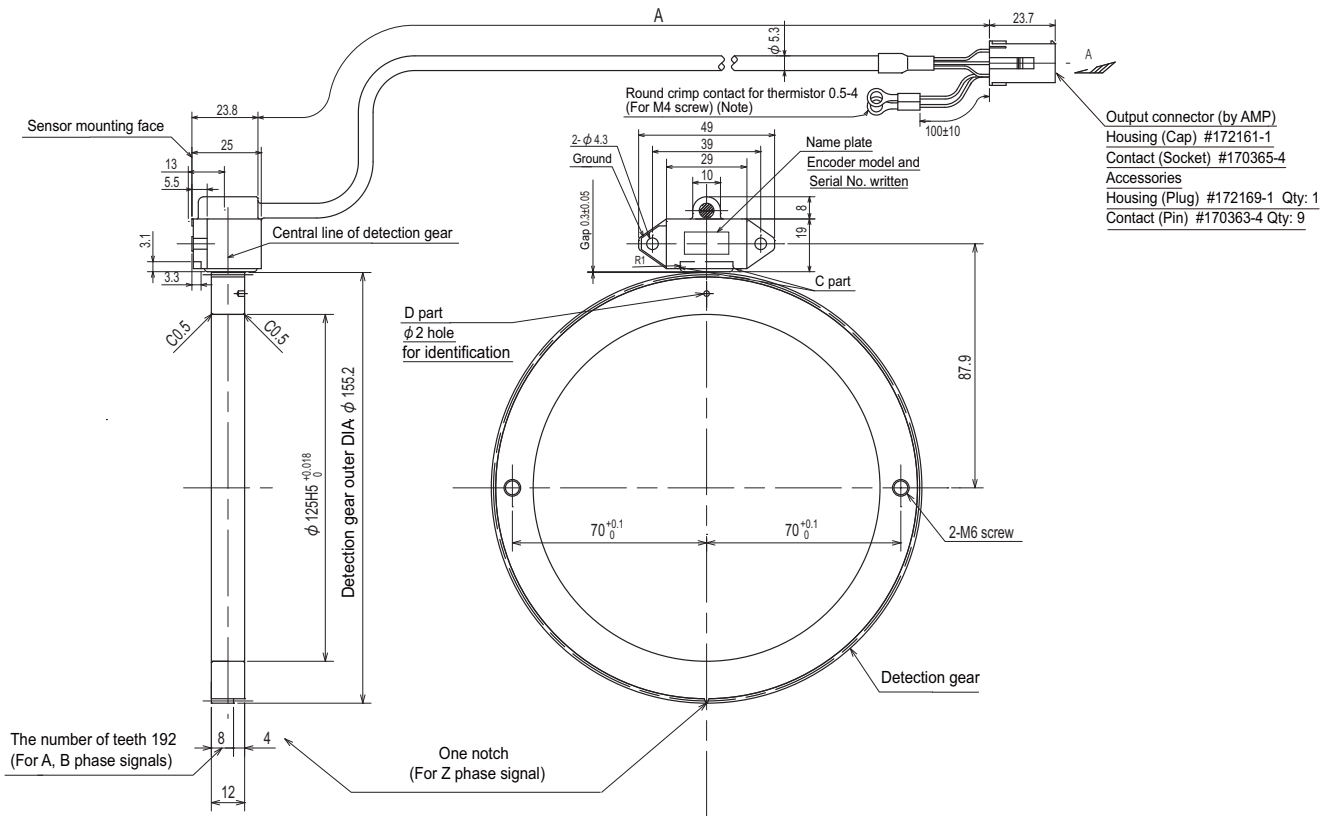
Seen from Arrow A Pin layout of output connector

Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N1912	400 \pm 10	Vertical direction	MU1606N203
TS5690N1922	800 \pm 20		
TS5690N1932	1200 \pm 20		
TS5690N1942	1600 \pm 30		
TS5690N1952	2000 \pm 30		

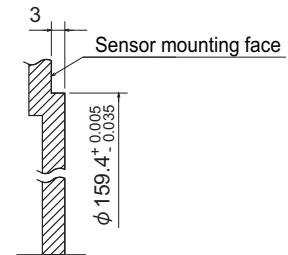
2 Specifications

< TS5690N19x7 + MU1606N203 >

[Unit: mm]

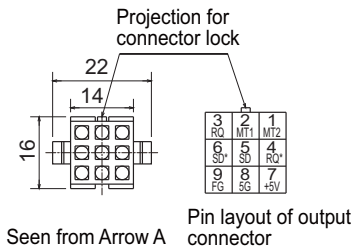


(Note) The thermistor contact is not used when the encoder is used as a spindle side encoder. Insulate the terminal.



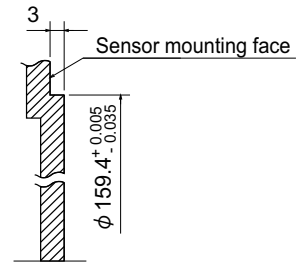
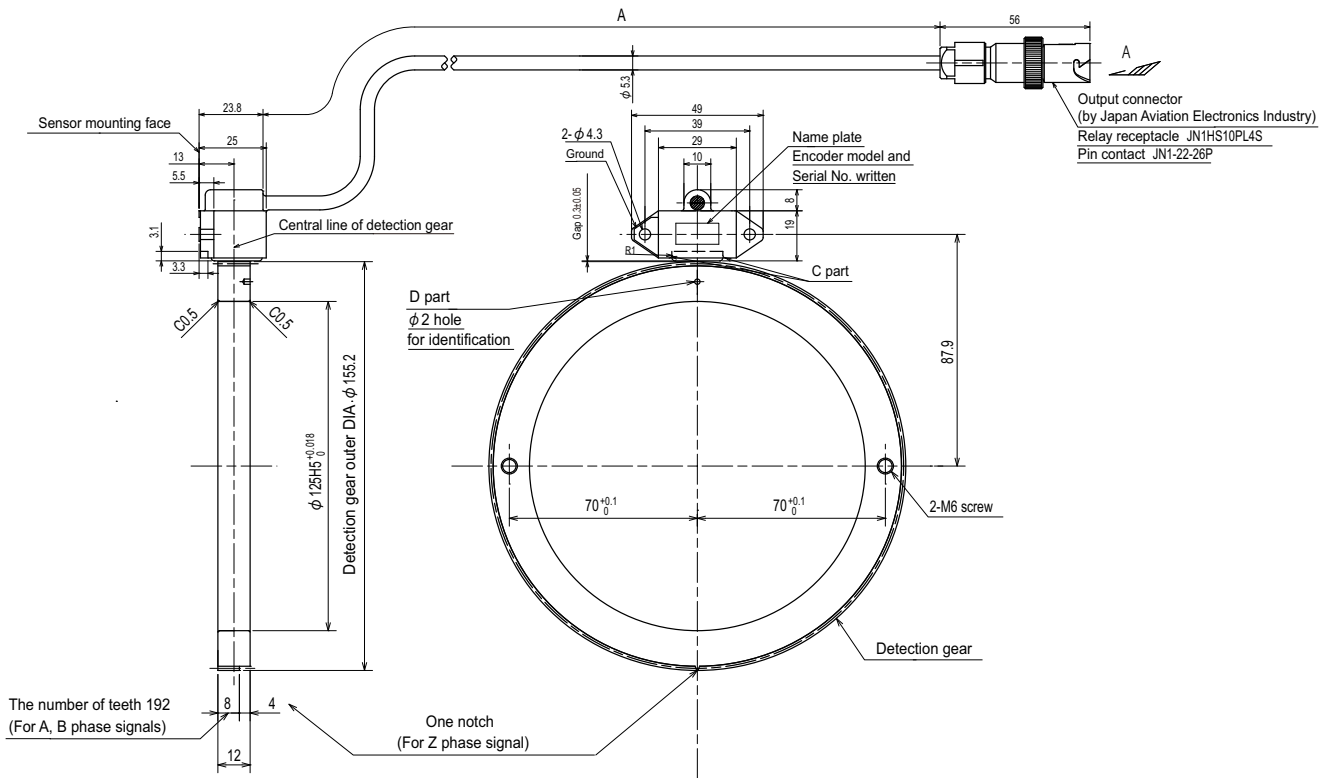
Encoder mounting face of machine side

Sensor		Lead-out direction of lead	Detection gear
Parts name	Lead wire length A [mm]		Parts name
TS5690N1917	400±10	Axis direction	MU1606N203
TS5690N1927	800±20		
TS5690N1937	1200±20		
TS5690N1947	1600±30		
TS5690N1957	2000±30		

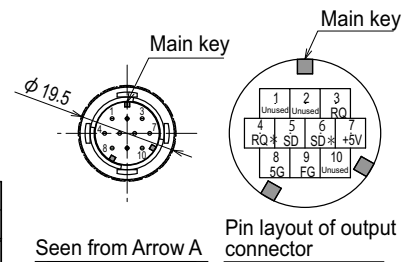


< TS5690N19x8 + MU1606N203 >

[Unit: mm]



Encoder mounting face of machine side

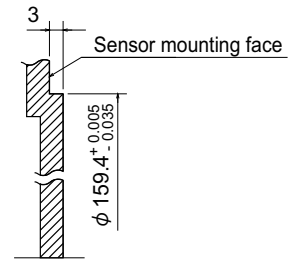
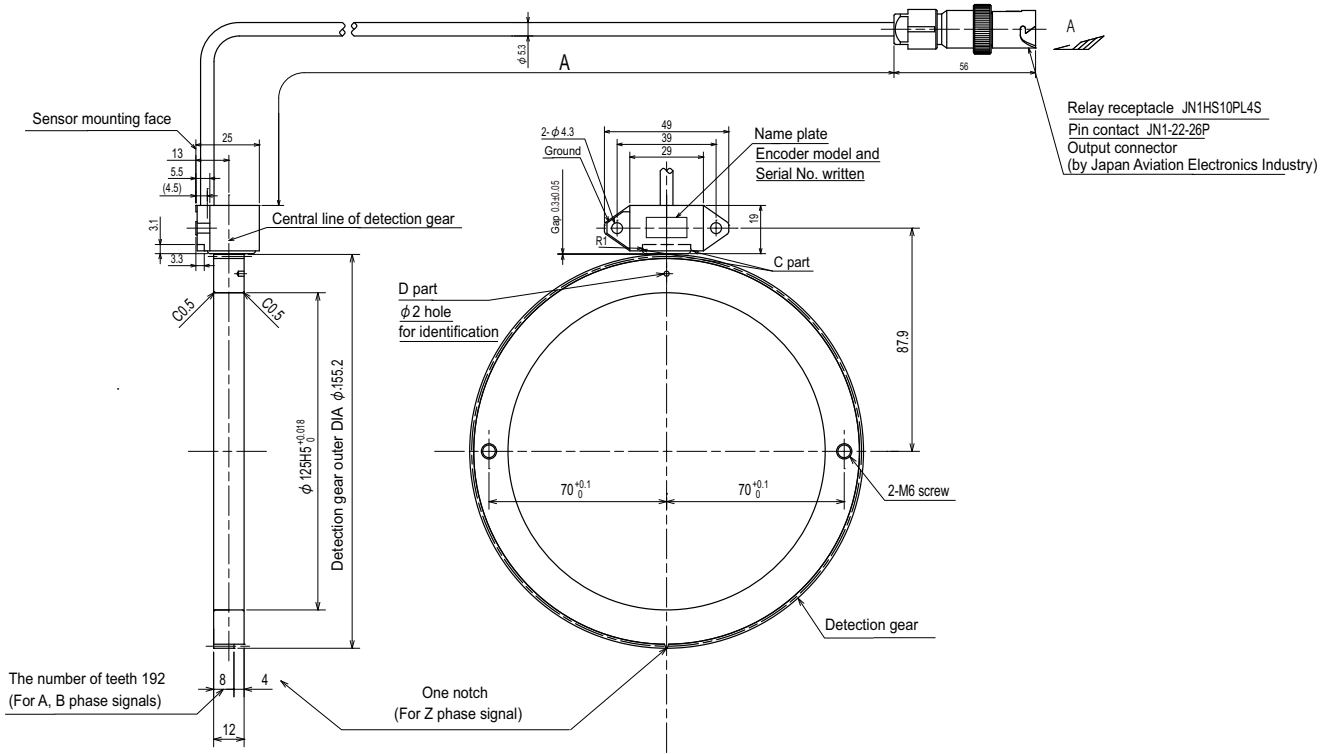


Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N1918	400±10	Axis direction	MU1606N203
TS5690N1928	800±20		
TS5690N1938	1200±20		
TS5690N1948	1600±30		
TS5690N1958	2000±30		

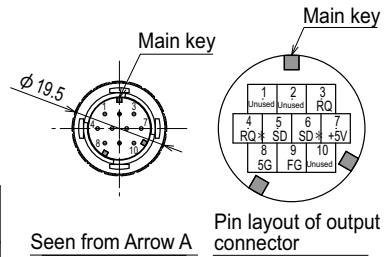
2 Specifications

< TS5690N19x9 + MU1606N203 >

[Unit: mm]



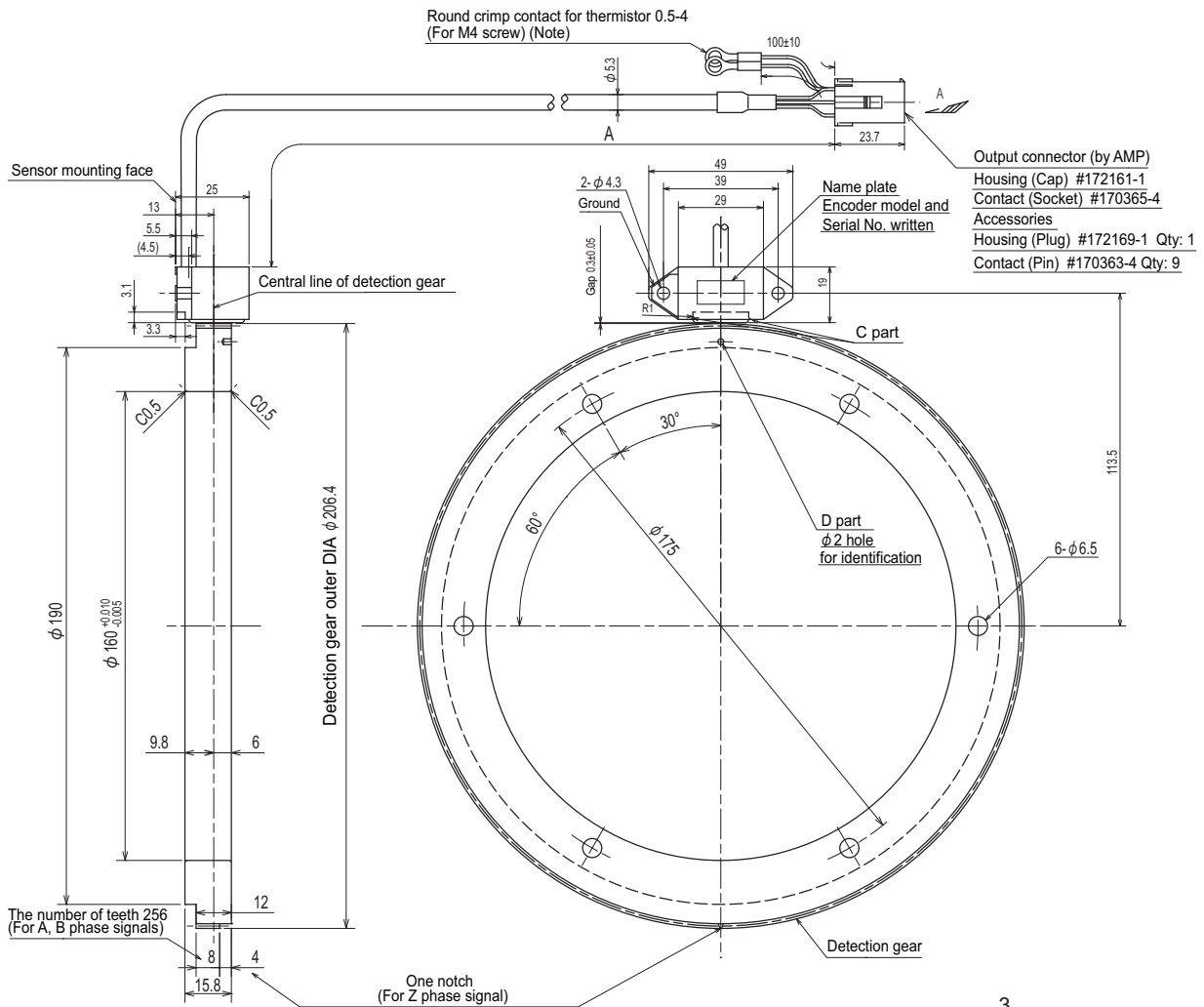
Encoder mounting face of machine side



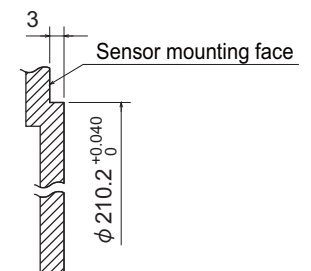
Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N1919	400±10	Vertical direction	MU1606N203
TS5690N1929	800±20		
TS5690N1939	1200±20		
TS5690N1949	1600±30		
TS5690N1959	2000±30		

< TS5690N25x2 + MU1606N802 >

[Unit: mm]

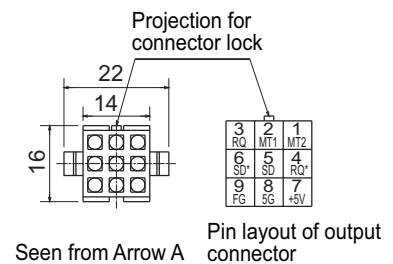


(Note) The thermistor contact is not used when the encoder is used as a spindle side encoder.
Insulate the terminal.



Encoder mounting face of machine side

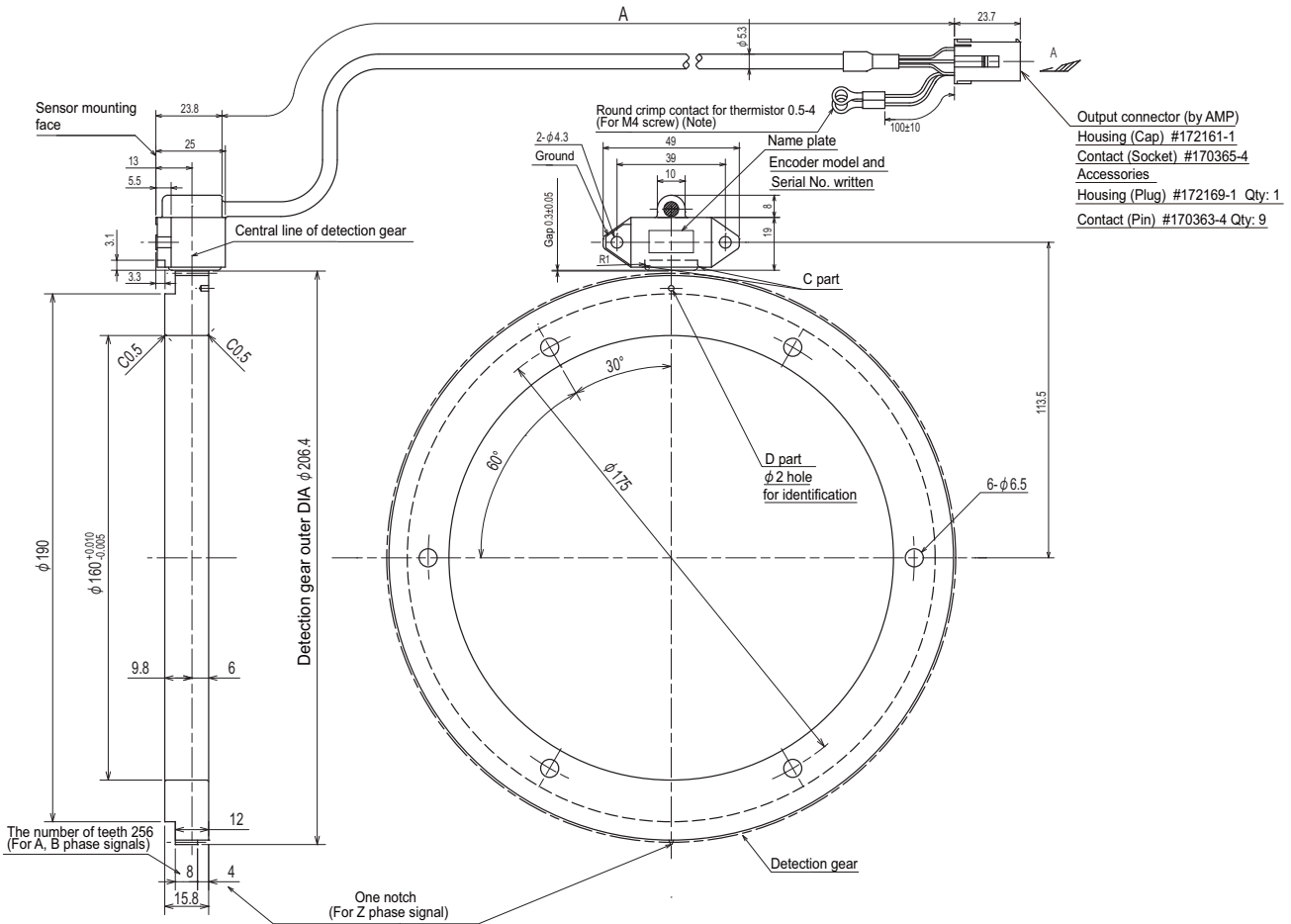
Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N2512	400±10	Vertical direction	MU1606N802
TS5690N2522	800±20		
TS5690N2532	1200±20		
TS5690N2542	1600±30		
TS5690N2552	2000±30		



2 Specifications

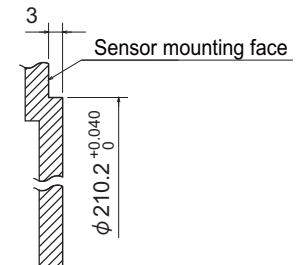
< TS5690N25x7 + MU1606N802 >

[Unit: mm]



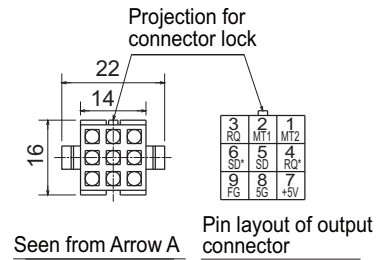
- Output connector (by AMP)
- Housing (Cap) #172161-1
- Contact (Socket) #170365-4
- Accessories
- Housing (Plug) #172169-1 Qty: 1
- Contact (Pin) #170363-4 Qty: 9

(Note) The thermistor contact is not used when the encoder is used as a spindle side encoder. Insulate the terminal.



Encoder mounting face of machine side

Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N2517	400±10	Axis direction	MU1606N802
TS5690N2527	800±20		
TS5690N2537	1200±20		
TS5690N2547	1600±30		
TS5690N2557	2000±30		

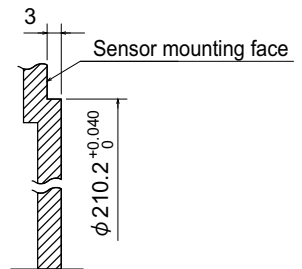
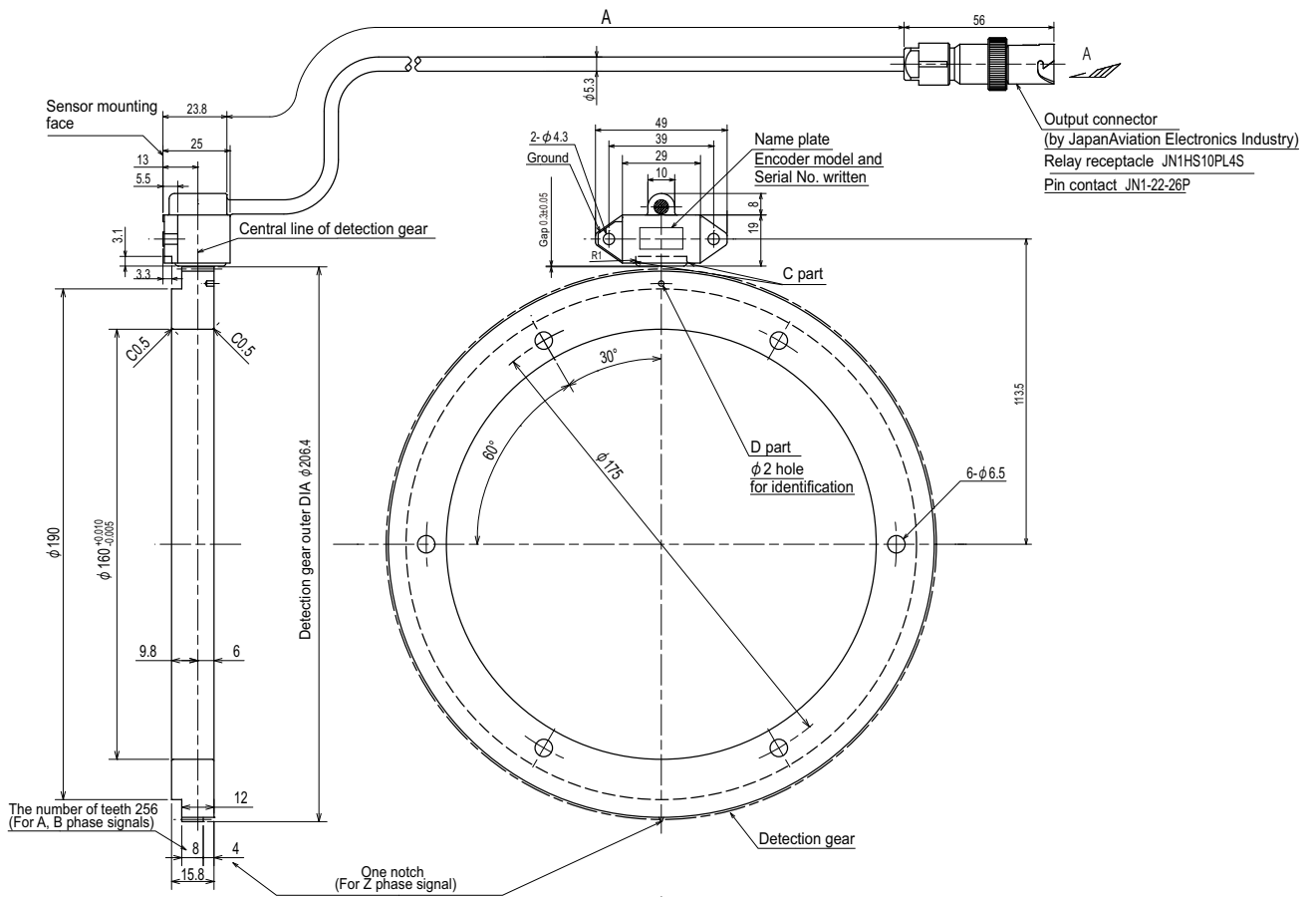


Seen from Arrow A

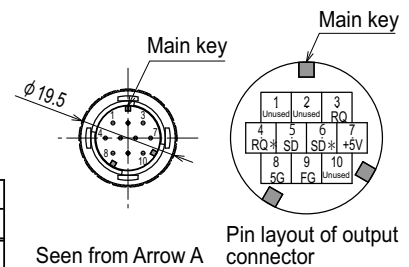
Pin layout of output connector

< TS5690N25x8 + MU1606N802 >

[Unit: mm]



Encoder mounting face of machine side



Seen from Arrow A

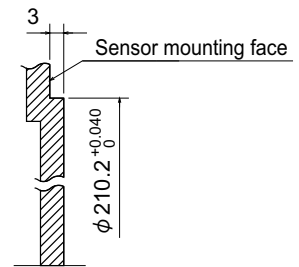
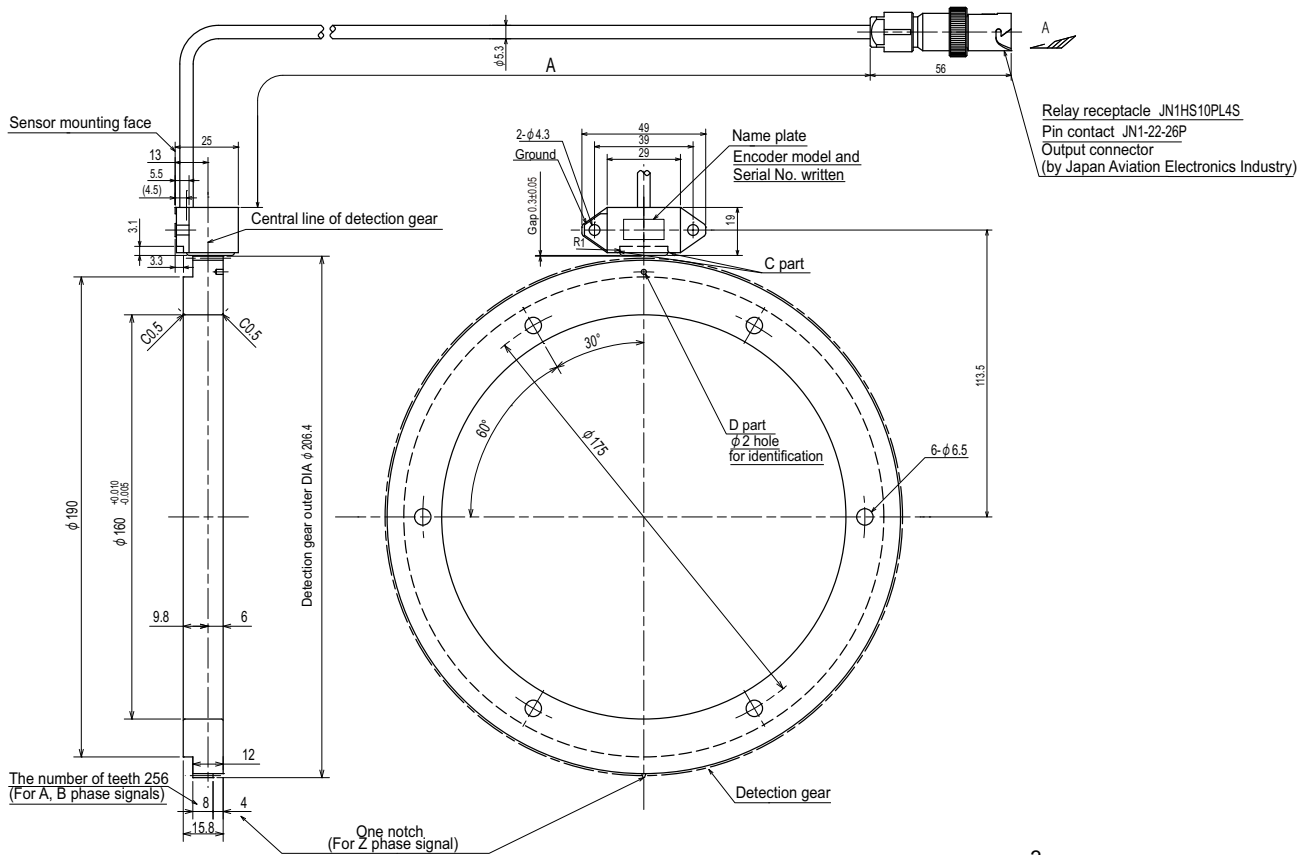
Pin layout of output connector

Sensor		Lead-out direction of lead	Detection gear
Parts name	Lead wire length A [mm]		Parts name
TS5690N2518	400±10	Axis direction	MU1606N802
TS5690N2528	800±20		
TS5690N2538	1200±20		
TS5690N2548	1600±30		
TS5690N2558	2000±30		

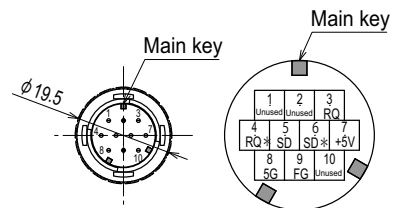
2 Specifications

< TS5690N25x9 + MU1606N802 >

[Unit: mm]



Encoder mounting face of machine side



Seen from Arrow A

Pin layout of output connector

Sensor			Detection gear
Parts name	Lead wire length A [mm]	Lead-out direction of lead	Parts name
TS5690N2519	400±10	Vertical direction	MU1606N802
TS5690N2529	800±20		
TS5690N2539	1200±20		
TS5690N2549	1600±30		
TS5690N2559	2000±30		

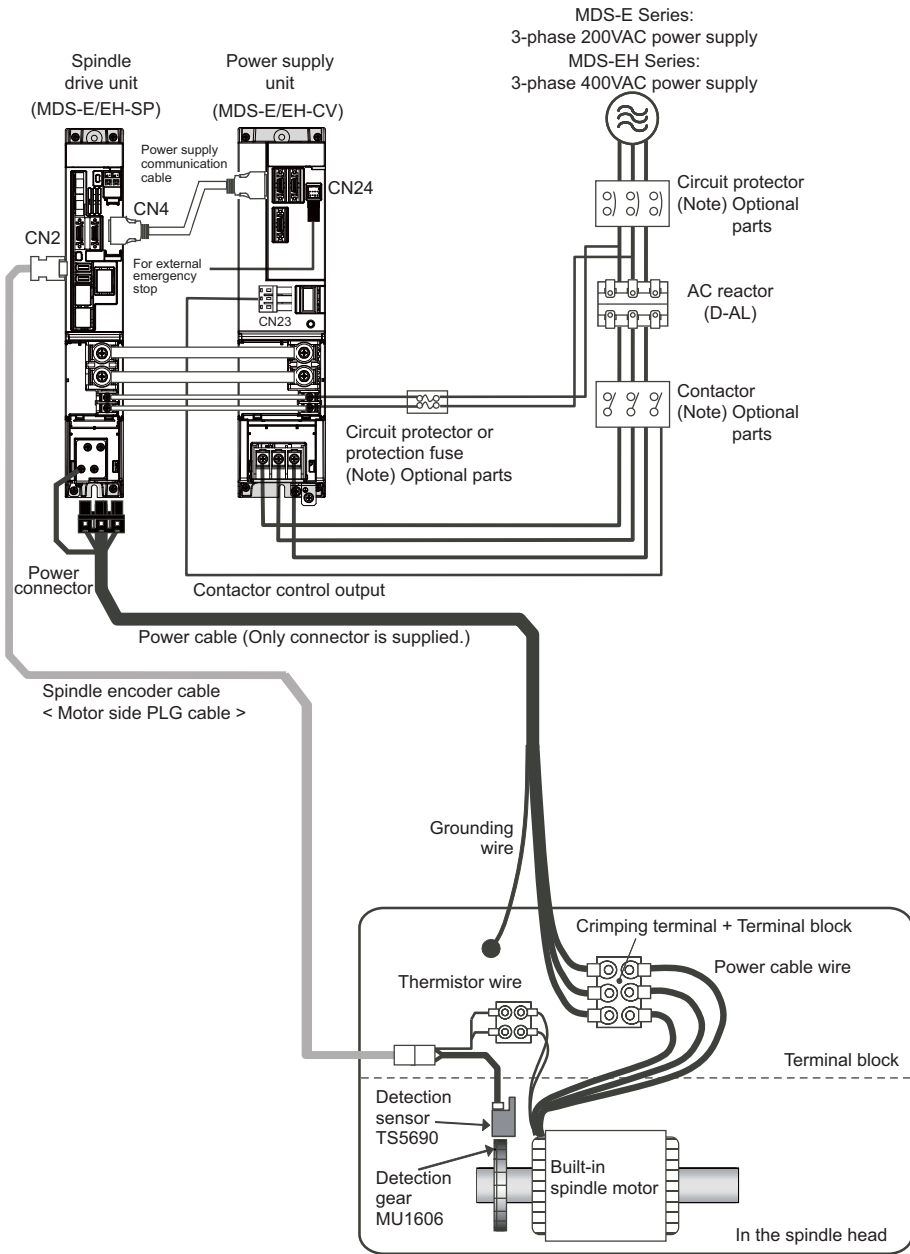
Dedicated Options

3.1 Cables and Connectors

3.1.1 Cable Connection Diagram

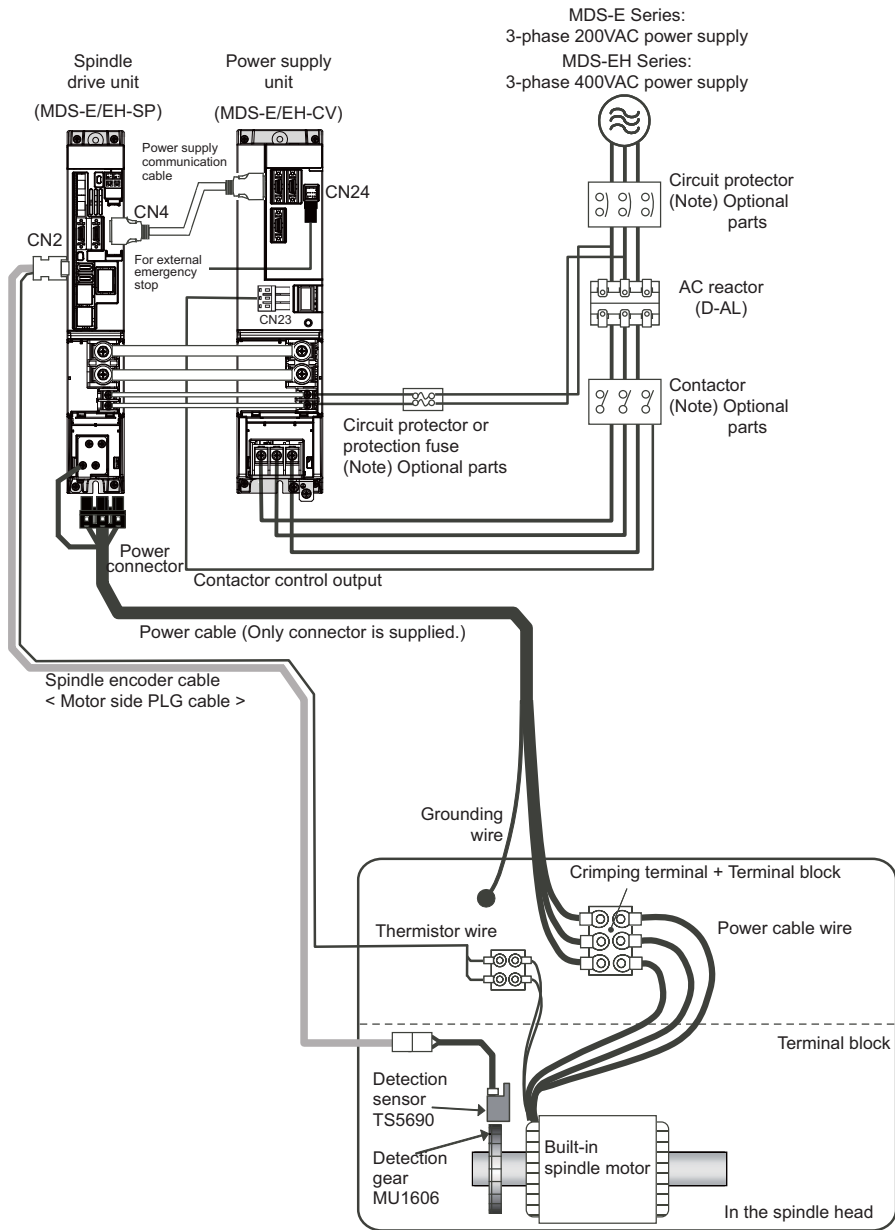
The cables and connectors that can be ordered from Mitsubishi Electric Corp. as option parts are shown below. Cables can only be ordered in the designated lengths. Purchase a connector set, etc., to create special length cables.

< Standard connector specifications >



*The wiring is an example.

< Waterproof connector specifications >

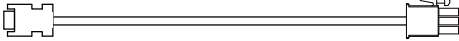





*The wiring is an example.

*Lead the thermistor wire from CN2 connector side.

3.1.2 List of Cables and Connectors

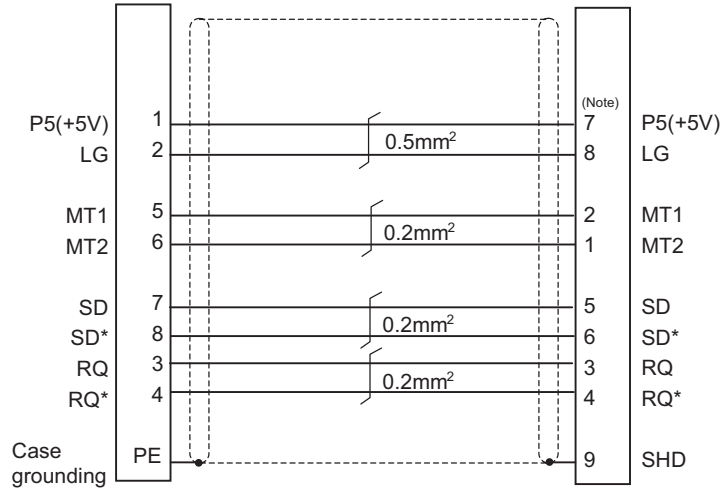
< Spindle encoder cable and connector >

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 (MOLEX) Connector set : 54599-1019	Spindle motor side connector (Tyco Electronics) Connector : 172169-1 Contact :170363-1(AWG26-22) 170364-1(AWG22-18) 
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) 
	Motor side PLG waterproof specification connector Spindle side accuracy encoder TS5690 connector 		Spindle motor side connector (Japan Aviation Electronics Industry) Connector : JN1DS10SL1 Contact :JN1-22-22S-PKG100(AWG21-25) JN1-22-20S-R-PKG100(AWG20-21) 
For CN2	Spindle encoder drive unit side connector CNU2S(AWG18)	Spindle drive unit side connector (3M) Receptacle : 36210-0100PL Shell kit : 36310-3200-008 (MOLEX) Connector set : 54599-1019	

< CNP2E-1 cable connection diagram >

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

Spindle motor side connector
(Tyco Electronics)
Connector: 172169-1
Contact: 170363-1(AWG26-22)
170364-1(AWG22-18)

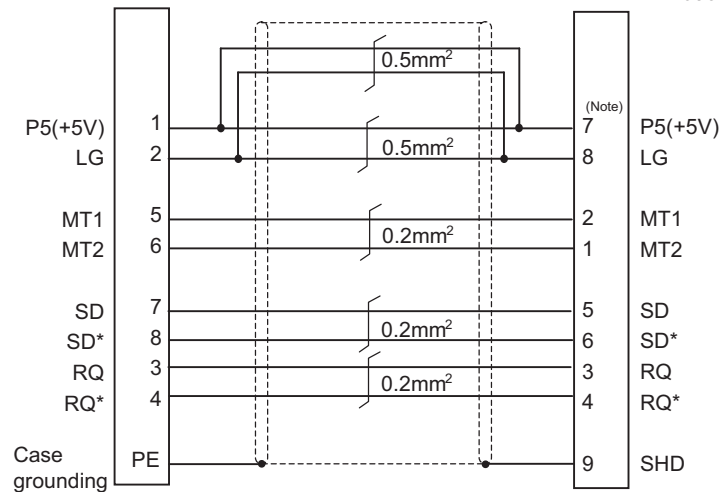


(Note) For the pin "7" or "8", use the contact "170364-1".
For the other pins, use the contact "170363-1".

< For 15m or less >

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

Spindle motor side connector
(Tyco Electronics)
Connector: 172169-1
Contact: 170363-1(AWG26-22)
170364-1(AWG22-18)



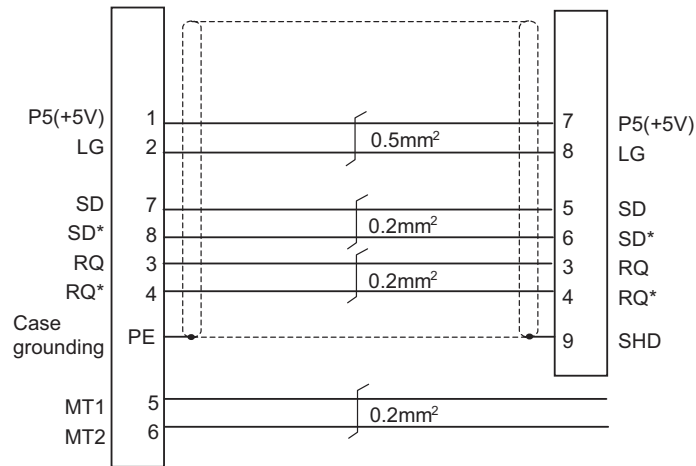
(Note) For the pin "7" or "8", use the contact "170364-1".
For the other pins, use the contact "170363-1".

< For 15m to 30m >

< Waterproof connector specification cable connection diagram >

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

Spindle motor side connector
 (Japan Aviation Electronics Industry)
 Connector: JN1DS10SL1
 Contact: JN1-22-22S-PKG100(AWG21-25)
 JN1-22-20S-R-PKG100(AWG20-21)

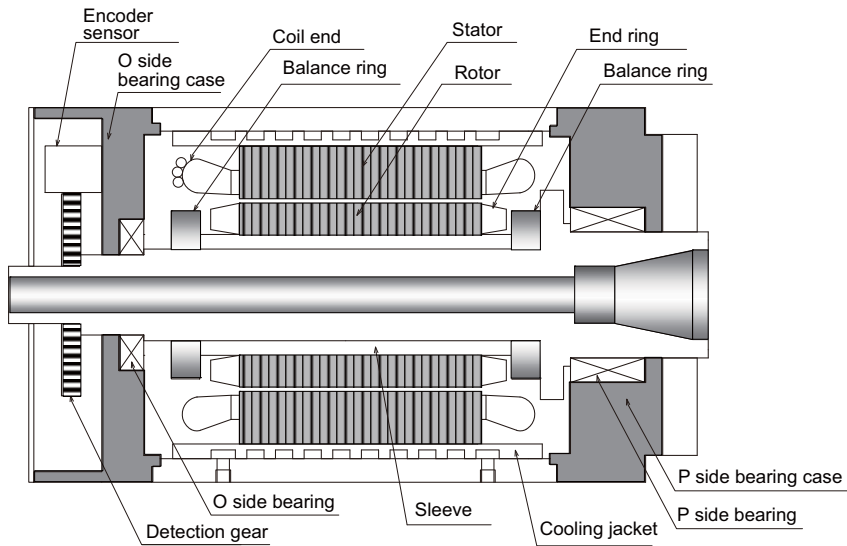


4

Assembly and Installation

4.1 Motor Structure

< Example of finished built-in motor assembly >



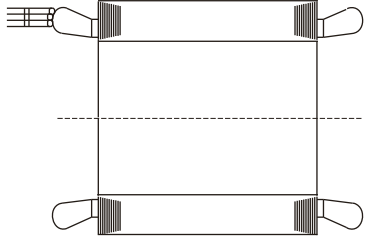
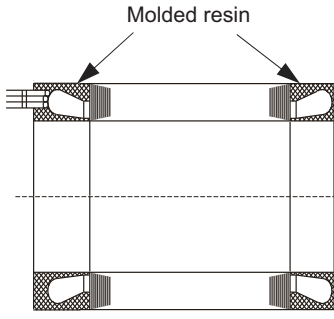
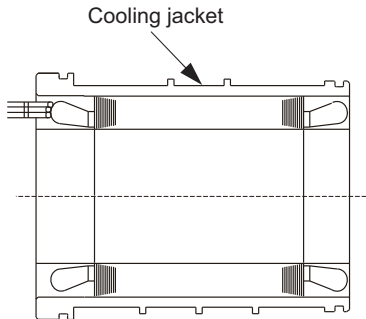
CAUTION

1. This chapter describes for the motors listed in the specifications list in chapter 2. Please contact your Mitsubishi Electric dealer for the special products.
2. Install a cooling jacket around the stator and use fluid cooling (oil cooling).
Refer to the specifications list for the cooling condition.
3. Create a structure that will prevent cutting powder, water, oil, or mist, etc. from entering the motor. Take care not to allow foreign matters to stick to it during assembly.
4. Attach a seal or drain so that lubricating oil or refrigerant does not contact the stator coil ends.
5. Create a structure that will prevent foreign materials from entering the encoder sensor section or encoder gears. Make sure that the structure allows replacement.
6. Chamfer or round the corners so that the lead wires from the stator are not damaged by the inlet edges.
7. Make sure that the bending radius for the lead wire is four times or more of the lead wire diameter.
8. The lead wire of the motor is not a movable cable. Do not connect to the moving part.
Fix the wire so that it does not move.
9. Take care not to apply strong impacts to the motor during transportation, storage, and assembly.

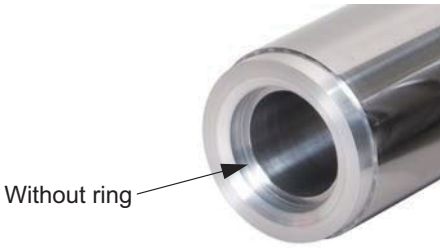
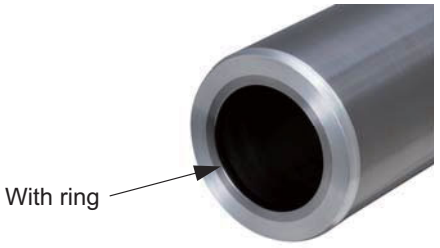
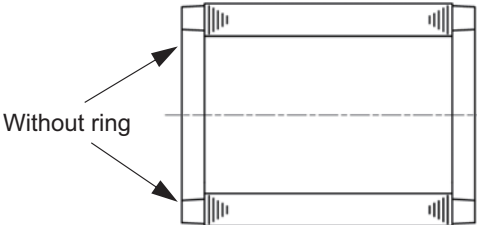
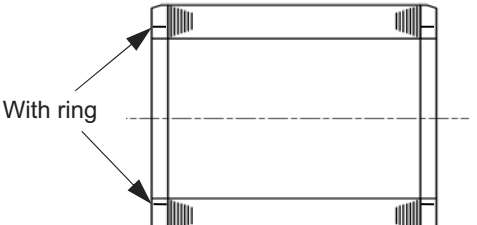
< Type of stator and rotor >

Perform the assembly procedure for the applicable stator and rotor. For detailed assembly procedure and cautions for handling, refer to "4.2 Stator Assembly" and "4.3 Rotor Assembly of IM motor (BG Series)" for IM motor (BG Series), and "4.2 Stator Assembly" and "4.5 Precautions for Handling Built-in SPM Spindle Motor (BGS Series)" for SPM spindle motor (SJ-BGS Series).

Stator specifications

Specifications	Varnish	Mold	With cooling jacket
Stator diagram			
Stator assembly procedure	Shrink fitting the stator and cooling jacket ↓ Finishing machining ↓ Checking insulation and coil resistance ↓ Completed		-

Rotor specifications

Specifications	Normal	High-speed
Rotor appearance		
Rotor diagram		
Rotor assembly procedure	Shrink fitting the rotor and shaft (sleeve) ↓ Adjusting (finish machining) the outer diameter of the rotor ↓ Balancing ↓ Completed	Machining the rotor's inner diameter ↓ Shrink fitting the rotor and shaft (sleeve) ↓ Adjusting (finish machining) the outer diameter of the rotor ↓ Balancing ↓ Completed

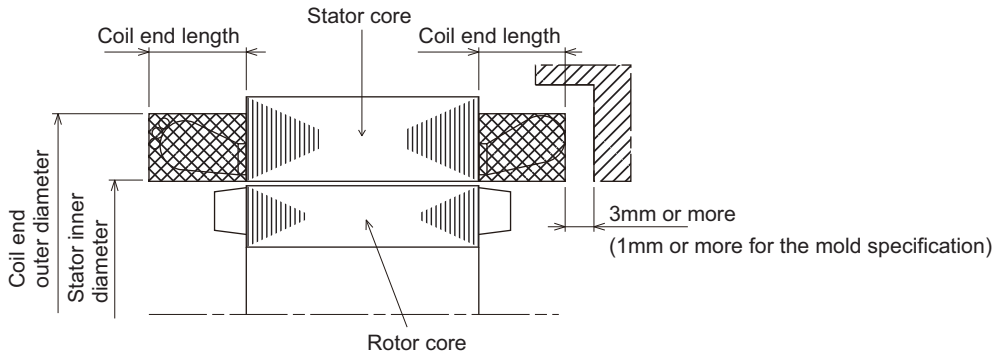
< Position relation of the motor in the spindle >

(1) Ensuring the space for the stator coil end

The coil end dimensions are as shown in the outline dimension drawing but the minimum value of the coil end inner diameter must take the stator inner diameter into consideration. The coil end is made of a congregation of coil ends, so there may be an inconsistency in the shape and dimensions. Leave at least 3mm between the structure and the coil end assuming that the coil end might exist in the areas indicated with cross-lines in the diagram below.

For the mold specification, leave at least 1mm between the structure and the mold surface.

When the space dimension is specified in the outline dimension drawings, leave the specified space. Make sure to check the outline dimension drawings when designing the structure.



(2) Relative position of the stator and rotor

Make sure that the deviation in the axis direction between the stator and the rotor is $\pm 2\text{mm}$ or less based on the core end. If the core width is less than 100mm, it must be $\pm 2\%$ or less of the core width.

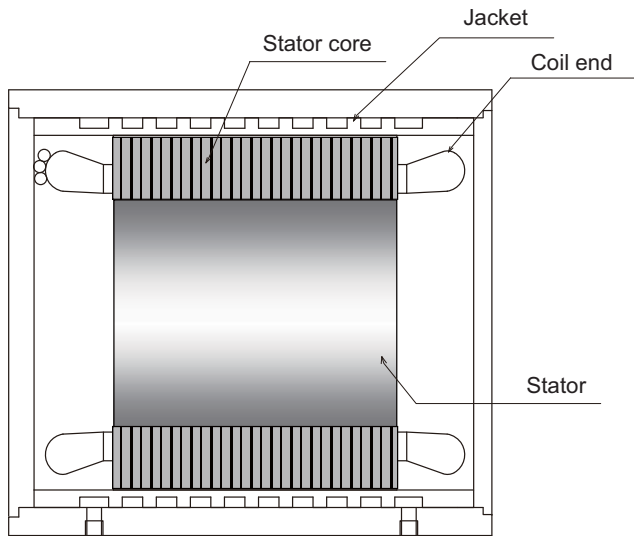
(Note) Design the rotor taking the swell into consideration because the inner diameter side of the normal specification rotor end is swelled from 0.5 to 1.0mm.

Refer to "Rotor Assembly" for details of the dimensions.

Keep the gap between the stator and rotor within $\pm 5\%$ of the specified gap described on the outline dimension drawings.

4.2 Stator Assembly

< Example of finished stator assembly >



[Stator assembly procedure]

Shrink fitting the stator and cooling jacket



Finishing machining



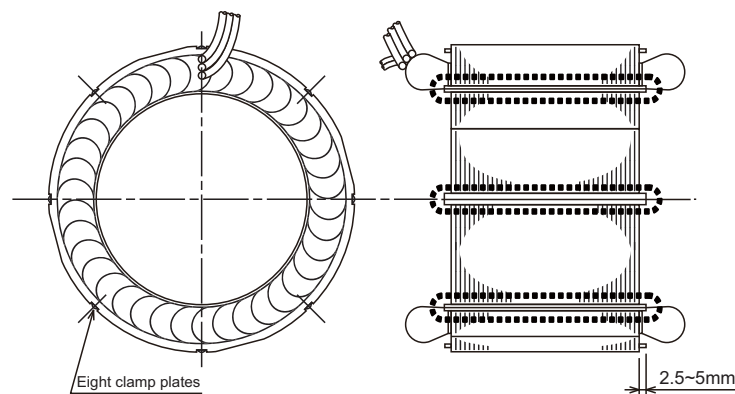
Checking insulation and coil resistance



Completed

⚠ CAUTION

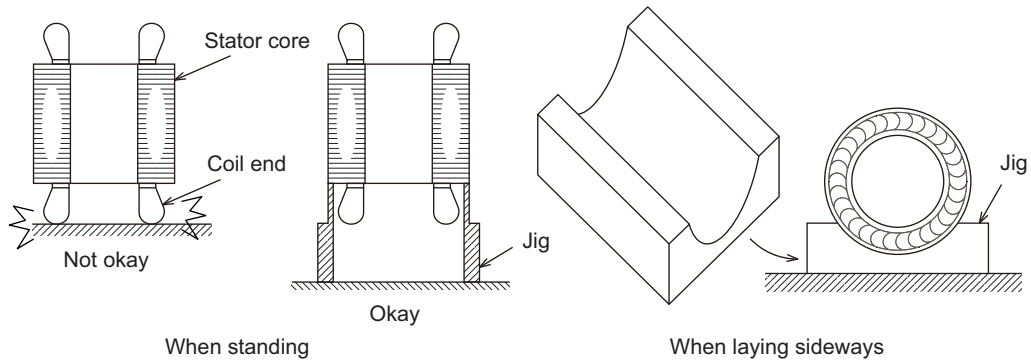
1. An insulation defect may occur if metallic dusts stick to the coil end, or if there are bumps or scratches on the coil end.
2. Prepare a cylindrical jig when pressing the stator into the cooling jacket. Press the stator core end, and never press the coil end. Do not apply excessive shocks to the stator that is not assembled.
3. The cylindrical surface may have undulation or curve as the stator core is composed of layered steel. However, after assembling, the stator will fit to the jacket diameter and it will be resolved.
4. Some stators are caulked with clamp plates, and the clamp plates will protrude as shown below. When contacting a jig or spindle configuration components to the stator end surface, create the shape that avoids the clamp plates.
5. Refer to each outline dimension drawing for detail dimension.



(1) Stationary and storage of the stator

Do not place the stator directly onto a table or the floor, but use jigs as shown below to prevent breakage of the coil ends. Place the stator sideways when possible, and do not stack more than three layers.

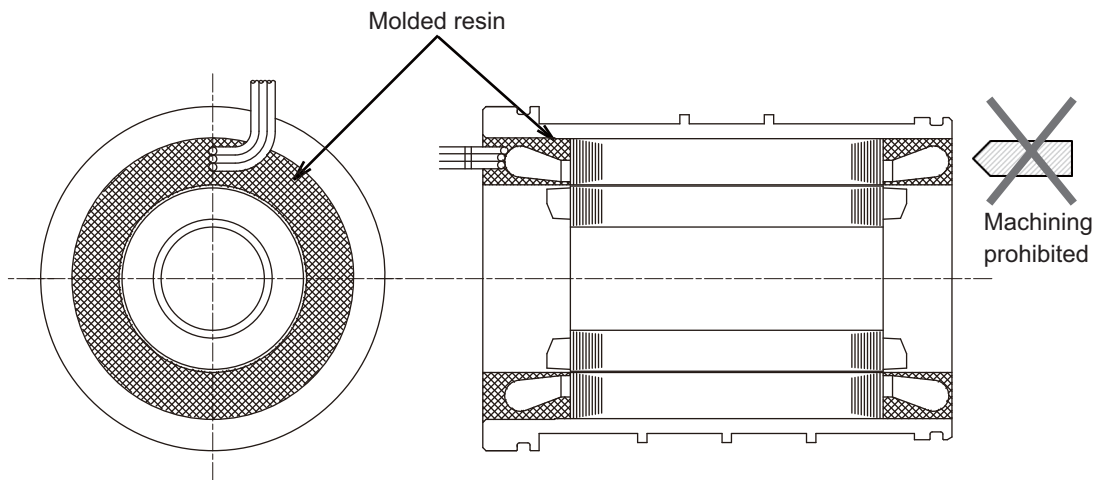
Do not apply a load by holding the coil end to lift the stator.



< When the coil ends are molded by resin >

The coil ends of some models are molded by resin but a resin itself is low in strength. Handle these stators in the same way as the one which is not molded, and do not apply excessive shocks or loads to the molded resin sections. Do not place the stator directly onto a table, but use jigs for stationary and storage.

Take care so that water or oils do not contact the stator because it does not have a waterproof and oil-proof structure. Never carry out a hole drilling on the resin part. An insulation defect may occur.



Stator of mold specification

(2) Cooling jacket fit dimension

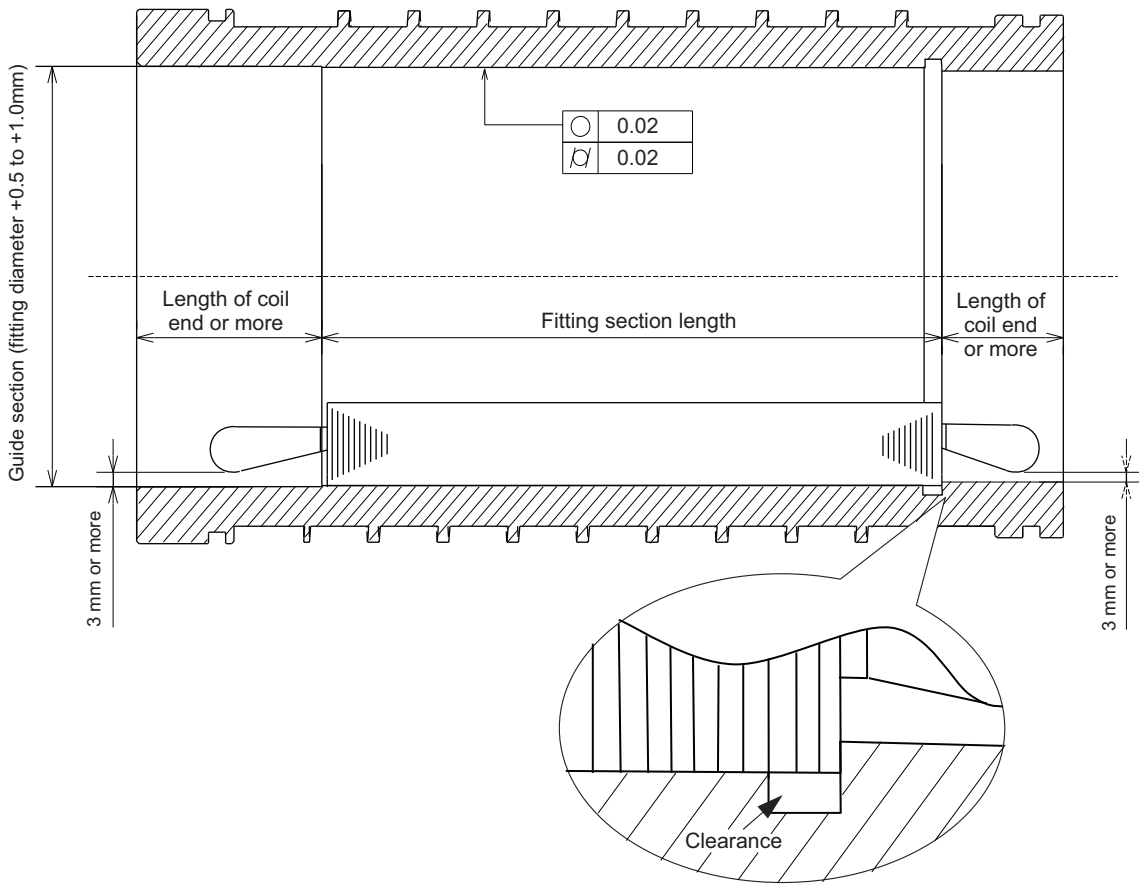
< Recommended fit dimension >

Securely carrying out interference-fitting to match the stator and cooling jacket. The recommended values for the interference are given below.

The inner diameter of the cooling jacket may deform after shrink-fitting. Machining the jacket outer diameter after shrink fitting is recommended. When machining the jacket outer diameter after assembling the stator onto the jacket, cover the coil ends with tape, etc., so that the cutting chips do not adhere onto the coil. Any chips on the coil will cause defective insulation.

Match the size of the jacket inner diameter according to the stator outer diameter with setting the lower limit of the interference to prevent the deformation of the jacket outer diameter.

To improve workability, it is recommended that a push-in guide section that is 0.5-1mm larger than the housing diameter be created. Create a clearance on the cooling jacket when creating the push-in guide section.



Cooling jacket reference dimension

Symbol of stator outline	Recommended interference
90	0.01 to 0.07
110	0.01 to 0.07
120	0.01 to 0.075
135	0.01 to 0.075
150	0.01 to 0.075
160	0.01 to 0.075
180	0.14 to 0.124
240	0.15 to 0.095
300	0.35 to 0.120

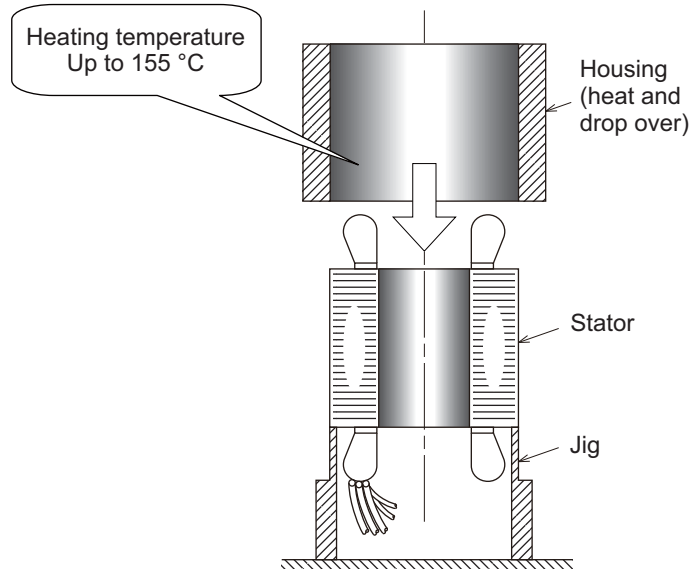
When the interference is specified in the outline dimension drawings, fit the cooling jacket with the specified interference.

(Note 1) The position of the axis direction is determined by butting the step in this diagram, but if a step is not created, determine the position with a pushing jig, etc.

(Note 2) Set the dimension so that the finished size of the fitting section is longer than the core length.

(3) Installation to the cooling jacket

1. An example of shrink fitting the jacket to the stator is shown below. Hold the stator lower side with a jig so that the coil end is not damaged.
2. Evenly heat the jacket with an electric furnace, and when using an oil vat, use insulating oil. The jacket has a small heat capacity and easily cools down, so carry out the operation swiftly.
3. The jacket heating temperature should be up to 155 °C.
4. If the stator and jacket are shrink fit assembled, it may be difficult to disassemble.
Confirm the depth of the axis direction and position of the lead wire inlets before assembly.



< Example of stator shrink fitting jig >

(4) Checking for each resistance value

Check the following items after assembling the stator.

- (a) Insulation resistivity 10M or higher at room temperature (use a 500V insulation resistance tester at 20°C)
- (b) Dielectric strength AC1500V/min. (at 20°C)
- (c) Stator coil resistance (described in each rating table at 20°C)
- (d) Thermistor zero-power resistance 7.8kΩ to 13.1kΩ (at 25°C)

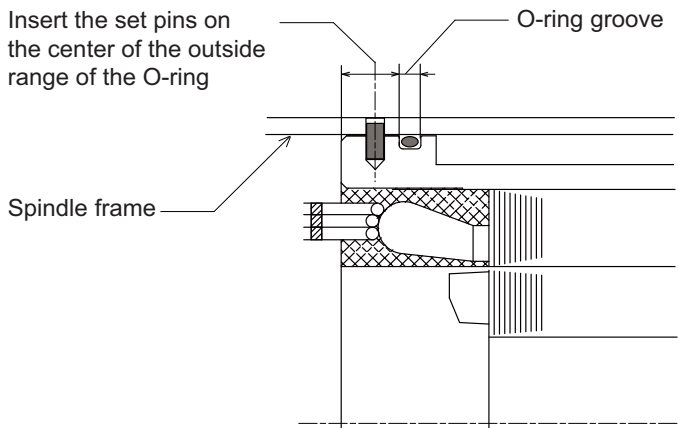
When measuring the stator coil resistivity, use a milli-ohm meter that has 10mΩ or less measurement range.

The coil resistivity is low at 1 or less, so the measurement error will be large if there is a contact resistivity, etc., in the measurement circuit. If a solderless terminal is installed on the motor power line, a contact resistance may occur due to the oxidized film on the solderless terminal surface. To remove the oxidized film, hold the terminal with a clip of the milli-ohm meter, and move the clip to right and left two to three times before measuring.

< Stator with a cooling jacket >

For the motor with a cooling jacket, the outline of the fitting section is h7 finishing.

Use the fitting dimension H6 for the machine side structural part to assemble. After assembling the parts, insert the set pins on the outer side of the O-ring groove as a stopper. (Refer to the outline dimension drawing for detail dimension.)



[O-ring recommended specifications]

- Standards: JIS B 2401 (For fixation)

- Material: Fluorocarbon rubber

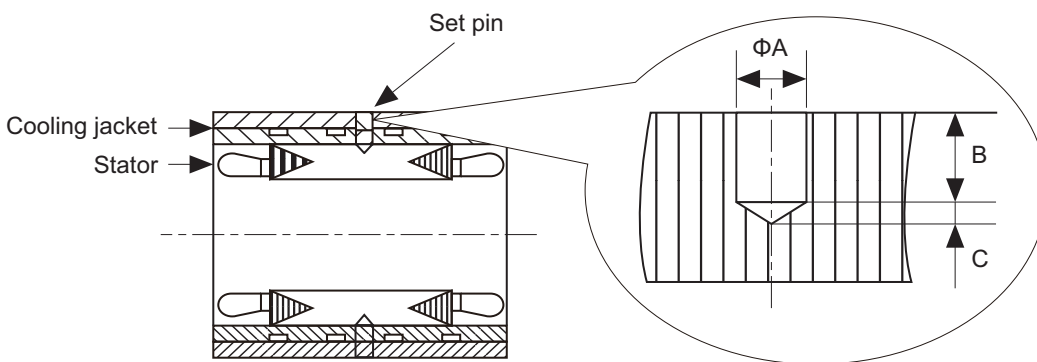
* Select the material which is suitable for the refrigerant to be used.

< Example of stopper machining for a cooling jacket >

< When recommended interference cannot be ensured in assembling the stator and cooling jacket >

If press fit is carried out because shrink-fitting is difficult for a cooling jacket, make sure to carry out interference-fitting and create a stopper with the set pins. Refer to the outline dimension drawing for the number of the set pins to be used. Unless otherwise specified, use one set pin.

The recommended set pin dimensions and machinable depth of the set holes are shown below. The stator coils may be damaged if the set holes are deeper than the dimensions given below.



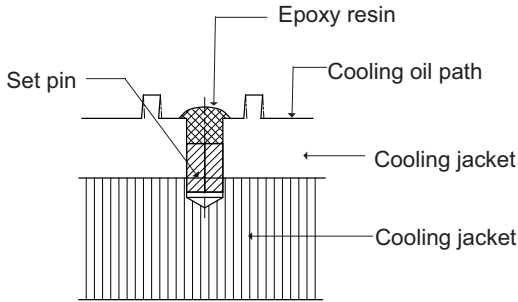
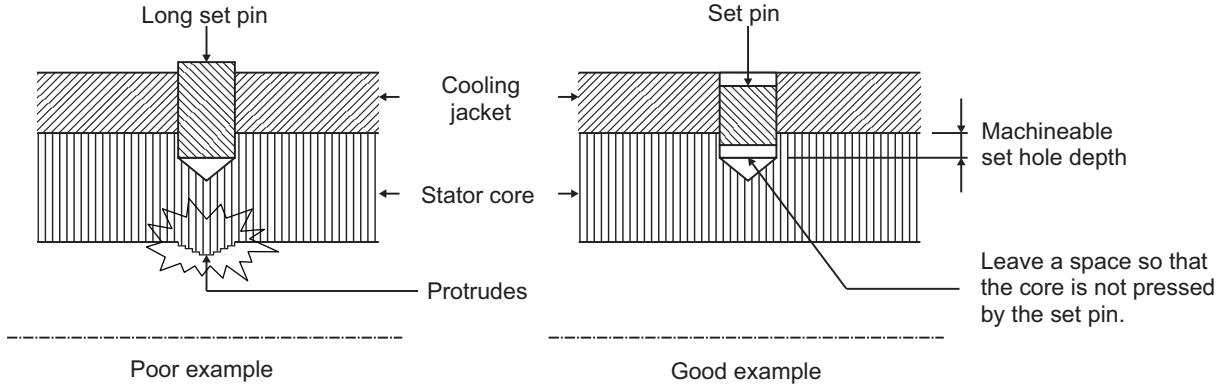
Symbol of stator outline	Set pin outer diameter ϕA [mm]	Machinable depth of set holes B [mm]	Drilling depth C [mm]
90	Shrink fit the stator to the housing,		
110	$\phi 8$	3	2.3
120	$\phi 8$	3	2.3
135	$\phi 8$	5.5	2.3
150	$\phi 8$	5.5	2.3
160	$\phi 8$	5.5	2.3
180	$\phi 8 \times 2$	5.5	2.3
240	$\phi 10 \times 2$	8	2.9
300	$\phi 10 \times 2$	10	2.9

When the set pin outer diameter and machinable depth of set holes are specified in the outline dimension drawings, assemble the stator and cooling jacket using the specified dimensions.

< Installation of the set pin >

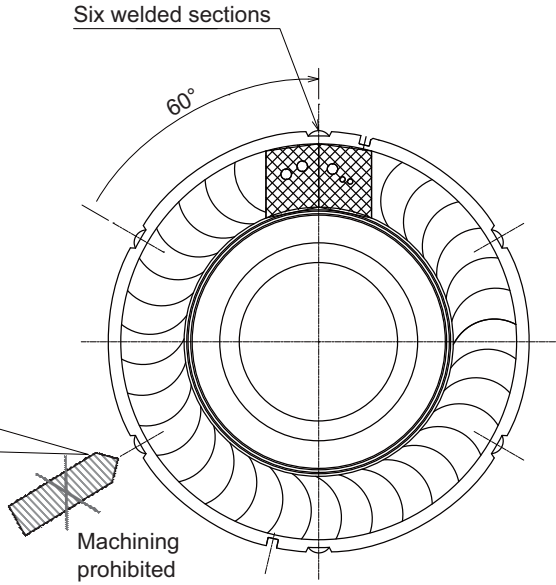
Avoid inserting the set pin into the welded section on the circumference of the stator core, the clamp section or groove section. Insert the set pin near the center of the core width. Fill the top of the pin with epoxy resin after inserting the pins so that the cooling fluid will not leak out.

If pins that are too long are used or if excessive force is applied when inserting the pins, the layered steel plates inside the set pin may be deformed and project into the stator or may damage the coils.



< Example of enclosure structure by resin >

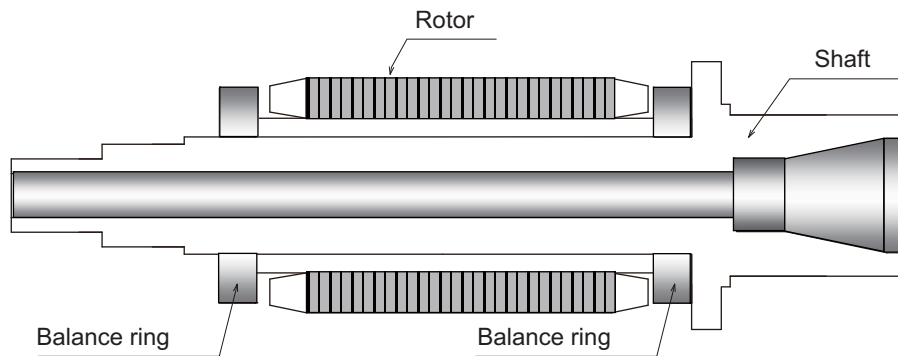
Machine the cylindrical surface avoiding the welded section or groove section.



< Hole machining prohibited section >

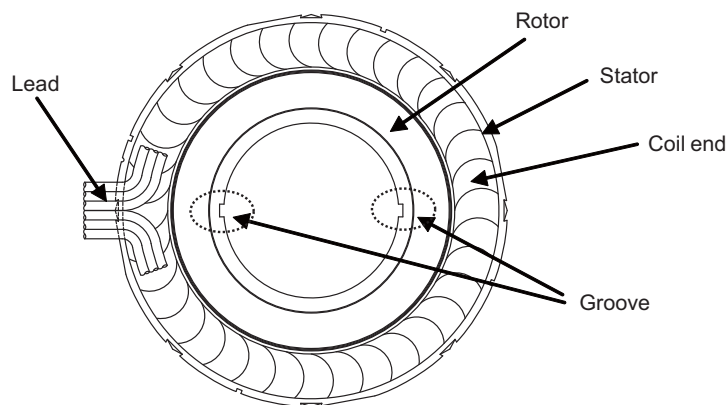
4.3 Rotor Assembly of IM motor (BG Series)

< Example of finished rotor assembly >



⚠ CAUTION

1. The rotor before shrink fitting is deformable, so take care not to apply strong impacts to it. Take care not to let foreign matters (metallic powder, etc.) enter the rotor before assembling.
2. The inner diameter and outer diameter may have an approximately 0.1mm curve as the rotor core is composed of layered steel. However, when the rotor is shrink fit, it will be resolved, so the dimensions noted in the outline dimension drawing can be used for the reference value of the rotor inner diameter.
3. Use a magnetic material such as carbon steel or alloy steel for the shaft material.
4. Some rotor types have a groove to be used as a guide when layering the steel plates, however, do not use this to fix the rotor.



Lead side outline dimension drawing

5. If the heating is improper or if uneven, trouble such as shrink fitting defect may occur.
6. The oils on the rotor may evaporate and generate a gas when the rotor is heated, so ventilate the area well.
7. Not cool rapidly but naturally after shrink fitting the rotor.
8. A slight strain may occur on the shaft from the rotor shrink fitting, so finish machine the parts that require precision after shrink fitting.
9. The rotor is symmetric in left and right.

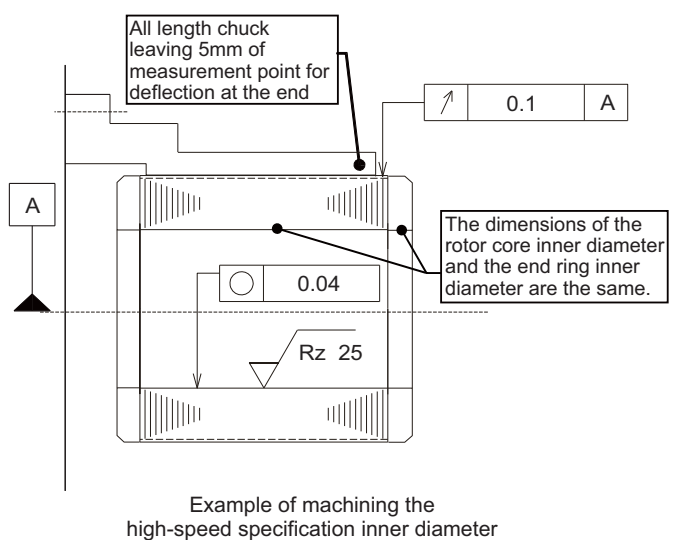
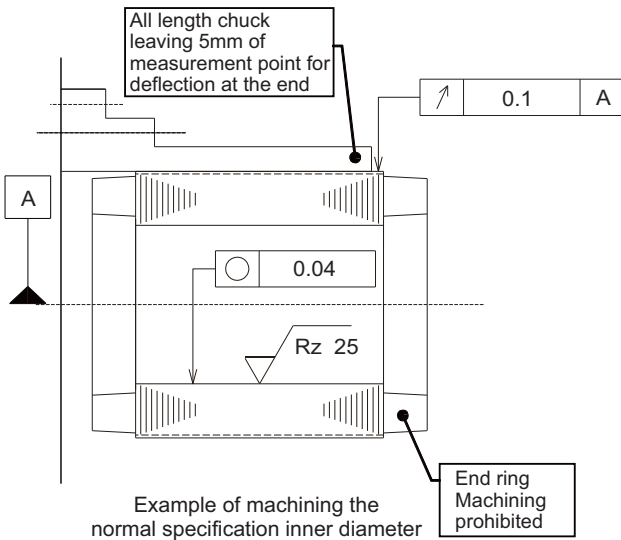
(1) Cutting machining of the rotor inner diameter

CAUTION

1. For normal specifications, normally the rotor inner diameter is manufactured and shipped according to the outline dimension drawing, however, if machining a rotor is required, observe the following precautions.
2. For high-speed specifications, observe the following precautions because machining a rotor inner diameter is required.
3. Refer to the outline dimension drawing for inner diameter dimensions after machining and recommended interference dimensions for inner diameter cutting.

< Precautions for machining the rotor inner diameter >

1. Prepare a jig which can support for all circumferences because the rotor core may deform due to a bend or shearing load since it has lamination steel structure (such as split sleeve or chuck long pawl). Machining with difficult conditions may cause the steel plates to deform or peel.
2. Dry machining should be used on the machining of the rotor's outer diameter to prevent corrosion of the steel or aluminum. If dielectric fluid must be used, use noncorrosive, and dry the part completely after machining.
3. Check the deflection at the end after chuck and perform the proper centering. To prevent the core deviation due to regripping, machine by one chuck.
4. If the centering is difficult for the rotor due to its own weight, machine with a vertical lathe, etc. without using a steady rest and the like.
5. Normal specifications: Do not machine the end ring (aluminum part). Do not apply a load such as chuck. High-speed specifications: Machine the rotor core inner diameter and the end ring inner diameter (excluding aluminum part) to be of the same dimension. Do not apply a load such as chuck to the end ring.



(2) Positioning of the normal specification shaft and the shape of the guide section

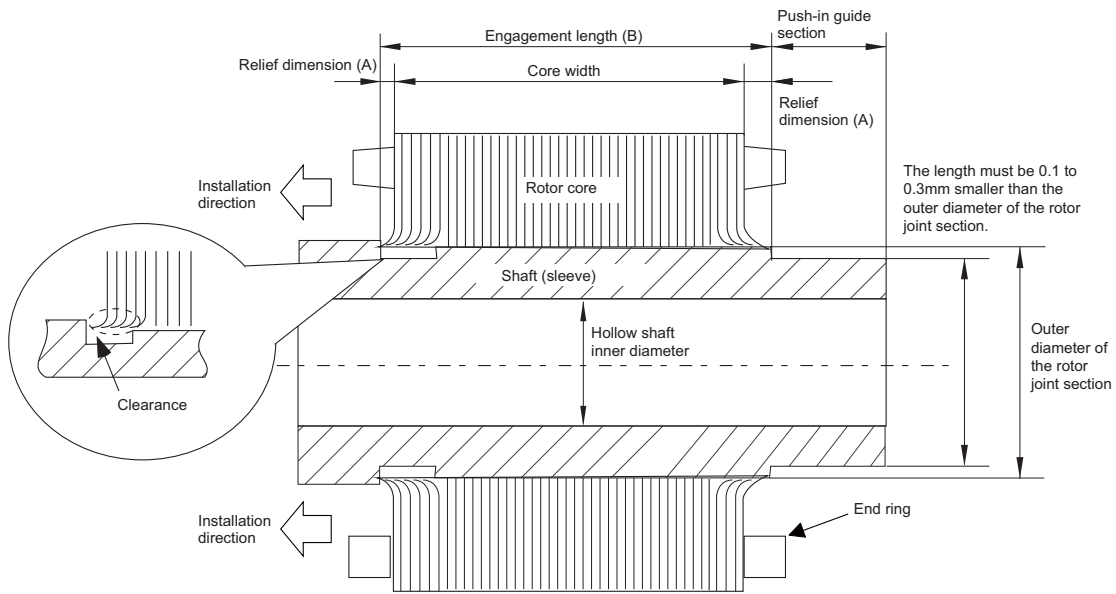
< When assembling the rotor directly to the shaft >

The inner diameter side of the both ends of the normal specification rotor core is swollen to the axis direction like the following diagram. When positioning the axis direction by butting etc., set the dimension including the swell amount. The following table shows the swell amount.

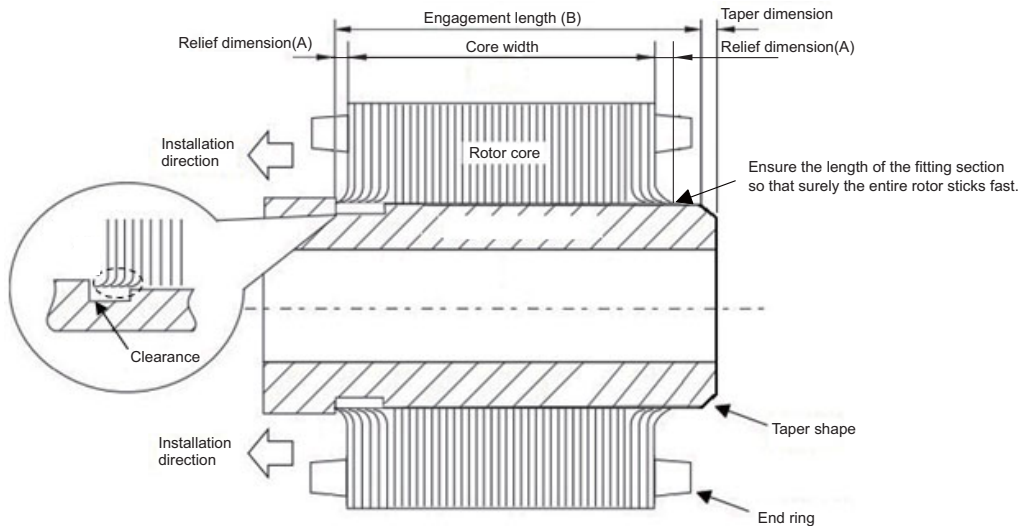
Create a clearance on the shaft (sleeve) so that the butting section does not contact with the core.

It is recommended that a push-in guide 0.1 to 0.3mm smaller than the outer diameter of the rotor fixing part or a taper about 15° to 30° be created on the shaft. If creating these shapes, ensure the length of the fitting section so that surely the entire rotor sticks fast.

< When a push-in guide is created >



< When a taper shape is created >



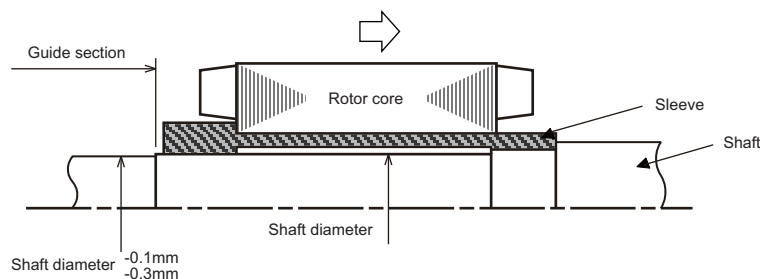
Symbol of stator outline	90	110	120	135	150	160	180	240	300
Relief dimension A [mm]	0.5							1	
Engagement length B [mm]	Core width +4 or more							Core width +6 or more	

< When a rotor sleeve is created >

Use a magnetic material such as carbon steel or alloy steel for the sleeve material.

Create a relief dimension or machining clearance for the positioning section on the sleeve side as with the shaft.

The recommended interference for the rotor and sleeve is the same as when shrink fitting the rotor to the shaft.



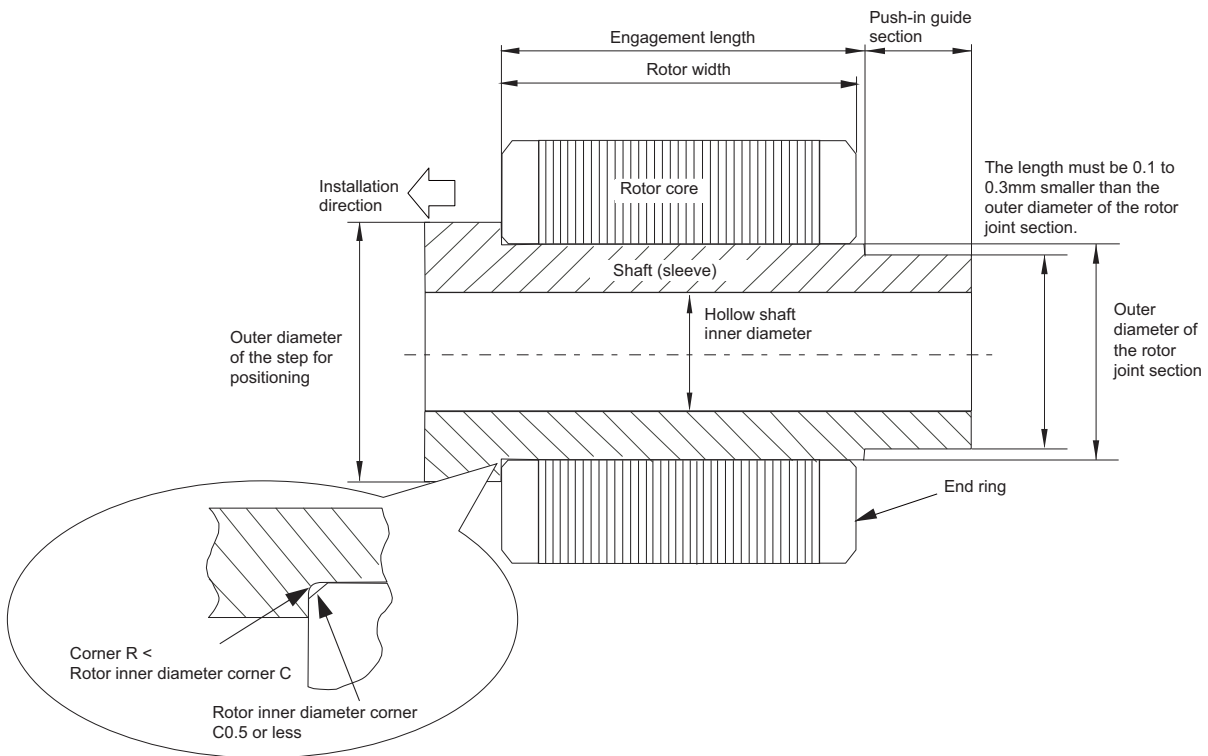
(3) Positioning of the high-speed specification shaft and the shape of the guide section

< When assembling the rotor directly to the shaft >

For the high-speed specification rotor, the end ring and the rotor core inner diameter have the same dimensions, and a ring is attached on the end ring inner diameter. When positioning the axis direction by butting etc., observe the following precautions.

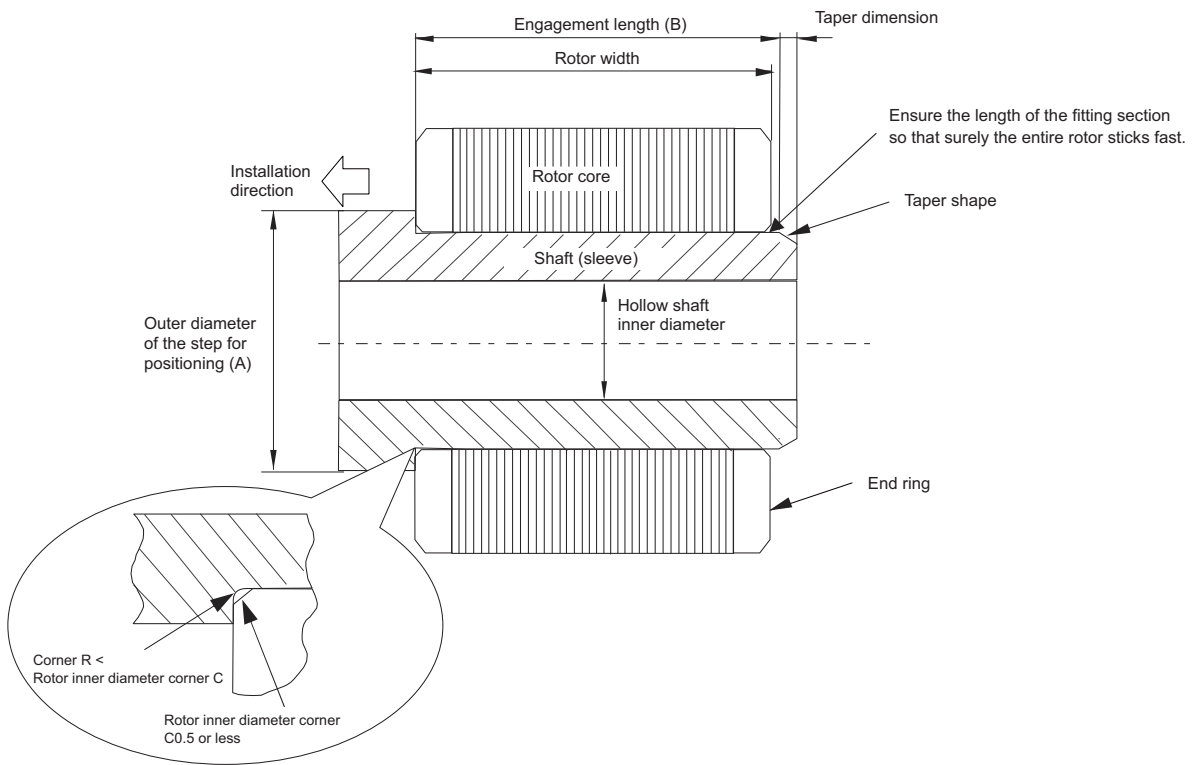
1. Set the outer diameter of the step for positioning as the dimension specified in the outline dimension drawing for each type to contact the ring only.
2. When chamfering the corner of the rotor inner diameter, it must be C0.5 or less.
3. Make sure that the radius of the corner of the step for positioning is smaller than the chamfering of the rotor corner. When it is larger than the chamfering of the rotor corner, the dimension for positioning may be deviated.
4. Do not create a clearance, etc. on the shaft so that the whole width of the rotor certainly contacts the shaft. It is recommended that a push-in guide 0.1 to 0.3mm smaller than the outer diameter of the rotor fixing part or a taper about 15° to 30° be created on the shaft. If creating these shapes, ensure the length of the fitting section so that surely the entire rotor sticks fast.

< When a push-in guide is created >



Symbol of stator outline	160	180	240
Engagement length [mm]	Core width +2 or more	Core width +4 or more	Core width +4 or more

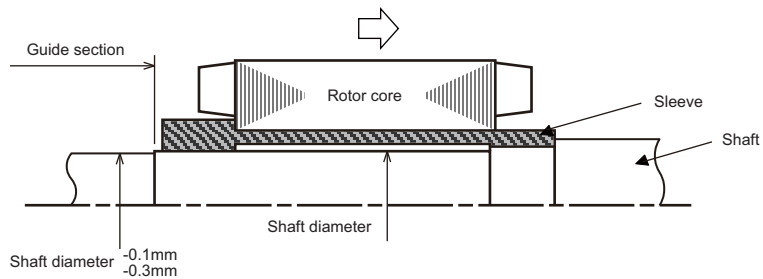
< When a taper shape is created >



< When a rotor sleeve is created >

Use a magnetic material such as carbon steel or alloy steel for the sleeve material.

The recommended interference for the rotor and sleeve is the same as when shrink fitting the rotor to the shaft.

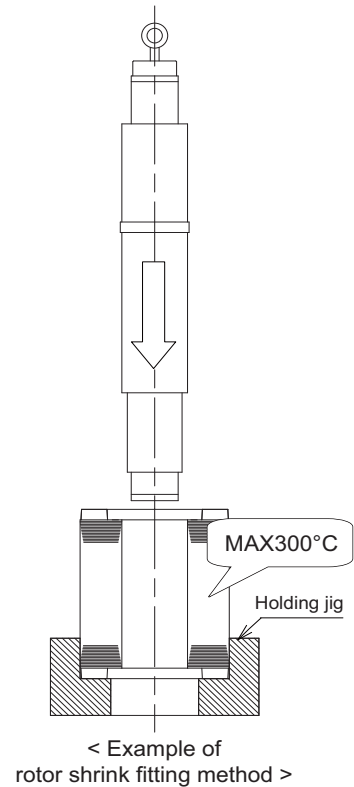


(4) Rotor fit dimension and the installation to the shaft

1. Shrink fitting is recommended for fixing the rotor to the shaft or sleeve.
2. The shrink fit interference will differ according to the type. Refer to the outline dimension drawing for each type.
3. If the tolerance width of recommended interference is small, match and machine the shaft or sleeve outer diameter to fit the rotor inner diameter.
4. When shrink fitting the shaft or sleeve onto the rotor, heat the rotor in an electrical furnace so that the temperature of each part is even. If the heating is improper or if uneven, trouble such as scratch in assembly or deformation may occur.
5. The upper limit of the temperature is 300°C or less on the rotor surface.

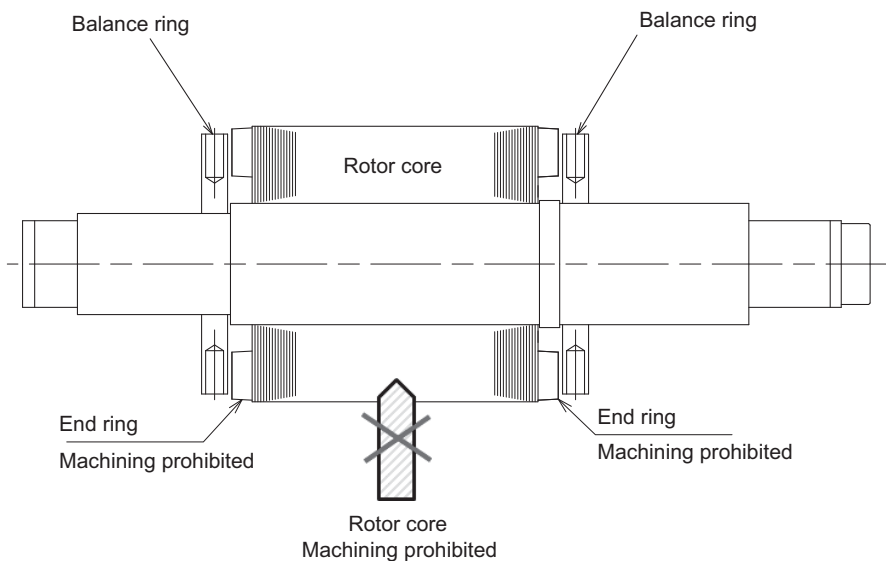
(5) Finish machining of the rotor outer diameter

- The rotor outer diameter is not finish machined, so finish machine the rotor outer diameter after shrink fitting. The finish amount will be more than 0.15mm unless otherwise specified in the outline dimension drawings.
- Dry machining should be used on the machining of the rotor's outer diameter to prevent corrosion of the steel or aluminum. If dielectric fluid must be used, use noncorrosive, and dry the part completely after machining.
- If dielectric fluid remains between the layered steel plates, not only the rotor balance may be lost but also the fluid may adhere onto the stator by the rotation and will cause a fault such as defective insulation.
- Applying an anti-corrosive agent onto the rotor after machining the rotor's outer diameter is recommended.



(6) Balancing the spindle

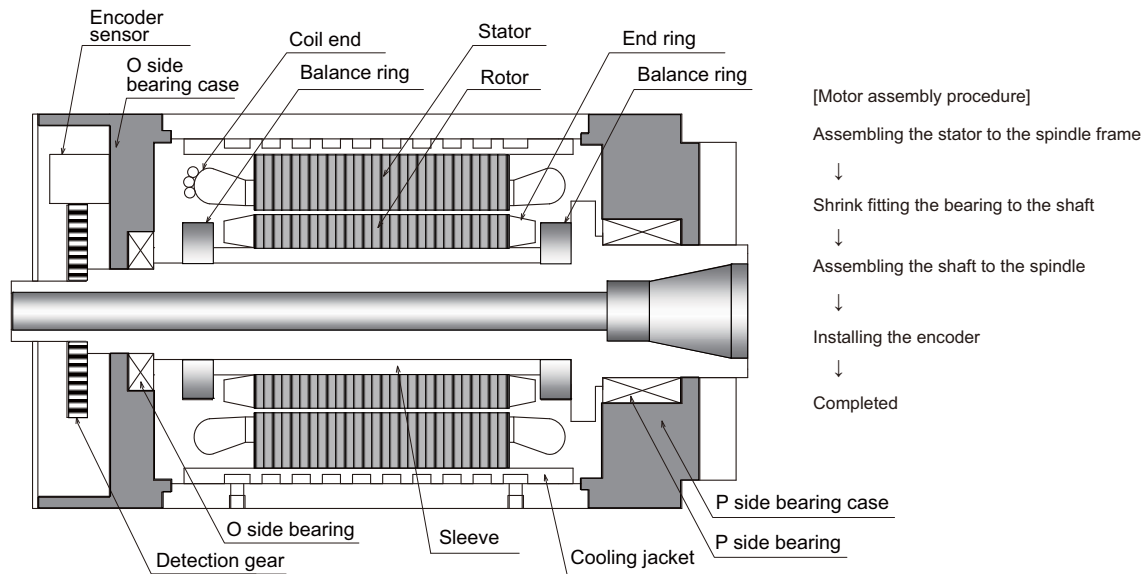
- The unbalance of the spindle will cause vibration and noise during high speed operation.
- The dynamic balance of the rotor unit has not been adjusted. Adjust the balance by opening a hole in the balance ring installed by the user.
- Use a non-magnetic material such as SUS304 for a balance ring.
- Shrink fitting at the both end of the rotor is recommended for installing the balance ring.
- Do not machine the rotor core and end ring when adjusting the balance.



< Reference diagram for rotor outer diameter machining and balancing >

4.4 Motor Assembly

< Example of finished built-in motor assembly >



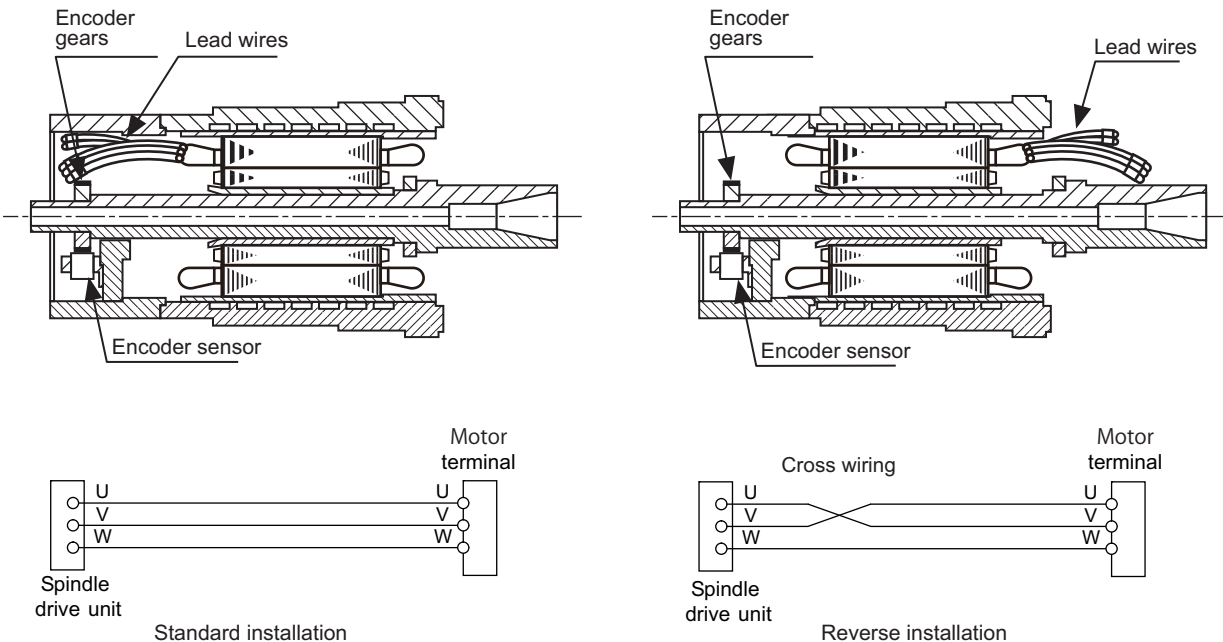
⚠ Cautions for assembling

1. Take care not to collide with the stator coil end when assembling the rotor shaft.
2. Do not let foreign objects such as the cutting chips, water, oil, or mist enter or adhere when assembling. Failure to observe this could result in a fault such as defective insulation.
3. Create a grounding terminal on the machine side structure (stator jacket, etc.), and connect with the controller grounding terminal.
4. Make sure the casting step, ingate, or burr, etc. does not contact the lead wire or coil end.
5. Use a packing such as O ring for the fluid cooling jacket to prevent fluid from entering inside the motor.
 * Fluorocarbon rubber (FKM) is recommended for the material of O ring.
6. Perform a leak test by air before adding the cooling fluid after assembly.
7. When performing an air purge inside the spindle, use an appropriate filter or dryer to prevent foreign objects or moisture from entering.
8. Unless otherwise noted in the outline dimension drawing, there are no limits to the installation direction of the stator and motor. The stator and motor combination can be changed without problems if the same motor specifications are used.

(1) Wiring

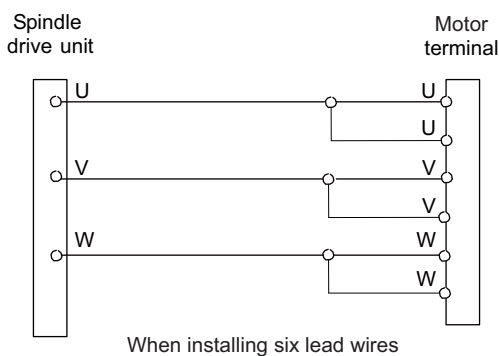
< The wiring between the drive unit and motor (When not using coil changeover) >

The installation direction of the stator and encoder is the "standard installation direction" if the lead wires are both protruding in the same direction as shown in the figure below. If the both lead wires are protruding away from each other, this will be the "reverse installation direction". Reverse the order of the phases of the stator lead wire when using the "reverse installation direction".



< For six lead wires >

The lead of 3-phase is divided into two and arranged six for some stators. In this case, connect to a pair of the same symbol in parallel.



< The wiring between the drive unit and motor (When using coil changeover) >

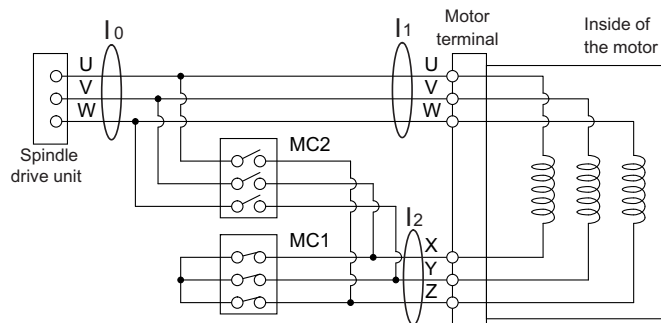
The illustration below shows the 2 types of changeover that occur after a coil changeover, (a) ⚡ (star) - Δ (delta) changeover, and (b) ⚡ (star) - ⚡ (star) changeover. One of the contactors (MC1 or MC2) is turned ON and the other is turned OFF.

(a) ⚡ (low-speed)-Δ (high-speed) changeover
 ⚡ (star)-Δ (delta) changeover circuit

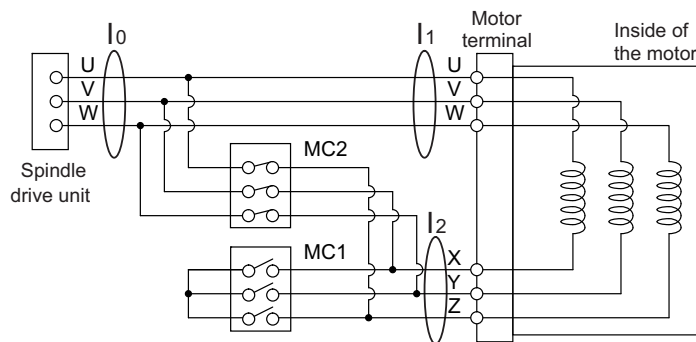
MC1: Contactor to connect low-speed coil (⚡-connection)
 MC2: Contactor to connect high-speed coil (Δ-connection)

Relationship of the current value of drive unit and motor terminal

Y-Δ	Coil changeover	
	Low-speed	High-speed
I ₁	I ₀	I ₀ /√3
I ₂	I ₀	I ₀ /√3



Low-speed connection [MC1-ON / MC2-OFF]



High-speed connection [MC1-OFF / MC2-ON]

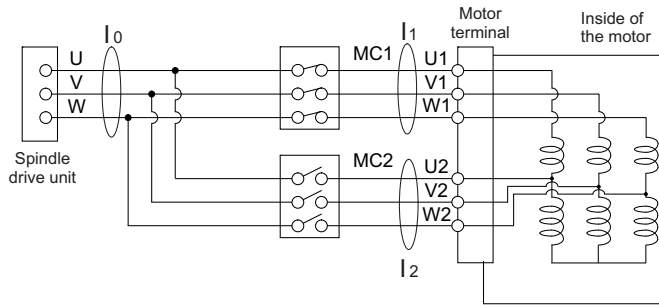
4 Assembly and Installation

Relationship of the current value of drive unit and motor terminal

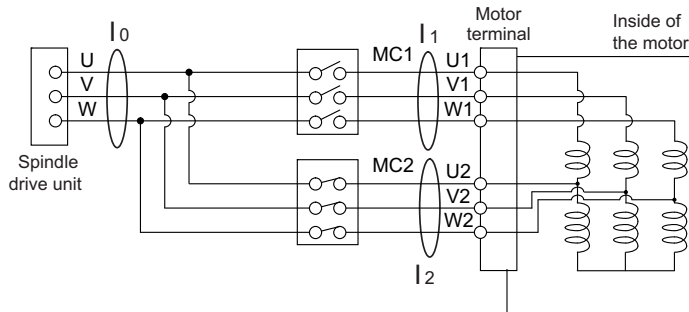
(b) Δ (low-speed) - Δ (high-speed) changeover
 Δ (star) - Δ (star) changeover circuit

MC1: Contactor to connect low-speed coil (1st Δ -connection)
 MC2: Contactor to connect high-speed coil (2nd Δ -connection)

Y-Y Current	Coil changeover	
	Low-speed	High-speed
I ₁	I ₀	0
I ₂	0	I ₀



Low-speed connection [MC1-ON / MC2-OFF]



High-speed connection [MC1- OFF/ MC2-ON]

4.5 Precautions for Handling Built-in SPM Spindle Motor (BGS Series)

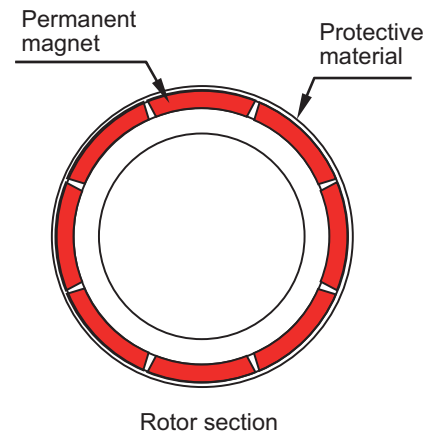
4.5.1 Precautions

The built-in SPM spindle motor rotor has a rotor in which permanent magnets are arranged. Very strong magnetic attraction force is generated between magnetic materials such as iron. The magnetic attraction force is generated mainly on the rotor outside. Therefore, when handling the single rotor unit, take safety measure to avoid accidents as fingers or hands may be caught due to the magnetic attraction force.

In addition, the magnetic force is released into the air, so it is highly dangerous to approach the rotor before assembling because medical electronics such as pacemaker may not operate normally.

Please note that if watch, magnetic tape, floppy disk, cash card, prepaid card, ticket etc., are approached, their magnetic memories may be destroyed or magnetized and may not be able to use due to the magnetic force.

< Rotor appearance >



< General precautions >

- (1) Do not put magnetic materials such as iron close to the rotor.
- (2) Before handling, remove metal items such as watch, piercing jewelry, necklace, etc.
- (3) Do not leave the rotor unattended.
->When the rotor is not securely fixed to the machine or device, make sure to store it in the package properly.
- (4) Do not modify the product, or do not give a shock.
- (5) Do not get on top of or place heavy objects on the product.

< Transportation and storage >

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




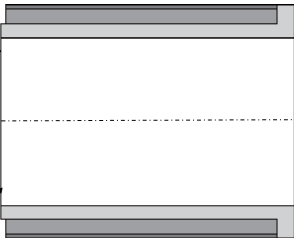
< Appearance >

The surface of the rotor is reinforced with CFRP (Carbon Fiber Reinforced Plastic). Due to the rotor manufacturing processes, fluffing of the carbon fibers and grooving may occur. However, these do not affect the characteristics of the carbon fiber.

< Rotor specifications >

Refer to the following table to determine the rotor specifications, and assemble the rotor according to the applicable procedures. Refer to "4.5.2. Rotor Assembly" and "4.5.3. Motor Assembly" for details of assembling methods and precautions for handling.

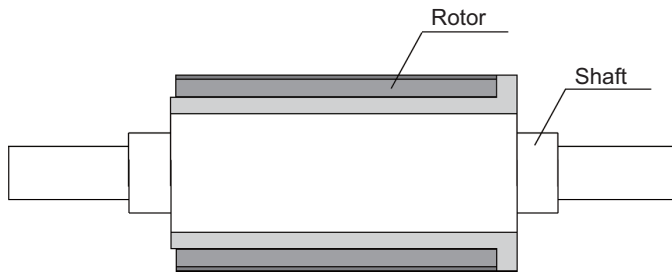
Rotor specifications

Specifications	With sleeve	Without sleeve
Rotor appearance		
Rotor diagram		
Rotor assembling procedures	<p>Join the rotor and the shaft with bolts</p> <p style="text-align: center;">↓</p> <p style="text-align: center;">Balancing</p> <p style="text-align: center;">↓</p> <p style="text-align: center;">Completed</p>	<p>Press-fit the shaft into the rotor</p> <p style="text-align: center;">↓</p> <p style="text-align: center;">Balancing</p> <p style="text-align: center;">↓</p> <p style="text-align: center;">Completed</p>

Refer to the outline dimension drawings for detailed rotor diagrams.

4.5.2 Rotor Assembly

< Example of finished rotor assembly (without sleeve) >



Press-fit the shaft into the rotor*



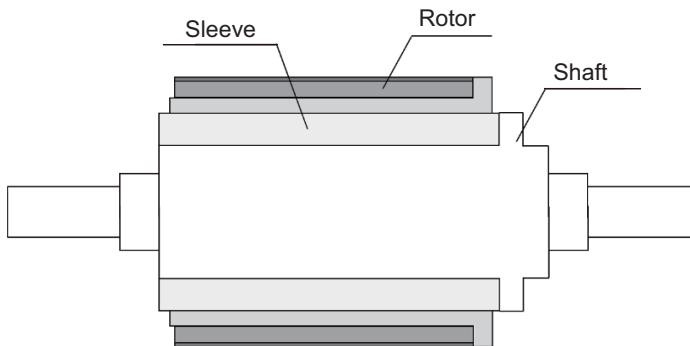
Balancing



Completed

*No shrink fitting procedure

< Example of finished rotor assembly (with sleeve) >



Join the rotor and the shaft with bolts



Balancing



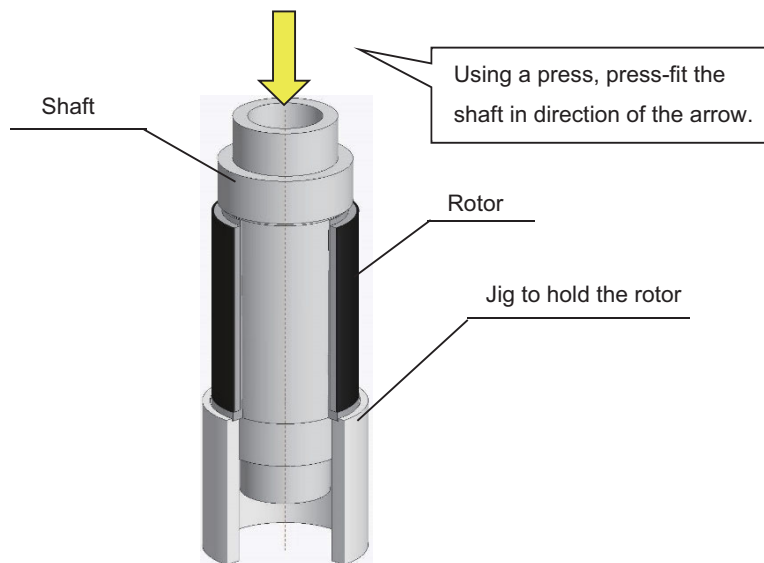
Completed

(1) Rotor installation to the shaft

- For a rotor without sleeve, press-fit the shaft to fix the rotor on the shaft or sleeve.
- For a rotor with sleeve, join the rotor and the shaft with bolts using the screw holes on the end of sleeve.

When shrink fitting the rotor and shaft, use an electric furnace, etc. to heat each part evenly. Keep the heating temperature of the SPM rotor to 130°C or lower. If it exceeds this temperature, the magnet could be demagnetized, and the specified characteristics will not be ensured. If the heating is improper or if uneven, trouble may occur.

< Example of shaft press-fit >



⚠ CAUTION

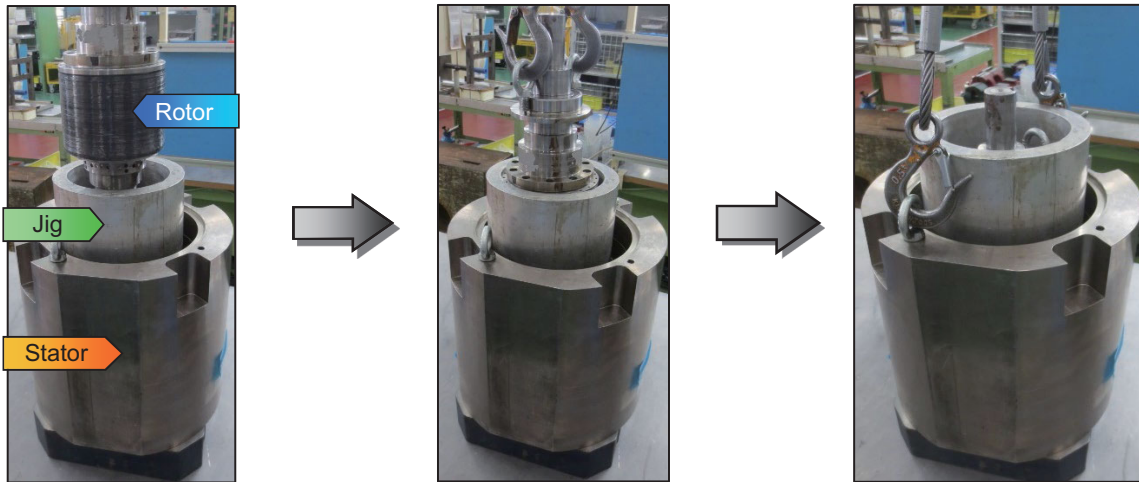
1. Clean the contact surfaces of the rotor and shaft to remove any foreign material from them before the shaft press-fitting. If there is any foreign material on the contact surfaces, the press-fitting force is increased, which may lead to an incorrect press-fitting.
2. When press-fitting the shaft, magnetic debris (such as iron filings and cutting chips) may adhere to the shaft. Press-fit the shaft in an environment where there are no such materials.
3. Shaft size and required press-fitting force vary between models. Refer to the outline dimension drawings for each model.
4. When press-fitting the shaft, do not scratch or apply an impact to the protective material on the outside of the rotor.
5. Use lubricant on the surface of the rotor and shaft when press-fitting.
6. When supporting the rotor while press-fitting, use the thick side (flange side) of the rotor. Supporting by the other parts of the rotor may scratch or deform the rotor.
7. When press-fitting the rotor, leave 1mm or more between the structure and the rotor to avoid applying force to the end of the thin side (opposite side of the flange).
8. Ensure the accuracy for the jig so as to press-fit the shaft vertically in to the rotor. Press-fitting an inclined shaft may increase the press-fitting force or lead to an incorrect press-fitting.
9. After press-fitting the shaft, measure the dimensions to check that the shaft is correctly press-fit by the specified stroke. If the shaft is not press-fit by the specified stroke, it may cause problems such as insufficient torque transmission when driving the spindle or damage of the rotor. Refer to the delivery specifications (taper shaft drawings) for the stroke.
10. After press-fitting the shaft, a large stress is applied to the rotor. We recommend checking the appearance of the rotor after press-fitting to check for any changes before proceeding with the following processes.
11. Do not use the screw holes on the thick side (flange side) of the rotor. Failure to observe this could damage the rotor.
12. For the rotor shrink fitting, refer to the recommended value as shown in the delivery specifications (outline dimension drawings).
13. Finishing machining for the rotor has already been performed, so do not modify such as the outer and inner diameters. Tools may be attracted or cutting chips may stick onto the rotor surface due to magnetic attraction force.

(1) Balancing

- For the rotor shrink fitting, refer to the recommended value as shown in the delivery specifications (outline dimension drawings).
- The dynamic balance of the rotor has not been adjusted. Adjust the balance by opening a hole in the balance ring installed by the user.
- Install balance rings in front and back of the rotor. The unbalance of the rotor will cause vibration and noise during high speed operation.
- When balancing with the rotor sleeve, use the screw holes on the rotor sleeve to add weight.

4.5.3 Motor Assembly

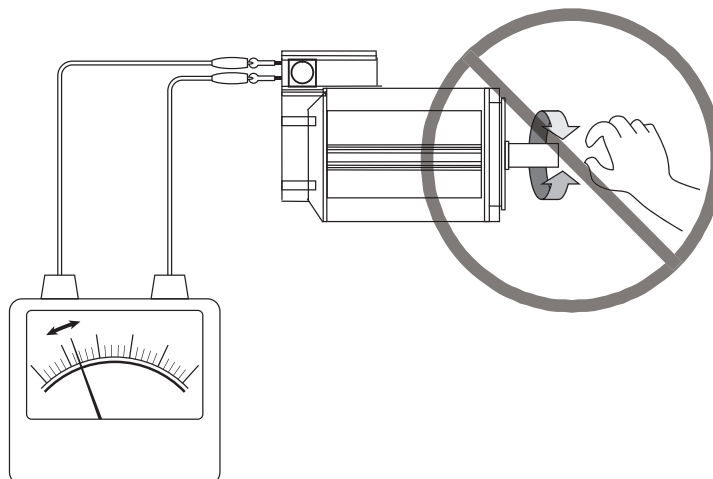
After assembling the stator and the rotor, assemble the motor. The basis of the built-in motor is completed in this procedure.



Example of assembling a rotor

(1) Cautions for assembling

- Tools may be attracted or cutting chips may stick onto the rotor surface due to magnetic attraction force.
- At the start of inserting a spindle with a rotor into a stator, the magnetic force attracting to the stator side is generated. Use a jig, etc. so as not to catch your hand or fingers.
- After assembling the spindle, if the rotor is rotated by hand etc., voltage occurs between the terminals of lead. Take care not to get electric shocks.

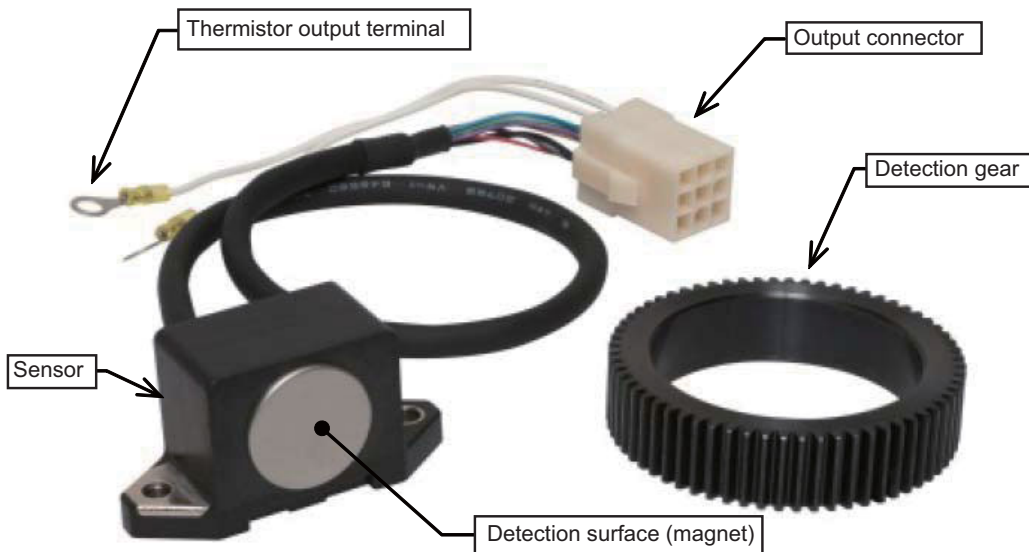


4.6 Installation of Encoder

Accuracy Encoder (TS5690 Series)

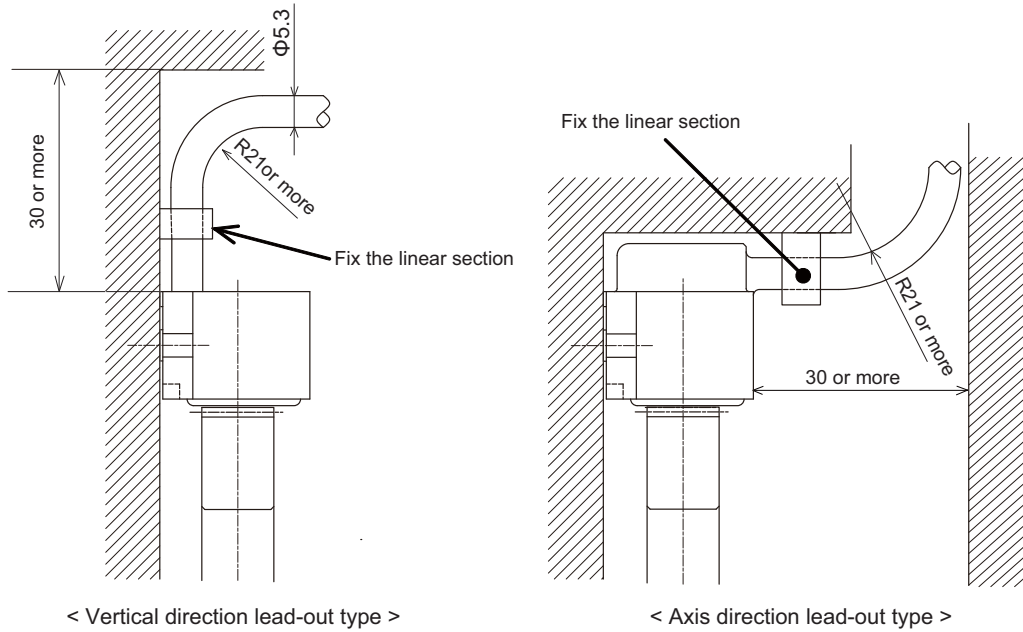
Cautions for handling

1. The encoder is configured of a sensor and detection gear. The sensor and detection gear must be used in the designated combination.
2. Do not apply an excessive force on the sensor's detection surface, as this could result in faults. Do not apply a load by pulling a cable, etc.
3. Make sure that force is not constantly applied on the sensor cable.
4. Make sure that foreign matters (iron chips, etc.) do not get on the sensor's detection surface or detection gears. If any foreign matter should get on these parts, carefully remove while taking care not to damage the parts. When handling the detection gears, take care not to damage or deform the teeth.
5. Do not put magnetic materials as a tool or screw close to the detection surface because magnets are used in the sensor. Do not use a magnetic tool such as magnet type driver to install the sensor.
6. Install the sensor and cable where it will not be subject to water or oil directly.
7. Make sure that the bending radius for the cable is four times or more of the diameter.
8. Fix the output connector and cable at the machine structure section or cable guide, etc. so that they will not vibrate. An example of the fixing positions is shown below.
9. Drive unit side connector is not attached. The user shall prepare.

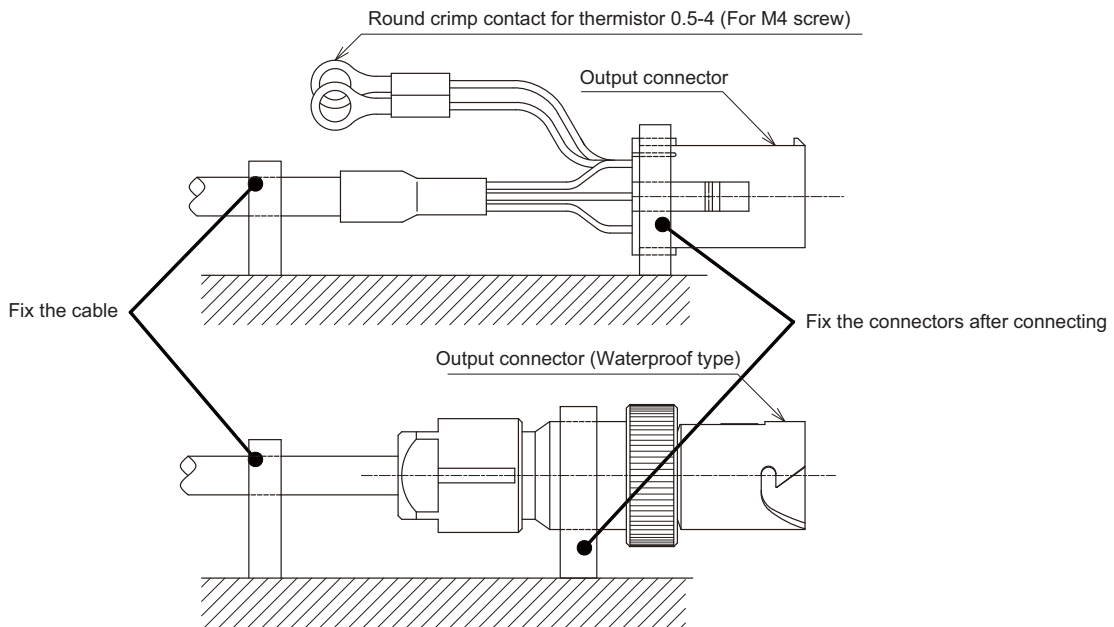


< Encoder appearance >

(Note) Refer to "2.2.2 Outline Dimension Drawings" for detail shapes and dimensions.



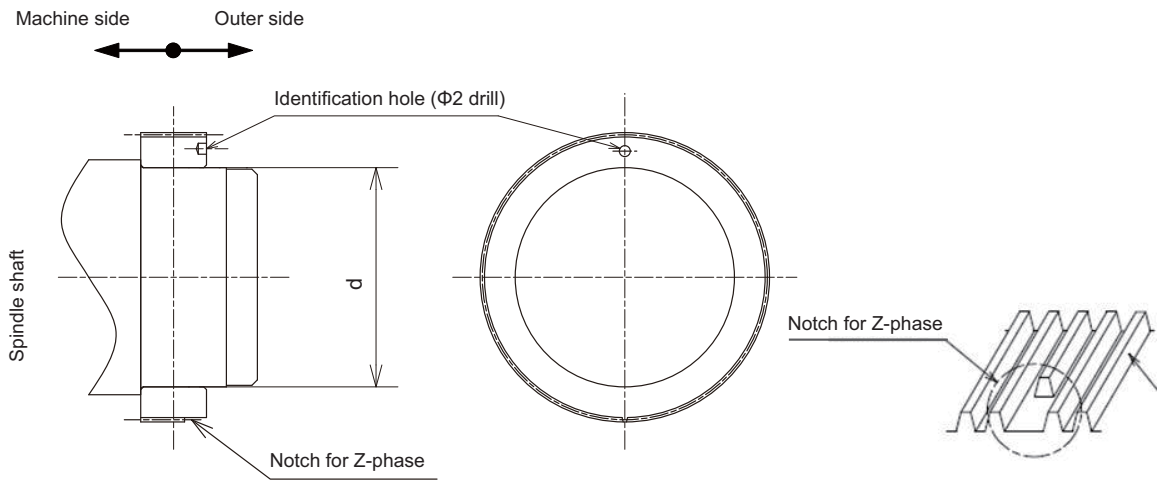
< Dimensions related to lead out the sensor cable >



< Reference diagram for wiring and connector fixing point >

(1) Installing the detection gears

1. Install the detection gears so that the first gear's teeth side (Z phase) face the sensor's lead side.
2. The detection gears and shaft should be fixed with shrink fitting. Refer to the following table for the interference values. The detection gears should be heated evenly 150°C or less using an electric furnace, etc.
3. Keep the deflection of the outer diameter, when the detection gears are installed on the shaft, to 0.02mm or less.
4. To remove a detection gear fixed with shrink fitting, use the screw holes opened in the axial direction for pulling, or push the end with a jig. Carry out this work carefully. Applying excessive force when pulling out the gears could cause the detection gears to deform.
5. Before reusing detection gears which have been removed, always measure the inner diameter dimensions, and carefully check that the inner diameter is not deformed, and that the sufficient tightening amount can be secured. Do not reuse the detection gears if the inner diameter is deformed, or if any abnormality such as damage to the teeth is found.



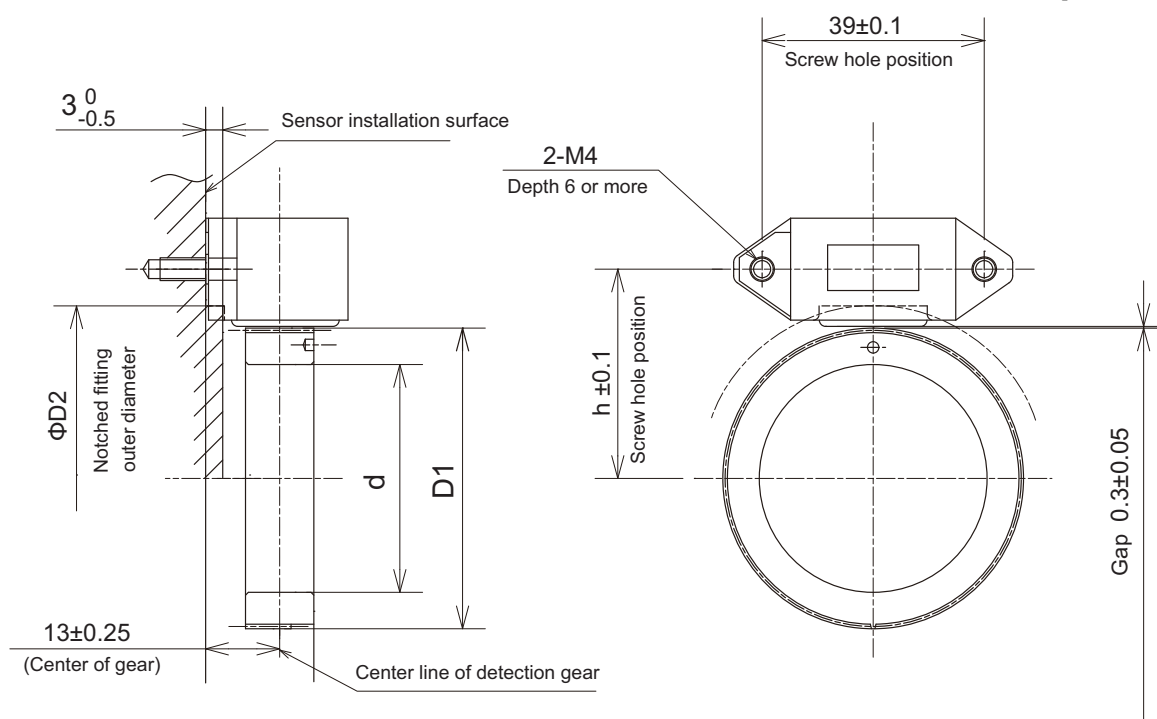
< Detection gear installation direction >

Encoder type		Recommended interference(μm)				
		TS5690-				
Inner diameter d [mm]		64xx	90xx	12xx	19xx	25xx
		φ 40	φ 60	φ 80	φ 125	φ 140
Rotation speed (r/min)	3000	5 to 27	5 to 31	6 to 32	7 to 43	10 to 46
	4500	5 to 27	6 to 32	6 to 32	10 to 46	15 to 51
	5000	5 to 27	6 to 32	7 to 33	11 to 47	18 to 54
	6000	5 to 27	6 to 32	8 to 34	14 to 50	23 to 59
	8000	5 to 27	7 to 33	10 to 36	21 to 57	37 to 73
	10000	5 to 27	8 to 34	12 to 38	30 to 66	55 to 91
	12000	5 to 27	9 to 35	15 to 41	41 to 77	-
	15000	7 to 29	11 to 37	21 to 47	62 to 98	-
	20000	9 to 31	16 to 42	34 to 60	-	-
	25000	11 to 33	22 to 48	-	-	-
	30000	13 to 35	29 to 55	-	-	-
35000	16 to 38	-	-	-	-	
40000	20 to 42	-	-	-	-	

(2) Installing the sensor

1. Prepare the notched fitting section and screw hole (M4 Effective depth 6mm) at the machine side's installation position to be of the specified dimensions. (Hatched area in the diagram below)
2. With the sensor installation seat's step section butted against the notched fitting section, fix the sensor installation seat with a mounting screw (M4). Use a bolt of 10.9 or more tensile strength [Tightening torque $1.85N \cdot m \pm 10\%$]. A locking agent should be applied on the screw section before it is tightened.
3. Position the axis direction of the sensor and detection gear so that the distance between the sensor installation surface and the center of the detection gear is 13 ± 0.25 mm (Maintain the dimension at the outer diameter section because some detection gears have thickness at the inner diameter section).
4. Check the gap between the encoder sensor and the gear (0.3 ± 0.05 mm). Fix the sensor with its R section butted against the notched fitting section so that the position relation between the detection gear and sensor is kept constant. This ensures favorable accuracy of the sensor installation.
5. If the gap outside the reference value exists, loosen the mounting screw and adjust the space.

[Unit: mm]



< Diagram of sensor installation relation >

Encoder type	TS5690-				
	64xx		90xx		25xx
Outer diameter of gear D1 [mm]	52.8		73.6		206.4
Inner diameter d [mm]	40.0		60.0		140.0
Sensor installation D2	$\phi 59.4$	$\begin{smallmatrix} -0.03 \\ -0.07 \end{smallmatrix}$	$\phi 79.2$	$\begin{smallmatrix} 0 \\ -0.04 \end{smallmatrix}$	$\phi 210.2$
Sensor screw height h [mm]	36.7		47.1		113.5

(3) Installation accuracy diagnosis for encoder**⚠ CAUTION**

Do not operate the spindle before performing this installation accuracy diagnosis.

If operated with an improperly installed encoder, the spindle motor may rotate at high speed. Always perform this diagnosis before normal operation.

[1] Outline

In this section, check if the installation polarity of encoder corresponds to the parameter setting, and the gap between the gear and the sensor is appropriate. In a full-closed loop control where the encoder is also installed on the spindle side, it is controlled based on the feedback of the encoder during the speed command operation (S command). Do not command a normal spindle operation before confirming the installation accuracy of the encoder. Encoders (TS5690 Series) have the specified gap from the gear by installing the sensor section on the machine-notched fitting section. Whether a signal is detected correctly or not can be confirmed using the servo diagnosis screen on NC while rotating the spindle motor in an open loop control.

[2] Confirmation of encoder installation accuracy

Open the drive monitor/spindle unit on the NC Diagnosis screen, and display "Machine position", "Motor end FB" and "FB error". Confirm that "Machine position" and "Motor end FB" are counted on the same polarity, and that "FB error" is not cumulated while rotating the spindle by hand. When the polarity of "Machine position" and "Motor end FB" is different and "FB error" is cumulated, change the setting of #13017/bit4 (SP017/bit4).

Set the spindle parameter so that the spindle system is in a full-closed loop control during this confirmation.

- #13019 (SP019) Set the encoder resolution of spindle side encoder correctly
- #13031 (SP031) Set to full closed loop control (6200)

[3] Confirmation of encoder installation accuracy

Whether the gap between the sensor section and the gear is ensured correctly or not can be confirmed using the servo diagnosis screen, [PLG diagn] on NC while rotating the spindle motor in an open loop control. Confirm it according to the following procedures.

- 1) Set the spindle parameter #13018/bit1 (SP018/bit1) to 1 to enable an open loop control.
- 2) Turn the NC power OFF. Then turn the NC power ON again.
- 3) Rotate the spindle by inputting 100r/min command. Although this is the same as normal S command operation, neither the spindle side encoder feed back or the motor side encoder feed back is used for the motor control on the spindle drive unit since the open loop control is set with the spindle parameter.
- 4) Switch to the [Servo diagn] menu on the NC maintenance screen and change from [Spindle unit] to [PLG diagn]. When all the diagnosis signal bits are constantly at "0", the installation of encoder is normal. When the diagnosis signal bit is "1", the result of diagnosis is abnormal. Perform troubleshooting following "[4] Diagnosis and remedy" by reference to the error details and main cause.
- 5) Set the spindle parameter #13018/bit1 (SP018/bit1) to 0 again and finish the open loop control after stopping the spindle with stop command.

⚠ CAUTION

The PLG diagnosis is only performed during the open loop control operation.

Diagnosis screen is displayed even during the normal operation, however, the error detection ("1" display) will not be performed.

< Display of spindle PLG diagnosis >

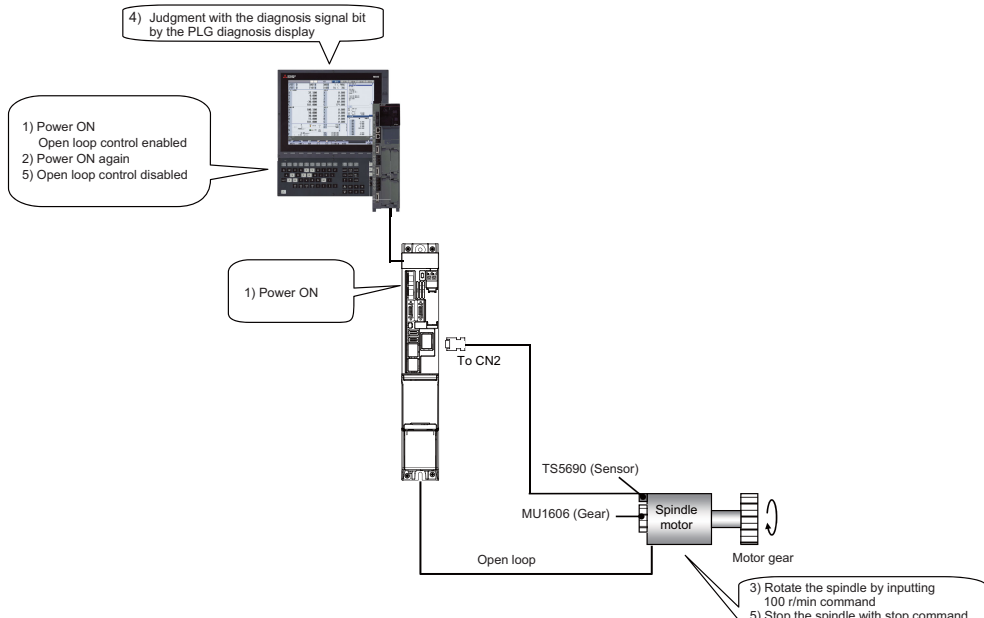
720V		MEMORY		Monitr	Setup	Edit	Diagn	Mainte	
		S1	S2	S3	S4				
Alarm times	1	13	2000	13	2000	13	2000	13	2000
Alarm times	2	18	11110	18	11110	18	11110	18	11110
Alarm times	3	1F	0	1F	0	1F	0	1F	0
Alarm times	4	21	200	21	200	21	200	21	200
Alarm times	5	2F	2000	2F	2000	2F	2000	2F	2000
Alarm times	6	34	10	34	10	34	10	34	10
Alarm times	7	35	500	35	500	35	500	35	500
Alarm times	8	36	1000	36	1000	36	1000	36	1000
Alarm times	9	38	0	38	0	38	0	38	0
Alarm times	10	3A	0	3A	0	3A	0	3A	0
Encoder Diagn L			00000000		00000000		00000000		00000000
Encoder Diagn H			00000000		00000000		00000000		00000000
Sub Encoder Diagn L			00000000		00000000		00000000		00000000
Sub Encoder Diagn H			00000000		00000000		00000000		00000000

When an error is detected with spindle PLG diagnosis → "1" is displayed on the corresponding diagnosis signal bit

Information for spindle PLG diagnosis (For details of each diagnosis signal bit, refer to the next page.)

Item	Details
Encoder Diagn L	Display the motor end PLG diagnosis signal bit 7 to 0.*
Encoder Diagn H	Display the motor end PLG diagnosis signal bit F to 8.*
Sub Encoder Diagn L	Display the spindle side PLG diagnosis signal bit 7 to 0.
Sub Encoder Diagn H	Display the spindle side PLG diagnosis signal bit F to 8.

* Used when adjusting a built-in motor.



Installation diagnosis for encoder

4 Assembly and Installation

Details of each diagnosis signal bit which is displayed as information for spindle PLG diagnosis are shown in the following table.

Diagnosis signal bit	Error details	Description	Main factor
0	A-phase amplitude excessive	The A-phase amplitude is larger than the specified value.	Too small gap
1	A-phase amplitude too small	The A-phase amplitude is smaller than the specified value.	Excessive gap
2	A-phase offset excessive +	The A-phase offset is larger than the specified value to + side.	The deviation between the sensor and the center of the gear
3	A-phase offset excessive -	The A-phase offset is larger than the specified value to - side.	The deviation between the sensor and the center of the gear
4	B-phase amplitude excessive	The B-phase amplitude is larger than the specified value.	Too small gap
5	B-phase amplitude too small	The B-phase amplitude is smaller than the specified value.	Excessive gap
6	B-phase offset excessive +	The B-phase offset is larger than the specified value to + side.	The deviation between the sensor and the center of the gear
7	B-phase offset excessive -	The B-phase offset is larger than the specified value to - side.	The deviation between the sensor and the center of the gear
8	Z-phase width excessive	The Z-phase width is larger than the specified value. [AL2C factor]	Too small gap
9	Z-phase width too small	The Z-phase width is smaller than the specified value.	Excessive gap
A	Z-phase error incorrect output	The relation of the phases between AB and Z is abnormal. [AL2C factor]	The deviation between the sensor and the center of the gear
B	Z-phase error sliver waveform	The relation of the phases between AB and Z is abnormal. [AL2C factor]	The deviation between the sensor and the center of the gear
C	Z-phase error no signal	The Z-phase signal is not detected. [AL2C factor]	Excessive gap, detection gear error
D	-	-	-
E	Z-phase error logic reversed	The Z-phase logic (normally positive) is reversed. [AL2C factor]	Detection gear error
F	-	-	-

[4] Diagnosis and remedy

When the diagnosis signal bit on [PLG diagn] is "1", check the installation of the encoder again.

< When the waveform of spindle side PLG installation gap diagnosis is abnormal >

The gap between the sensor section and the gear may deviate from the specified value. Confirm that the sensor section is installed on the notched fitting section properly. Also confirm that the notched fitting section is machined properly based on the specified dimensions for each encoder.

< When the waveform of spindle side PLG installation all errors diagnosis is abnormal >

The sensor section may deviate from the center of the gear. Confirm the installation of the sensor section and the gear.

⚠ CAUTION

1. When finely adjusting the sensor installation position, adjust after turning the power of the drive unit OFF.
2. "00000000" is also displayed in the following cases.
 - (1) When the spindle parameter #13018/bit1(SP018/bit1) is 0 (open loop disabled)
 - (2) When an encoder other than TS5690 Series is connected

【#13017(PR) SP017 SPEC1 Spindle specification 1

bit 4 : fdir Position feedback

Set the machine side encoder's installation polarity.
0: Forward polarity 1: Reverse polarity

【#13018(PR) SP018 SPEC2 Spindle specification 2

bit 1 : oplp Open loop control

This allows the operation in which no encoder feedback signals are used.
It is used when adjusting the encoder, etc.
0: Disable 1: Enable

【#13113] SP113 OPLP Current command value for open loop

Set the current command value for when the open loop control is enabled.
When "0" is set, the state will be the same as when "50" is set.
When not using, set to "0".
The open loop control is enabled when "SP018/bit1" is set to "1".

---Setting range---

0 to 999 (Short-time rated %)

5

Wiring and Connection

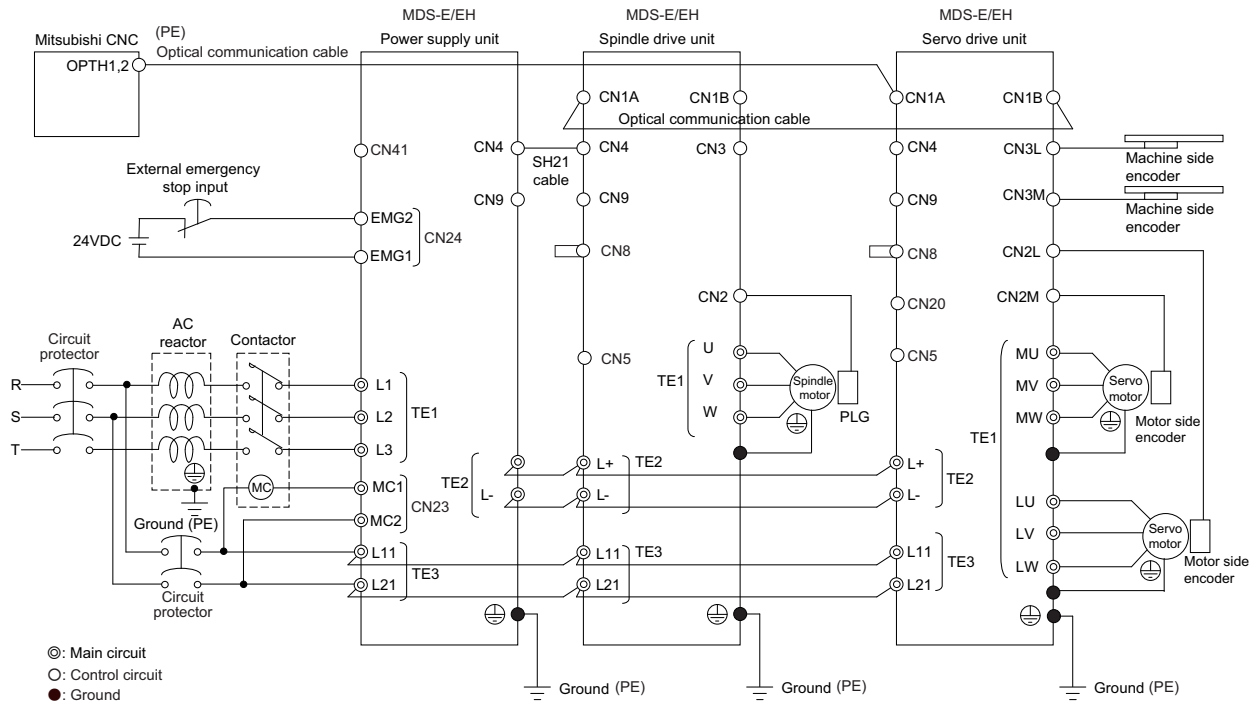
 **DANGER**

1. Wiring work must be done by a qualified technician.
2. Wait at least 15 minutes after turning the power OFF and check the voltage with a tester, etc., before starting wiring.
Failure to observe this could lead to electric shocks.
3. Securely ground the drive units and spindle motor.
4. Wire the drive units and spindle motor after installation. Failure to observe this could lead to electric shocks.
5. 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.
6. Always insulate the power terminal connection section. Failure to observe this could lead to electric shocks.

 **CAUTION**

1. Correctly and securely perform the wiring. Failure to do so could result in runaway of the spindle motor or injury.
2. Do not mistake the terminal connections.
3. Do not mistake the polarity (+ , -). Failure to observe this item could lead to ruptures or damage, etc.
4. Electronic devices used near the drive units may receive magnetic obstruction. Reduce the effect of magnetic obstacles by installing a noise filter, etc.
5. Do not install a phase advancing capacitor, surge absorber or radio noise filter on the power line (U, V, W) of the spindle motor.
6. Do not modify this unit.
7. If the connectors are connected incorrectly, faults could occur. Make sure that the connecting position and the connection are correct.
8. When grounding the motor, connect to the protective grounding terminal on the drive units, and ground from the other protective grounding terminal.(Use one-point grounding)
Do not separately ground the connected motor and drive unit as noise could be generated.

5.1 Part System Connection Diagram



- (Note 1) The total length of the optical communication cable from the NC must be within 30m and the specified bending radius (for wiring inside panel: 25mm, and for wiring outside panel: 50mm) or more.
- (Note 2) The connection method will differ according to the used motor.
- (Note 3) Battery for the encoder back up is built-in the drive unit. (An external battery is available as an option.)
- (Note 4) The main circuit (⊙), control circuit (○) and ground (●) are safely separated.
- (Note 5) Connect the ground of the motor to the ground of the connected drive unit.

6

Setup

6.1 Initial Setup for SPM Spindle Motor

This section explains the initial setup procedures for SPM spindle motor system.

CAUTION

1. Perform the initial setup after the operation is enabled for NC system.
2. The initial setup is required for each SPM spindle motor.
3. Perform the initial setup again after replacing the encoder.
4. SPM Spindle motor cannot use pulse application method in the initial magnetic pole detection.

6.1.1 Adjustment Procedure

In the SPM spindle motor drive system, create the initial magnetic pole by the initial magnetic pole estimate function after the power ON. The DC excitation function detects the magnetic pole shift amount on the Z-phase basis when using an SPM spindle motor, so the SPM spindle motor will be driven with the initial magnetic pole and perform the DC excitation function (decision of the magnetic pole shift amount) after the Z-phase has been passed.

Creation method of the initial magnetic pole	Creation timing of the initial magnetic pole	Related parameters	Compatible system
Detection by the initial magnetic pole estimate function	At the initial servo ON	SP121(Kpp), SP122(Kvp), SP123(Kvi)	SPM spindle motor + Relative position encoder

The SPM spindle motor will be driven according to the magnetic pole shift amount set in the spindle parameter #13118 (SP118), which you determined through the DC excitation function, after turning the NC power ON next and the Z-phase has been passed. (The SPM spindle motor will be driven with the initial magnetic pole in the above table until the Z-phase has been passed even after the magnetic pole shift amount is set.)

With the DC excitation function, once the spindle parameter #13118 (SP118) is set, resetting is not required unless the encoder is replaced.

< Confirmation of the initial magnetic polar detection >

- (1) Turn ON the spindle drive unit and NC. Confirm that there is no error such as Initial parameter error (37).
- (2) Set the the initial magnetic pole estimate parameters.
(#13121 (SP121)=6, #13122 (SP122)=1500, #13123 (SP123)=2000)
- (3) Release the emergency stop and then start the spindle with S command.
- (4) The LED on the drive unit changes to "Cx" and the SPM spindle motor moves by little and little for about five seconds (start initial magnetic pole estimate).
- (5) Confirm that the LED on the drive unit changes to "dx" and the motor stops (terminate initial magnetic pole estimate).
[Check] Spindle monitor Control output 1/bit1 (In servo ON) changes from "0" to "1"
Control output 4/bit7 (Magnetic pole position not set) changes from "1" to "0"
- (6) The SPM spindle motor will be driven after the operation (5). Drive the motor until the Z-phase has been detected.
-> Switch to the [Servo diagn] menu on the NC maintenance screen, select [Servo unit] and confirm [Control output 2/bit0(Z-phase passed)] is "1".

< DC excitation function >

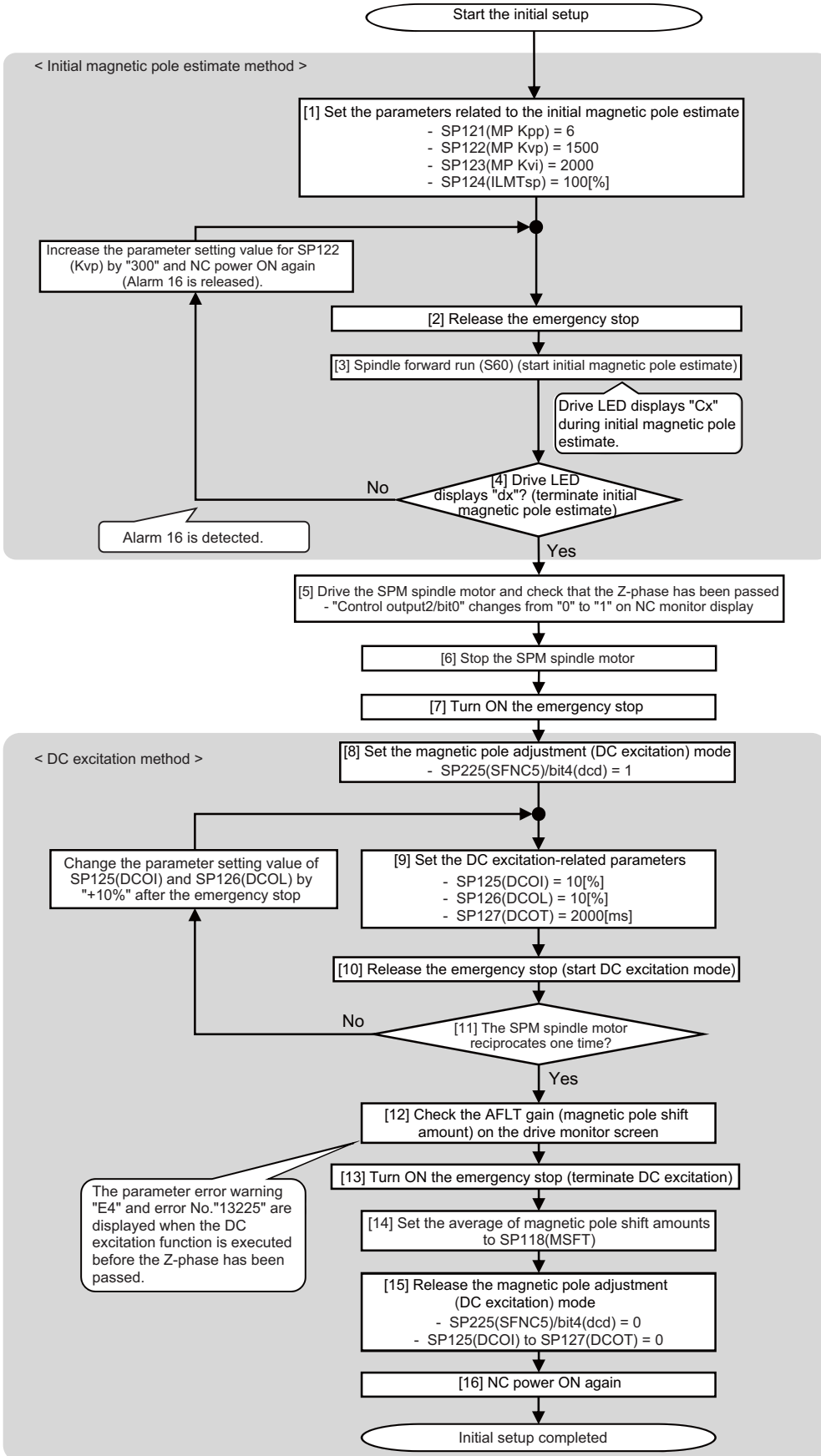
- (7) Turn ON the emergency stop.
- (8) Set the parameters related to the DC excitation (#13125 (SP125) to 10, #13126 (SP126) to 10, and #13127 (SP127) to 2000).
- (9) Set the spindle parameter #13225/bit4 (SP225/bit4) to "1" to enable the DC excitation mode.
- (10) Release the emergency stop.
- (11) Confirm that the SPM spindle motor carries out a reciprocation operation between about $\pm 10^\circ$ and 20° once (start DC excitation).
- (12) Confirm that the SPM spindle motor stops after the reciprocation operation.
- (13) Switch to the [Diagn] menu on the NC maintenance screen, select [Spindle unit] and monitor [AFLT gain].
- (14) Turn ON the emergency stop (terminate DC excitation).
- (15) Repeat (10) to (14) 5 times, and monitor the ALFT gain value (magnetic pole shift amount) each time.
If difference of the magnetic pole shift amounts is 1000 data or bigger, reset the related parameter settings (#13125 (SP125)=+10, #13126 (SP126)=+10) and perform (10) to (14) again.
- (16) Calculate the average of the magnetic pole shift amounts, and set it to #13118 (SP118).
- (17) Return the spindle parameter #13225/bit4 (SP225/bit4) back to the original setting, "0".
- (18) Turn the NC power ON again.

 **CAUTION**

1. Never operate the SPM spindle motor before DC excitation function is enabled.
2. The motor carries out a reciprocation operation at about the magnetic pole pitch while DC excitation function is enabled.
3. The magnetic pole shift amount cannot be calculated correctly with incorrect wiring in the motor power line or encoder cable.

Initial setup procedures for SPM spindle motor

Perform the initial setup for the SPM spindle motor by following the steps in the flow diagram below.



6.1.2 Related Parameters

As DC excitation is a function used for initial setup for the SPM spindle motor, use the spindle parameters #13125 (SP125), #13126 (SP126), and #13127 (SP127) that have another function (D/A output) used for adjustment.

Note, however, that these parameters are enabled as the DC excitation function parameters when the spindle parameter #13225/bit4 (SP225/bit4) is set to "1".

< DC excitation function related parameters >

[#13118(PR)] SP118 MSFT Magnetic pole shift amount

Set the magnetic pole shift amount of SPM spindle motor.

During DC excitation of the initial setup: Set the same value displayed in the "AFLT gain" on the NC monitor screen in SP225 (SFNC5)/bit4 (dcd)=1.

---Setting range---

-18000 to 18000 (electrical angle 0.01°)

[#13125] SP125 DCOI Initial DC excitation level

[When driving an SPM spindle motor]

Use in the DC excitation function.

DC excitation: Set the initial excitation level when SP225 (SFNC5)/bit4 (dcd)=1.

When "0" is set, the state will be the same as when "20" is set.

---Setting range---

0 to 100 (Short-time rated %)

[#13126] SP126 DCOL Final DC excitation level

[When driving an SPM spindle motor]

Use in the DC excitation function.

DC excitation: Set the final excitation level when SP225 (SFNC5)/bit4 (dcd)=1.

When "0" is set, the state will be the same as when "50" is set.

---Setting range---

0 to 100 (Short-time rated %)

[#13127] SP127 DCOT Initial DC excitation time

[When driving an SPM spindle motor]

Use in the DC excitation function.

DC excitation: Set the initial excitation time when SP225 (SFNC5)/bit4 (dcd)=1.

When "0" is set, the state will be the same as when "10000" is set.

---Setting range---

0 to 32767 (ms)

[#13225] SP225 SFNC5 Spindle function 5

bit 4 : dcd DC excitation mode

0: Normal 1: Start



CAUTION

The parameters SP125 to 128 act as the adjustment parameters while SPM magnetic pole is being estimated, and thus normal D/A output is disabled.

< Initial magnetic pole estimate function related parameters >

【#13121】 SP121 MP Kpp Magnetic pole detection position loop gain

Set the position loop gain in the magnetic polar detection loop.
This is used in the initial magnetic polar detection when the SPM spindle motor is turned ON.
Set to "0" when using an IM spindle motor.

---Setting range---
0 to 32767

【#13122】 SP122 MP Kvp Magnetic pole detection speed loop gain

Set the speed loop gain in the magnetic polar detection loop.
This is used in the initial magnetic polar detection when the SPM spindle motor is turned ON.
Set to "0" when using an IM spindle motor.

---Setting range---
0 to 32767

【#13123】 SP123 MP Kvi Magnetic pole detection speed loop lead compensation

Set the speed loop lead compensation in the magnetic polar detection loop.
This is used in the initial magnetic polar detection when the SPM spindle motor is turned ON.
Set to "0" when using an IM spindle motor.

---Setting range---
0 to 32767

【#13124】 SP124 ILMTsp Magnetic pole detection current limit value

Set the current limit value for the magnetic polar detection loop.
This is used in the initial magnetic polar detection when the SPM spindle motor is turned ON.
Set to "0" when using an IM spindle motor.

---Setting range---
0 to 999 (Short-time rated %)

6.2 Protective Functions List of Units

The following are the alarms and warnings specific to the SPM spindle motor system. Refer to the Instruction Manual of the drive unit currently used for other alarms and warnings.

6.2.1 Drive Unit Alarm

No.	Name	Details	Reset method	Stop method
16	Initial magnetic pole position detection error	- In the SPM spindle motor system, the magnetic pole position is not correctly detected during the initial magnetic pole position detection function. It can occur when the motor is mechanically constrained at servo ON or when an excessive force is applied to the motor during magnetic pole estimation.	PR	Coast to a stop
37	Initial parameter error	- An incorrect set value was detected among the parameters send from the NC at the power ON.	PR	Initial error
3E	Magnetic pole position detection error	- The magnetic pole position, detected in the magnetic pole position detection control, is not correctly detected. The setting of magnetic pole shift amount (SP118) is not reliable. - The encoder installation polarity may be reverse.	AR	Coast to a stop
46	Motor overheat / Thermal error	- An overheat is detected on the motor. - The thermistor signal receiving circuit of the motor was disconnected. - The thermistor signal receiving circuit was short-circuited.	NR	Deceleration stop
51	Overload 2	- Current command of 95% or more of the unit's max. current was given continuously for 1 second or longer. - The encoder installation polarity may be reverse.	NR	Deceleration stop
52	Excessive error 1	- A position tracking error during servo ON was excessive. - The encoder installation polarity may be reverse.	NR	Deceleration stop

(Note 1)Resetting methods

NR : Reset with the NC RESET button. This alarm can also be reset with the PR and AR resetting conditions.

PR : Reset by turning the NC power ON again. This alarm can also be reset with the AR resetting conditions.

When the control axis is removed, this alarm can be reset with the NC RESET button. (Excluding alarms 32 and 37.)

AR : Reset by turning the servo drive unit power ON again.

Encoder alarm (Spindle drive unit)

Alarm number when the encoder is connected toCN2 side		2B	2C	2D	2E	48	49	4A	4B
Alarm number when the encoder is connected to CN3 side		1B	1C	1D	1E	27	28	29	2A
TS5690 TS5691	Mitsubishi Electric	Memory error	Waveform error	-	-	-	Overspeed	-	Relative position data error

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

6.2.2 Drive Unit Warning

No.	Name	Details	Reset method	Stop method
E4	Parameter warning	An incorrect set value was detected among the parameters send from the NC in the normal operation.	*	-

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

(Note 2)Resetting methods

* : Automatically reset once the cause of the warning is removed.

NR: Reset with the NC RESET button. This warning can also be reset with the PR and AR resetting conditions.

PR: Reset by turning the NC power ON again. This warning can also be reset with the AR resetting conditions.

AR: Reset by turning the spindle drive unit power ON again.

(Note 3)SPM spindle motor does not stop when the warning occurs.

(Note 4)When an emergency stop is input, SPM spindle motor decelerates to a stop. (When SP055 or SP056 is set.)

6.2.3 Parameter Numbers during Initial Parameter Error

< Parameter error No. >

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

S02 Initial parameter error ○○○○□
 ○○○○ : Error parameter No.
 □ : Axis name

S52 Parameter error warning ○○○○□
 ○○○○ : Error parameter No.
 □ : Axis name

If an error No. in the following table is displayed as the error parameter No. even when the parameter is set to a value within the setting range, an error is occurring due to the hardware compatibility or specifications or in relation to several other parameters. Check the specifications and initial setup method of the SPM spindle motor system, and correctly set the parameters according to the descriptions in the following table.

Error parameter No.	Details	Related parameters
13017	The motor selected is of a motor series different from the drive unit's input voltage (200V/400V). Or a motor of an incompatible motor series is selected.	SP017
13019	- In a semi-closed loop control system, the setting value of SP019 is different from that of SP020. Set them to the same value. - SP019 is set to a value outside the setting range.	SP019
13032	The power supply type (SP032) is set, but a power supply unit is not connected. Always set the power supply type for the drive unit connected last on the NC optical communication cable.	SP032
13097	-The expansion sub side encoder resolution (SP097) is set to "0" for an encoder that requires the resolution expansion setting. If the upper 16 bits for the encoder resolution are "0", this should be set to "-1". -The expansion sub side encoder resolution (SP097) is set to a value other than "0" for an encoder that does not support the resolution expansion setting.	SP019,SP097
13098	-The expansion main side encoder resolution (SP098) is set to "0" for an encoder that requires the resolution expansion setting. If the upper 16 bits for the encoder resolution are 0, this should be set to "-1". -The expansion main side encoder resolution (SP098) is set to a value other than "0" for an encoder that does not support the resolution expansion setting.	SP020,SP098
13125	When the DC excitation mode (SP225/bit4) is set, the initial DC excitation level (SP125) is set to a value outside the setting range.	SP225, SP125
13126	When the DC excitation mode (SP225/bit4) is set, the final DC excitation level (SP126) is set to a value outside the setting range.	SP225, SP126
13127	When the DC excitation mode (SP225/bit4) is set, the initial DC time (SP127) is set to a value outside the setting range.	SP225, SP127
13225	The DC excitation mode (SP225/bit4) has been set before the axis passes the Z phase. Set the DC excitation mode after the axis passes the Z phase.	SP225

Revision History

Date of revision	Manual No.	Revision details
Sep. 2015	IB(NA)1501425-A	First edition created.
Sep. 2017	IB(NA)1501425-B	<ul style="list-style-type: none"> - "Precautions for Safety" was revised. - "Explanation of Type" was revised. - "Specifications List", "Characteristics", and "Outline Dimension Drawings" were revised. - "□" was deleted from each type name. - Following motors were added. SJ-BG090A/300-01(R), SJ-BG090B/300-03, SJ-BG090D/300-03 SJ-BG110F/240-01, SJ-BG120A/200-01(R), SJ-BG120C/200-01(R) SJ-BG180B/150-01, SJ-BG180D/150-01, SJ-BG180F/150-01 SJ-BG180H/150-01, SJ-BG240H/100-01, SJ-BG300L/080-01 SJ-BG160D/200-01, SJ-BG180F/200-01, SJ-BG240H/130-01 - The descriptions "(Normal specifications)" were added due to addition of high-speed specofocations. - SJ-BG150B/150-01□ was replaced by SJ-BG150D/150-01. - 2-axis drive unit was added to "Compatible spindle drive unit". - "PLG Serial Output Encoder (TS5690, MU1606 Series)" was revised. - "List of Cables and Connectors" was revised. - "Assembly and Installation" was revised. - Miswrite is corrected.
Mar. 2019	IB(NA)1501425-C	<ul style="list-style-type: none"> - "Precautions for Safety" was revised. - Built-in SPM spindle motor SJ-BGS Series was added. - SJ-BG135D/200-01 was added. - SJ-BG160D/200-01 was replaced by SJ-BG160D/200-03. - "Introduction" was revised. - "Specifications List", "Characteristics", and "Outline Dimension Drawings" were revised. - "Outline Dimension Drawings" in "PLG Serial Output Encoder (TS5690, MU1606 Series)" was revised. - "Cable Connection Diagram" was revised. - "Assembly and Installation" was revised. - "Precautions for Handling Built-in SPM Spindle Motor (BGS Series)" was added. - "Part System Connection Diagram" was revised. - "Setup" was added. - Miswrite is corrected.

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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.

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