MITSUBISHI ELECTRIC

Changes for the Better

MITSUBISHI CNC

Specifications and Instruction Manual

Linear Motor

IB-1501213(ENG)-A

Introduction

Thank you for selecting the Mitsubishi numerical control unit. This instruction manual describes the handling and caution points for using this AC servo/spindle.Incorrect handling may lead to unforeseen accidents, so always read this instruction manual thoroughly to ensure correct usage.
Make sure that this instruction manual is delivered to the end user. Always store this manual in a safe place.
In order to confirm if all function specifications described in this manual are applicable, refer to the specifications for each CNC.

Notes on Reading This Manual

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

Precautions for Safety

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

⚠ DANGER

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

⚠ WARNING

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

⚠ CAUTION

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

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

The signs indicating prohibited and mandatory matters are explained below.

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

The meaning of each pictorial sign is as follows.

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

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

The numeric control unit is configured of the control unit, operation board, servo drive unit, spindle drive unit, power supply, servo motor and spindle motor, etc.
In this section "Precautions for safety", the following items are generically called the "motor".

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

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

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

 **POINT**

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

⚠ WARNING

1. Electric shock prevention

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

⚠ WARNING

2. Injury prevention

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

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

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

(1)Handling

- The linear servo motor, direct-drive motor and built-in IPM spindle motor could adversely affect medical electronics such as pacemakers, etc., therefore, do not approach the rotor.
- Do not place magnetic materials as iron.
- When a magnetic material as iron is placed, take safety measure not to pinch fingers or hands due to the magnetic attraction force.
- Remove metal items such as watch, piercing jewelry, necklace, etc.
- Do not place portable items that could malfunction or fail due to the influence of the magnetic force.
- When the rotor is not securely fixed to the machine or device, do not leave it unattended but store it in the package properly.

(2)Transportation and storage

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

(3)Installation

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

⚠ CAUTION

1. Fire prevention

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

2. Injury prevention

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

⚠ CAUTION

3. Various precautions

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

(1) Transportation and installation

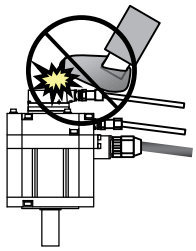
⚠ **Correctly transport the product according to its weight.**

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

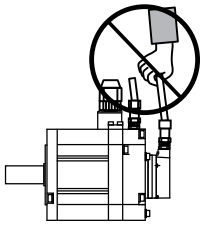
⚠ **Do not stack the products above the tolerable number.**

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

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



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



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

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

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

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

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

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

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

⚠ **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 detectors are precision devices, so do not drop them or apply strong impacts to them.**

⚠ CAUTION

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

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

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

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

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

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

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

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

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

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

⚠ **Store the motor in the package box.**

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

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

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

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

⚠ 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.**

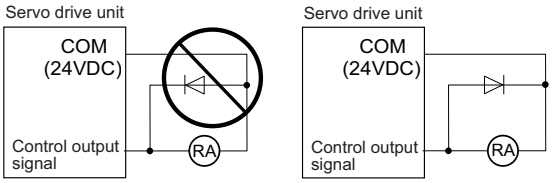
⚠ **Always connect the motor to the drive unit's output terminals (U, V, W).**

⚠ **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.**

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

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

(3) Trial operation and adjustment

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

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

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

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

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

⚠ CAUTION

(4) Usage methods

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

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

Do not disassemble or repair this product.

Never make modifications.

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

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

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

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

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

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

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

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

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

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

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

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

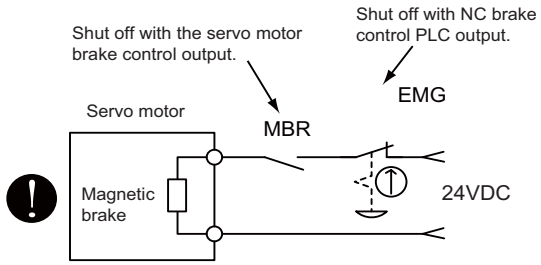
(5) Troubleshooting

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

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

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

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



⚠ CAUTION

(6) Maintenance, inspection and part replacement

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

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

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

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

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

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

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

(7) Disposal

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

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

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

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

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

(8) Transportation

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

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

(9) General precautions

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

Treatment of waste

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

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

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

Disposal

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

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

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

Trademarks

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

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

本製品の取扱いについて

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

Handling of our product

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

본 제품의 취급에 대해서

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

WARRANTY

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

1. Warranty Period and Coverage

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

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

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

2. Service in Overseas Countries

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

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

Whether during or after the term of warranty, we assume no responsibility for any damages arising from causes for which we are not responsible, any losses of opportunity and/or profit incurred by the customer due to a failure of this product, any damages, secondary damages or compensation for accidents arising under specific circumstances that either foreseen or unforeseen by Mitsubishi Electric, any damages to products other than this product, or compensation for any replacement work, readjustment and startup test run of on-site machines or any other operations conducted by the customer.

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.

Precautions of how to Handle Linear Motors

This section is on storage, installation, maintenance and disposal. Incorrect handling may lead to unforeseen accidents, so ensure correct usage according to the description in this section.
Even if not mentioned in this section, there may be a situation that may be dangerous. In such a situation, please take a measure to prevent the danger.

⚠ WARNING

1. All the processes as storage, installation, maintenance and disposal must be done by a qualified technician.
2. As the product has permanent magnets, not only motor operators but also machine or device operators must take special care in handling. Pay attention so that a person with a medical device such as pacemaker won't approach the product.
3. Do not place magnetic material such as iron close to the product.
4. Before handling, remove metal items such as watch, piercing jewelry, necklace, etc.
5. In installing the product and peripheral structures, make sure to use nonmagnetic tools (Explosion-proof beryllium copper alloy safety tool: Nihon Gaishi, etc).
6. Do not leave the product (primary and secondary side) unattended.
   →When they are not fixed to the machine or device, make sure to store them in the package.
7. Immediately stop using the product if any abnormality is found about the product.

⚠ CAUTION

1. Do not arrange the product, or do not give a shock.
2. Do not get on top of or place heavy objects on the product.
3. Correctly and securely perform the wiring.
   →Especially, fix the terminals or connectors of the power cables firmly enough.
4. Perform the wiring after installing the product to the machine and device.
5. Environment in transportation, storage and usage must follow the specified conditions.

Precautions of how to Handle Linear Motors

1 Production Outline

1.1 Structure of Liner Servo Motor

Our linear servo motor consists mainly of the primary side (LM-FP) with cores and coils, and the secondary side (LM-FS) with yoke and permanent magnets.
As the secondary side has permanent magnets, take special care in handling.

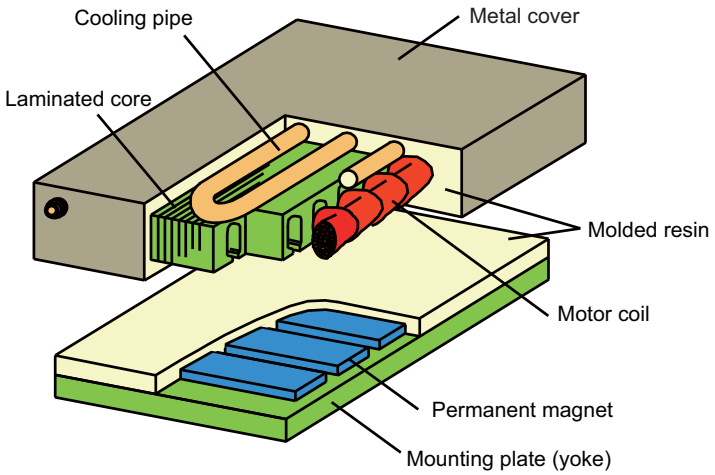


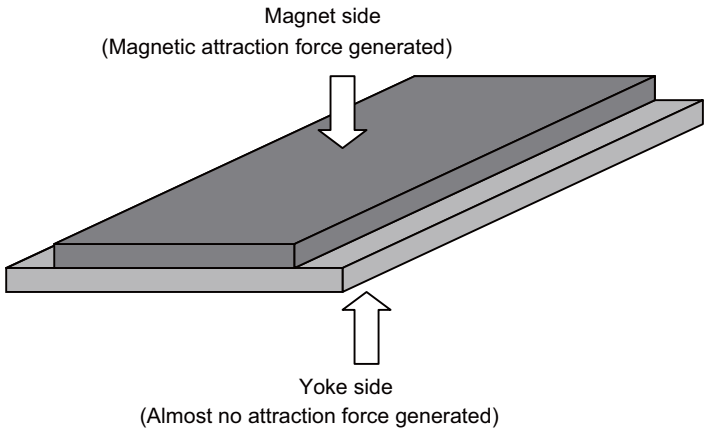
Fig. 1 Structure of linear servo motor

1.2 Primary Side

The primary side has motor cores to which windings are applied. The cores are protected by mold.
Compared with metal parts, the mold is susceptible to breaking or cracking due to shock or stress, which may deteriorate the product's quality.
Therefore, pay special attention in carrying and installing not to damage the mold.

1.3 Secondary Side

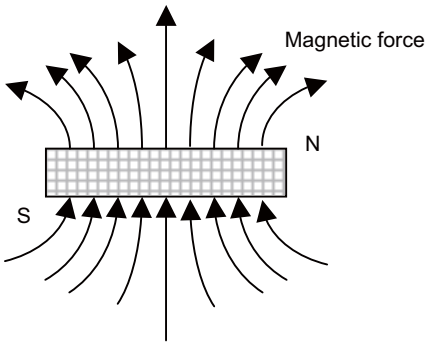
The secondary side has a yoke with permanent magnets on. The mold is applied to the surface of it.
As it has permanent magnets, magnetic attraction force is generated between it and magnetic material as iron.
The magnetic attraction force is generated mainly on the magnet side. (Almost no attraction force is generated on the yoke side.)
The linear servo motor uses an extremely powerful magnet, so if the motor is attracted on the metal surface or magnets are attracted to each other, an attraction force of maximum t is generated, and possibly resulting in serious bodily injury. Once attached, they cannot be separated without destruction of the product.
Therefore, take safety measure in handling to avoid accidents due to the attraction force.
In addition, the magnetic force is released into the air, so do not make devices that are affected by the magnetic force such as pacemaker, watch, etc. approach to the product.



<Permanent magnet>

Permanent magnet releases the magnetic force into the air all the time.
So the magnetic attraction force is generated if magnetic material is placed close to the magnet.
In addition, as the magnetic force is released into the air, devices susceptible to the magnetic force may be damaged if they are placed near the product.
As our linear servo motor has high quality magnets, take special care in handling.

The size of the magnetic attraction force is about 4 [kgf/cm^2] between a magnet and iron.
↓
However, when an iron plate completely attaches to LM-FS50-480, the attraction force size is about 20cm × 48cm × 4kgf/cm^2 = 3840kgf, so they cannot be separated easily.



Especially if two secondary sides are placed close to each other, it is highly dangerous as the magnetic attraction force will be greatly strong. For the secondary side, take the sufficient safety measure.
If more than one secondary side are used together, or when you exchange secondary sides, never leave the secondary sides unattended.

2 Transportation/Storage

⚠ WARNING

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

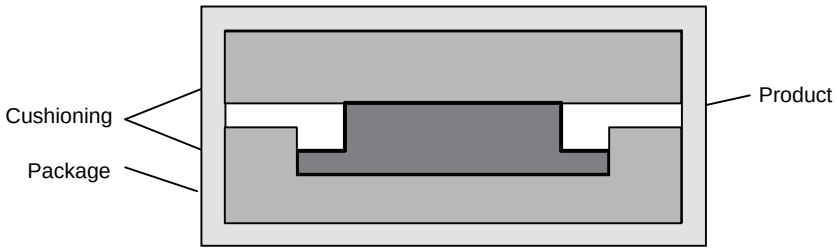
⚠ CAUTION

1. Follow the conditions below in transportation and storage.
   Storage temperature : -15°C to +50°C (with no freezing)
   Storage humidity : 90%RH or less (with no dew condensation)
   Atmosphere :
   - Indoors (where the product is not subject to direct sunlight)
   - No corrosive gas, combustible gas or dust
   - No oil or water splash

   Vibration : 5G or less
2. Do not arrange the product, or do not give a shock.
3. Do not get on top of or place heavy objects on the product.
4. When suspending the product with lifting sling, etc, do not give a shock or stress to the mold.
5. If the product has been stored for a long time, please contact your local service center or service station.

⚠ POINT

The secondary side's package structure is as in the figure below. The structure avoids dangers caused by the magnetic attraction force released outside the package.

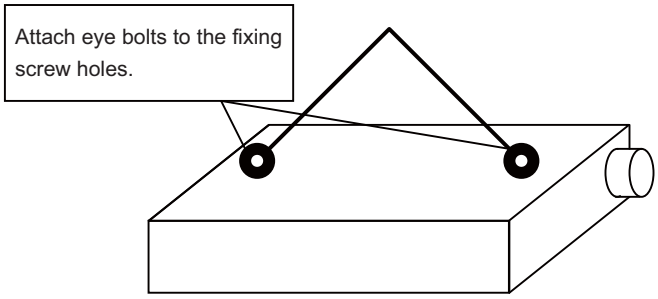


2.1 How to Suspend the Product

(1) Primary side (coil)

Before you suspend the primary side (coil) alone, attach eye bolts, etc. to the fixing screw holes for a slider. Please ensure that the wires put no stress on the lead wire, connector or cooling vent when suspending the product.

When suspending the product, support it at the both ends in the lengthwise direction (two or more points).



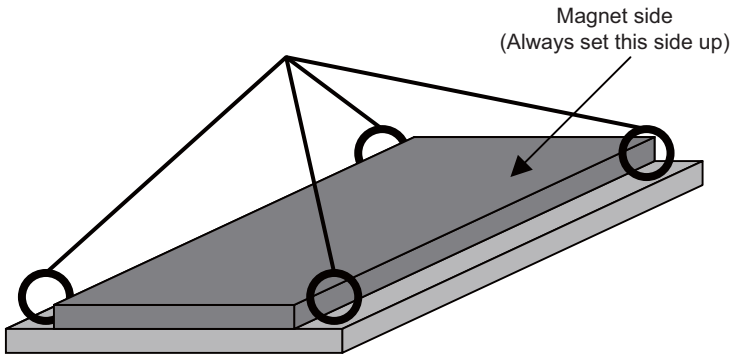
We recommend that you attach the primary side (coil) to the slider and then attach the hanging tools to the slider before suspending the primary side.

(Note) General sliders have larger dimensions than the primary side (coil), therefore the sliders can protect itself mechanically. But they may obscure the product's peripheral area from view, therefore you have to prepare wider working area.

(2) Secondary side

Before you suspend the secondary side, attach the hanging tools such as eye bolts to the screw holes for hanging tool.

In order to avoid any risks posed by the magnetic attraction force, always place the secondary side with its magnet side up. Support it at four points to keep this posture.



3 Installation

⚠ WARNING

1. Installation must be done by a qualified technician.
2. Pay attention so that a person with a medical device such as pacemaker won't approach the product. The device may be affected by the permanent magnets.
3. Do not place magnetic material such as iron close to the product.
4. Before installing, remove metal items such as watch, piercing jewelry, necklace, etc.
5. In installing the product and peripheral structures, make sure to use nonmagnetic tools (Explosion-proof beryllium copper alloy safety tool: Nihon Gaishi, etc).
6. Do not leave the permanent magnet of secondary side unattended after taking it out from the package. Pay special attention not to approach the permanent magnet except a worker during installation.
7. Immediately stop using the product if any abnormality is found about the product.
8. Perform the installation correctly following the example in this manual.
9. When multiple operators are engaged in the operation, confirm that no operator is within the range of motion before energizing the product. If any operator remains in the range of motion, take measures to prevent the motion with interlock system, etc.
10. 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

1. Do not arrange the product, or do not give a shock.
2. Do not get on top of or place heavy objects on the product.
3. Correctly and securely perform the wiring.
   → Especially, fix the terminals or connectors of the power cables firmly enough.
4. Perform the wiring after installing the product to the machine and device.
5. If iron chips, etc. adhere to the product during installation, completely remove them.
6. Do not install with wet hands.
7. Perform the installation following the conditions below.
   Ambient temperature : 0°C to +40°C (With no freezing)
   Ambient humidity : 80%RH or less (With no dew condensation)
   Atmosphere :
   - Indoors (where the product is not subject to direct sunlight)
   - No corrosive gas, combustible gas or dust
   - No oil or water splash

   Vibration : 5G or less
   Altitude : 1000m or less

4 Maintenance/Inspection

⚠ WARNING

1. Maintenance, inspection or parts replacement must be done by a qualified technician.
2. Pay attention so that a person with a medical device such as pacemaker won't approach the product. The device may be affected by the permanent magnets.
3. Make sure to turn OFF the power before starting maintenance, inspection and parts replacement.
4. Do not place magnetic material such as iron close to the product.
5. Before starting maintenance, inspection or parts replacement, remove metal items such as watch, piercing jewelry, necklace, etc.
6. In installing the product and peripheral structures, make sure to use nonmagnetic tools (Explosion-proof beryllium copper alloy safety tool: Nihon Gaishi, etc).
7. Do not leave the product (primary and secondary side) unattended.
   →Particularly when you replace the secondary sides, observe the following sequence strictly:
   first, store the detached product in the package, take the secondary side to be replaced, and then attach it.
   If there are any magnetic substances around, take safety measures in order to avoid any risks posed by the magnetic attraction force of the secondary side.
8. When multiple operators are engaged in the operation, confirm that no operator is within the range of motion before energizing the product. If any operator remains in the range of motion, take measures to prevent the motion with interlock system, etc

Precautions of how to Handle Linear Motors

⚠ CAUTION

1. Do not arrange the product, or do not give a shock.
2. Do not get on top of or place heavy objects on the product.
3. Correctly and securely perform the wiring.
   →Particularly, fix the terminals or connectors of the power cables firmly enough.
4. The accessory cables (both power cable and thermal cable) have a hard-wired specification. Therefore fix them firmly enough to a motor or equipment.
5. Perform the wiring after installing the product to the machine and device.
6. If iron chips, etc. adhere to the product during installation, completely remove them.
7. Do not work with wet hands.
8. Perform the operation following the conditions below.
   Ambient temperature : 0°C to +40°C (with no freezing)
   Ambient humidity : 80%RH or less (with no dew condensation)
   Atmosphere :
   - Indoor (where the product is not subject to direct sunlight.)
   - No corrosive gas, flammable gas or dust.
   - No oil or water splash
   Vibration : 5G or less
   Altitude : 1000m or less

Precautions of how to Handle Linear Motors

< Maintenance/Inspection >

Periodic inspection is required so that the unexpected failures can be prevented. The inspection items and the remedies are described in the following table.

Location	Item	Detail	Remedy for errors
Primary side (Coil)	Appearance	- Confirm that there are no cracks or breaks.	- If any cracks or breaks are found, replace the product.
		- Confirm that there are no traces of rubbing.	- If any traces of rubbing are found, remove the causes of rubbing. Replace the product in case that rubbing is considerable, or it causes cracks or breaks.
		- Confirm that no water or oil remains. → Continuous wet condition may cause considerable insulation degradation.	- If it is severely wet, enhance the water and oil resistance. - If the insulation resistance is below the specified value, replace the product.
	Insulation resistance	- Measure the insulation resistance with a megger tester. <Specified value> Room temp. (about 20°C) : 100MΩ or more High temp. (just after operation) : 10MΩ or more These are the values of Coil-GND, Coil-Thermal and Thermal-GND.	- If the insulation resistance is below the specified value, replace the product.
	Loosened screw	- Confirm that no fixing screws are loosened.	- If any screws are loosening, tighten them. (Note) Replacing bolts at the time of inspection is recommended.
	Lead wire Connector	- Confirm that there is no abnormality such as discoloration, cracks or breaks of the lead wire or connector.	- If there is any abnormality, replace the product.
Secondary side (Magnet)	Appearance	- Confirm that there are no cracks or breaks.	- If any cracks or breaks are found, replace the product.
		- Confirm that there are no traces of rubbing.	- If any traces of rubbing are found, remove the causes of rubbing. Replace the product in case that rubbing is considerable, or it causes cracks or breaks.
		- Confirm that no water or oil remains.	- If it is severely wet, enhance the water and oil resistance.
	Loosened screw	- Confirm that no fixing screws are loosened.	- If any screws are loosening, tighten them. (Note) Replacing bolts at the time of inspection is recommended.

5 Disposal

⚠ WARNING

1. Disposal work must be done by a qualified technician.
2. Do not place the devices such as pacemakers and watches near the product. The magnetic force of the permanent magnet may cause damage or malfunction of those devices.
3. Do not place the magnetic substance (e.g. iron) near the product.
4. Put off the metal products such as watch, pierce and necklace before disposing of the product.
5. Use nonmagnetic tools (Explosion-proof beryllium copper alloy safety tool: Nihon Gaishi, etc) when disposing of the product.
6. Do not leave the product (primary side or secondary side) alone.
7. Dispose of the motor primary side as general industrial waste.
8. After demagnetizing the motor secondary side with the heat of over 300°C, dispose of it as general industrial waste.
9. If demagnetization is not possible, please return the product to Mitsubishi Electric.
   →In such a case, return the motor after storing it in the package.

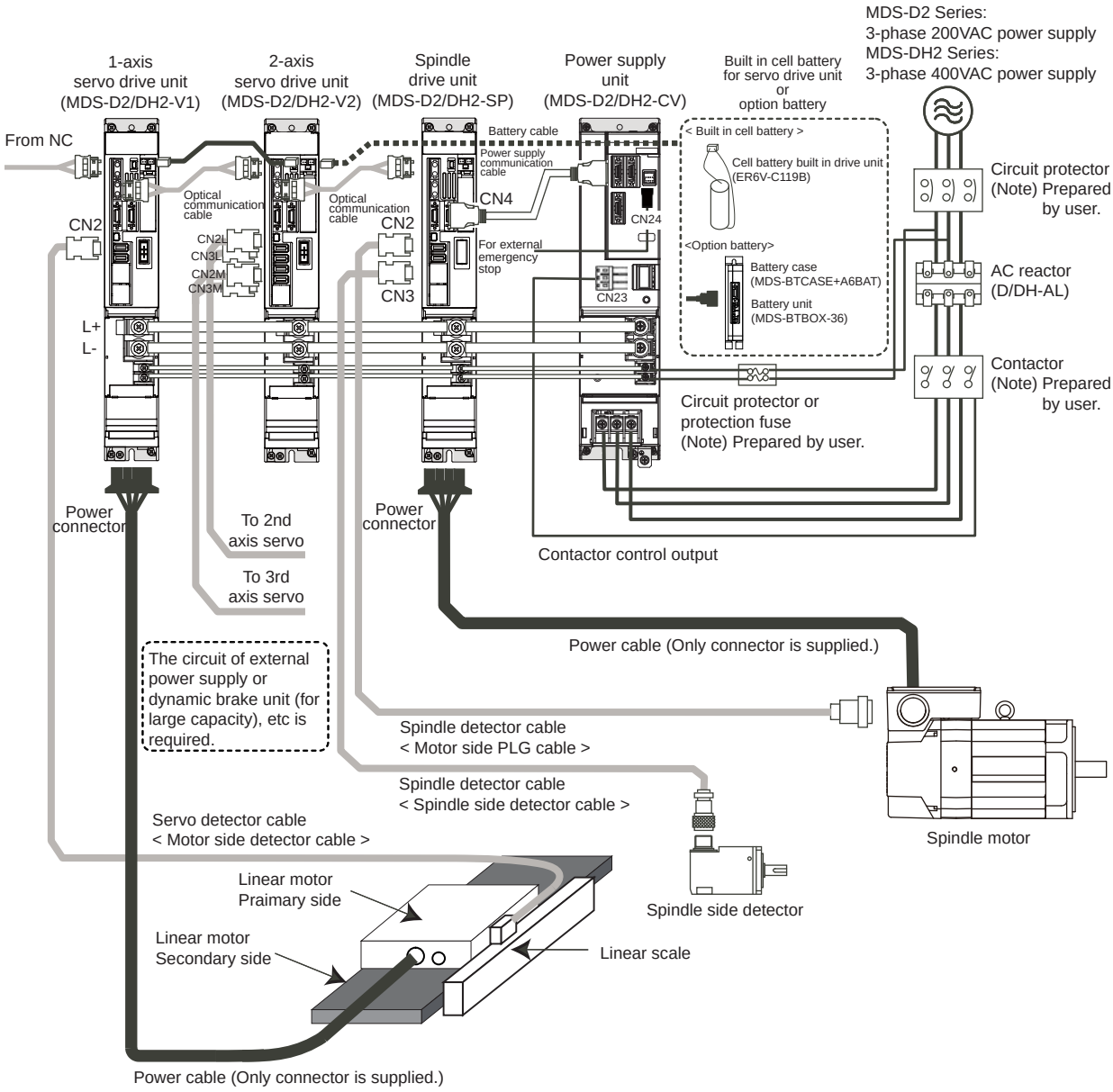
Contents

1

Introduction

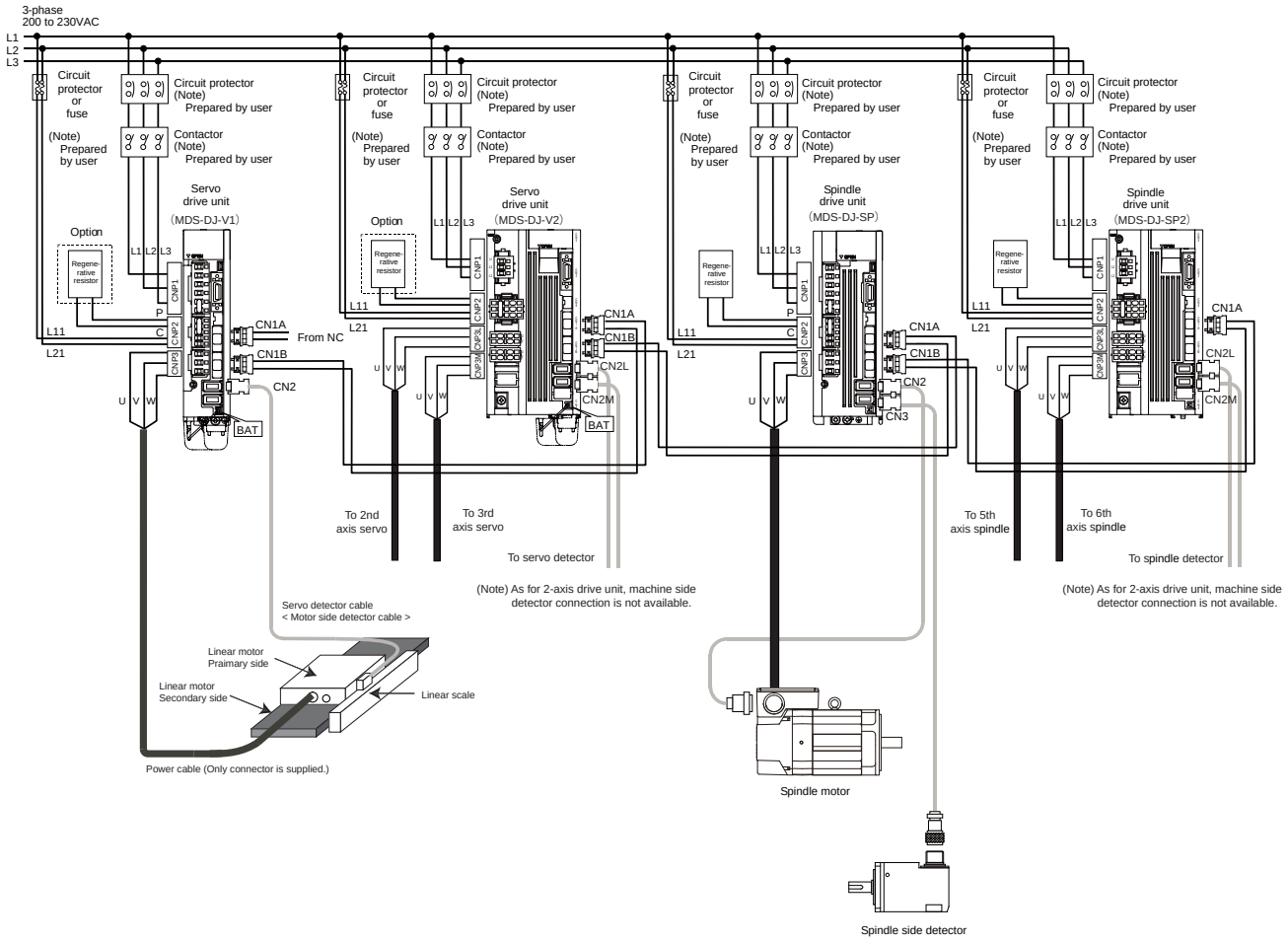
1.1 Drive System Configuration

1.1.1 System Configuration



For details on the drive units, refer to “MDS-D2/DH2 Series Specifications Manual” (IB-1501124(ENG)).

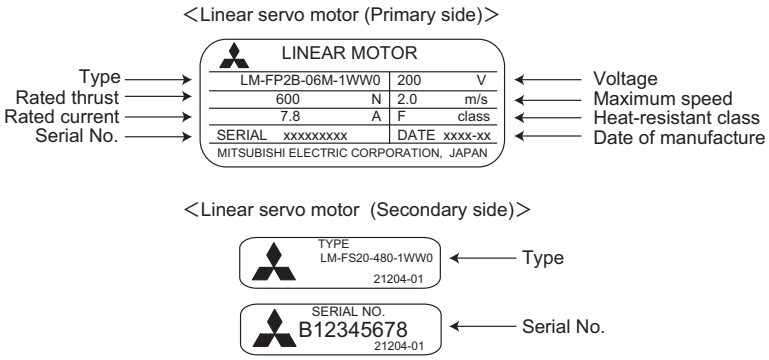
< MDS-DJ Series >



For details on the drive units, refer to "MDS-DJ Series Specifications Manual" (IB-1501130(ENG)).

1.2 Explanation of Type

1.2.1 Linear Servo Motor Type



Nameplate

LM-F Series

< Primary side: Coil >

LM - FP (1) (2) - (3) M - 1WW0

(2) Length

Symbol	Length
A	170mm
B	290mm
D	530mm
F	770mm
H	1010mm

Maximum speed

Symbol	Maximum speed
M	2.0m/s

(3) Rated thrust

Symbol	Rated thrust
03	300N
06	600N
12	1200N
18	1800N
24	2400N
36	3600N
48	4800N
60	6000N

(1) Width

Symbol	Width
2	120mm
4	200mm
5	240mm

< Secondary side: Magnet >

LM - FS (1) 0 - (2) - 1WW0

(2) Length

Symbol	Length
384	384mm
480	480mm
576	576mm

(1) Width

Symbol	Width
2	120mm
4	200mm
5	240mm

(Note) The linear dimension of 384mm is available for LM-FS20 only.

2

Specifications

2.1 Linear Servo Motor

2.1.1 Specifications List

LM-F Series

(1) For drive with standard unit and motor

		LM-F Series				
Linear servo motor type		LM-FP2A-03M	LM-FP2B-06M	LM-FP2D-12M	LM-FP2F-18M	LM-FP4B-12M
Type	Primary side type	LM-FP2A-03M	LM-FP2B-06M	LM-FP2D-12M	LM-FP2F-18M	LM-FP4B-12M
	Secondary side type	LM-FS20- ☐	LM-FS20- ☐	LM-FS20- ☐	LM-FS20- ☐	LM-FS40- ☐
Compatible servo drive unit type	MDS-D2-V1-	40	40	80	160	80
	MDS-DH2-V1-	-	-	-	-	-
	MDS-D2-V2-	4020 (L) 4040 8040 (M)	4020 (L) 4040 8040 (M)	8040 (L) 8080 16080 (M)	16080 (L) 160160	8040 (L) 8080 16080 (M)
	MDS-D2-V3-	404040	404040	-	-	-
	MDS-DJ-V1-	40	40	80	-	80
Power facility capacity [kVA]		2.0	3.5	5.5	10	7.5
Current	Rated (natural-cooling) [Arms]	3.5	3.9	7.7	11.9	7.5
	Rated (liquid-cooling) [Arms]	6.9	7.8	15.3	23.2	15.7
	Maximum [Arms]	26.1	28.1	57.8	84.7	55.7
Cooling method		Natural-cooling, liquid-cooling				
Thrust	Rated (natural-cooling) [N]	150	300	600	900	600
	Rated (liquid-cooling) [N]	300	600	1200	1800	1200
	Maximum [N]	900	1800	3600	5400	3600
Maximum speed [m/s] (Note)		2.0				
Magnetic attraction force [N]		2500	4500	9000	13500	9000
Mass	Primary side [kg]	5	9	18	27	14
	Secondary side [kg]	5.8 (384mm) 7.1 (480mm) 9.0 (576mm)	5.8 (384mm) 7.1 (480mm) 9.0 (576mm)	5.8 (384mm) 7.1 (480mm) 9.0 (576mm)	5.8 (384mm) 7.1 (480mm) 9.0 (576mm)	13.5 (480mm) 16.0 (576mm)
Recommended load mass ratio		15 times linear servo motor primary side mass maximum				
Structure		Open (Degree of protection IP00)				
Environment	Ambient temperature	0 to 40˚C (with no freezing), Storage: -15˚C to 55˚C (with no freezing)				
	Ambient humidity	80%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)				
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust				
	Vibration	49m/s ^{2} or less				
	Altitude	1000 meters or less above sea level				

(Note) The above value may be limited by the maximum speed of the linear scale.

		LM-F Series			
Linear servo motor type		LM-FP4D-24M	LM-FP4F-36M	LM-FP4H-48M	LM-FP5H-60M
Type	Primary side type	LM-FP4D-24M	LM-FP4F-36M	LM-FP4H-48M	LM-FP5H-60M
	Secondary side type	LM-FS40- ☐	LM-FS40- ☐	LM-FS40- ☐	LM-FS50- ☐
Compatible servo drive unit type	MDS-D2-V1-	160	320	320	-
	MDS-DH2-V1-	-	-	-	200 (Note 2)
	MDS-D2-V2-	16080 (L) 160160	-	-	-
Power facility capacity [kVA]		18	18	18	22
Current	Rated (natural-cooling) [Arms]	14.1	24.7	33.6	21.1
	Rated (liquid-cooling) [Arms]	28.6	49.2	65.8	42.2
	Maximum [Arms]	101.9	174.9	237.4	142.0
Cooling method		Natural-cooling, liquid-cooling			
Thrust	Rated (natural-cooling) [N]	1200	1800	2400	3000
	Rated (liquid-cooling) [N]	2400	3600	4800	6000
	Maximum [N]	7200	10800	14400	18000
Maximum speed [m/s] (Note 1)		2.0			
Magnetic attraction force [N]		18000	27000	36000	45000
Mass	Primary side [kg]	28	42	56	67
	Secondary side [kg]	13.5 (480mm) 16.0 (576mm)	13.5 (480mm) 16.0 (576mm)	13.5 (480mm) 16.0 (576mm)	20.0 (480mm) 26.0 (576mm)
Recommended load mass ratio		15 times linear servo motor primary side mass maximum			
Structure		Open (Degree of protection IP00)			
Environment	Ambient temperature	0 to 40˚C (with no freezing), Storage: -15˚C to 55˚C (with no freezing)			
	Ambient humidity	80%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)			
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust			
	Vibration	49m/s ^{2} or less			
	Altitude	1000 meters or less above sea level			

(2) For drive with one unit and two motor

		LM-F Series (driving with one unit and two motors)					
Linear servo motor type		LM-FP2A-03M	LM-FP2B-06M	LM-FP2D-12M	LM-FP2F-18M	LM-FP4B-12M	LM-FP4D-24M
Type	Primary side type	LM-FP2A-03M	LM-FP2B-06M	LM-FP2D-12M	LM-FP2F-18M	LM-FP4B-12M	LM-FP4D-24M
	Secondary side type	LM-FS20- ☐	LM-FS20- ☐	LM-FS20- ☐	LM-FS20- ☐	LM-FS40- ☐	LM-FS40- ☐
Compatible servo drive unit type	MDS-D2-V1-	80	80	160	320	160	320
	MDS-D2-V2-	8040 (L) 8080 16080 (M)	8040 (L) 8080 16080 (M)	16080 (L) 160160	-	16080 (L) 160160	-
	MDS-DJ-V1-	80	80	-	-	-	-
Power facility capacity [kVA]		4.0	7.0	11.0	20.0	15.0	36.0
Current	Rated (natural-cooling) [Arms]	6.9	7.8	15.3	23.8	15.1	28.3
	Rated (liquid-cooling) [Arms]	13.8	15.6	30.5	46.4	31.4	57.3
	Maximum [Arms]	52.2	56.2	115.7	169.4	111.4	203.9
Cooling method		Natural-cooling, liquid-cooling					
Thrust	Rated (natural-cooling) [N]	300	600	1200	1800	1200	2400
	Rated (liquid-cooling) [N]	600	1200	2400	3600	2400	4800
	Maximum [N]	1800	3600	7200	10800	7200	14400
Maximum speed [m/s] (Note 1)		2.0					
Magnetic attraction force (per one motor) [N]		2500	4500	9000	13500	9000	18000
Mass	Primary side [kg]	5 × 2	9 × 2	18 × 2	27 × 2	14 × 2	28 × 2
	Secondary side [kg]	5.8 (384mm) 7.1 (480mm) 9.0 (576mm)	5.8 (384mm) 7.1 (480mm) 9.0 (576mm)	5.8 (384mm) 7.1 (480mm) 9.0 (576mm)	5.8 (384mm) 7.1 (480mm) 9.0 (576mm)	13.5 (480mm) 16.0 (576mm)	13.5 (480mm) 16.0 (576mm)
Recommended load mass ratio		15 times linear servo motor primary side mass maximum					
Structure		Open (Degree of protection IP00)					
Environment	Ambient temperature	0 to 40˚C (with no freezing), Storage: -15˚C to 55˚C (with no freezing)					
	Ambient humidity	80%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)					
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust					
	Vibration	49m/s ^{2} or less					
	Altitude	1000 meters or less above sea level					

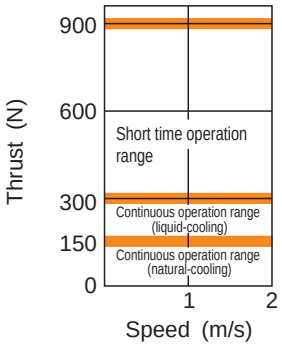
(Note 1) The above value may be limited by the maximum speed of the linear scale.

(Note 2) 400V specification is applied.

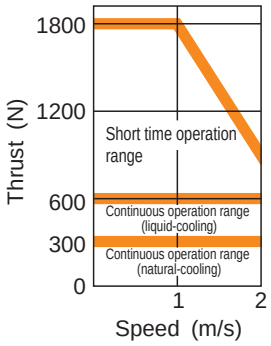
2.1.2 Thrust Characteristics

(1) LM-F Series

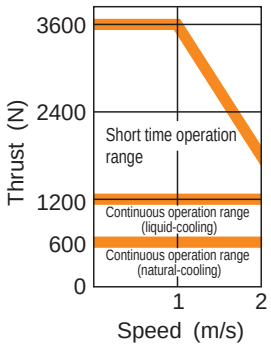
LM-FP2A-03M



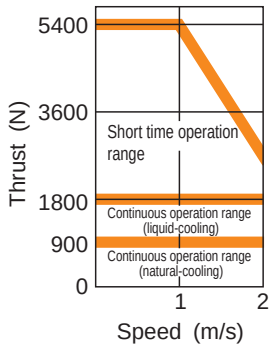
LM-FP2B-06M



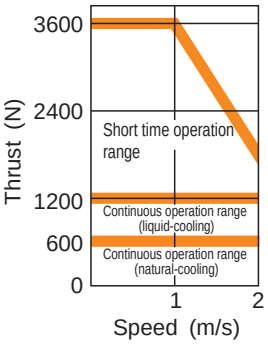
LM-FP2D-12M



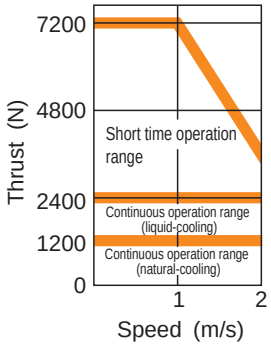
LM-FP2F-18M



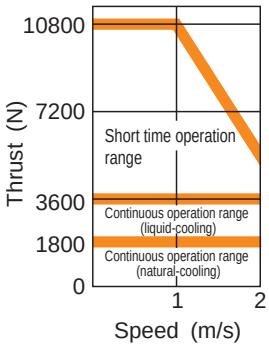
LM-FP4B-12M



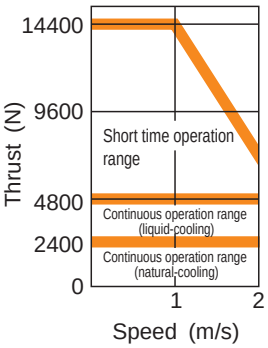
LM-FP4D-24M



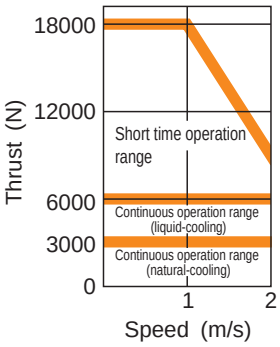
LM-FP4F-36M



LM-FP4H-48M



LM-FP5H-60M



(Note) The above graphs show the data when applied the input voltage of 200VAC(400VAC for FP5H). When the input voltage is 200VAC(400VAC for FP5H) or less, the short time operation range is limited.

2.1.3 Liquid Cooling Specification

Type	Required cooling ability (W)	Cooling liquid amount (L/min at 20° C)
LM-FP2A-03M	100	5L/min
LM-FP2B-06M	100	
LM-FP2D-12M	400	
LM-FP2F-18M	700	
LM-FP4B-12M	400	
LM-FP4D-24M	700	
LM-FP4F-36M	1000	
LM-FP4H-48M	1300	
LM-FP5H-60M	2000	

⚠ CAUTION

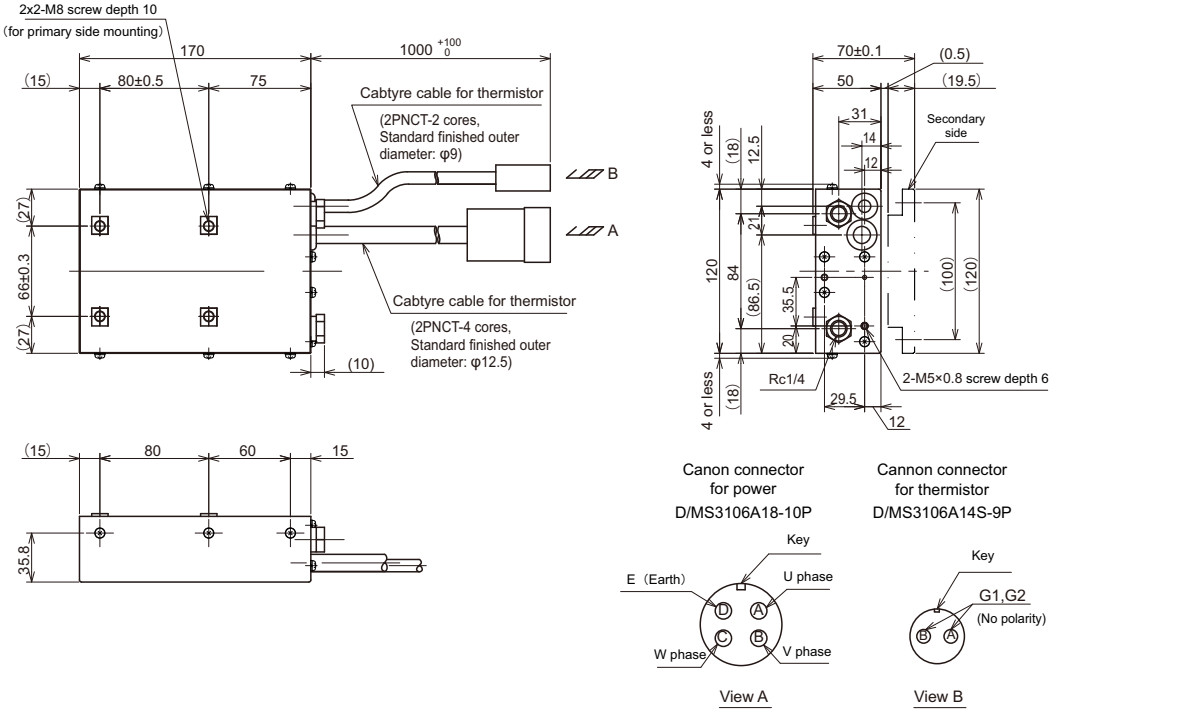
1. The required cooling capability (W) is not a specified value, but a reference value.
2. Customer is responsible for designing the cooling system, including piping to the coolant pipe embedded in the primary (coil) side, installing the pipes, and selecting parts, cooling device (chiller) and coolants.
3. Make sure to add an equipment, such as a filter, to the flow path to avoid foreign matters from flowing in the coolant pipe.
4. Customer should select appropriate liquid-cooling pipes and joints so that no leakage will occur. For the liquid-cooling pipes, select the ones that have enough bending tolerance.
5. We recommend that the liquid poured into the coolant pipe be at room temperature (around 20 degree C) or below. When the temperature is lower, the cooling effect will be enhanced, but dew condensation may be caused.
6. The coolant pipes are made of copper, so select a rust-preventive agent that won't cause copper corrosion, and add it to the coolant.

2.1.4 Outline Dimension Drawings

< LM-F Series Primary side >

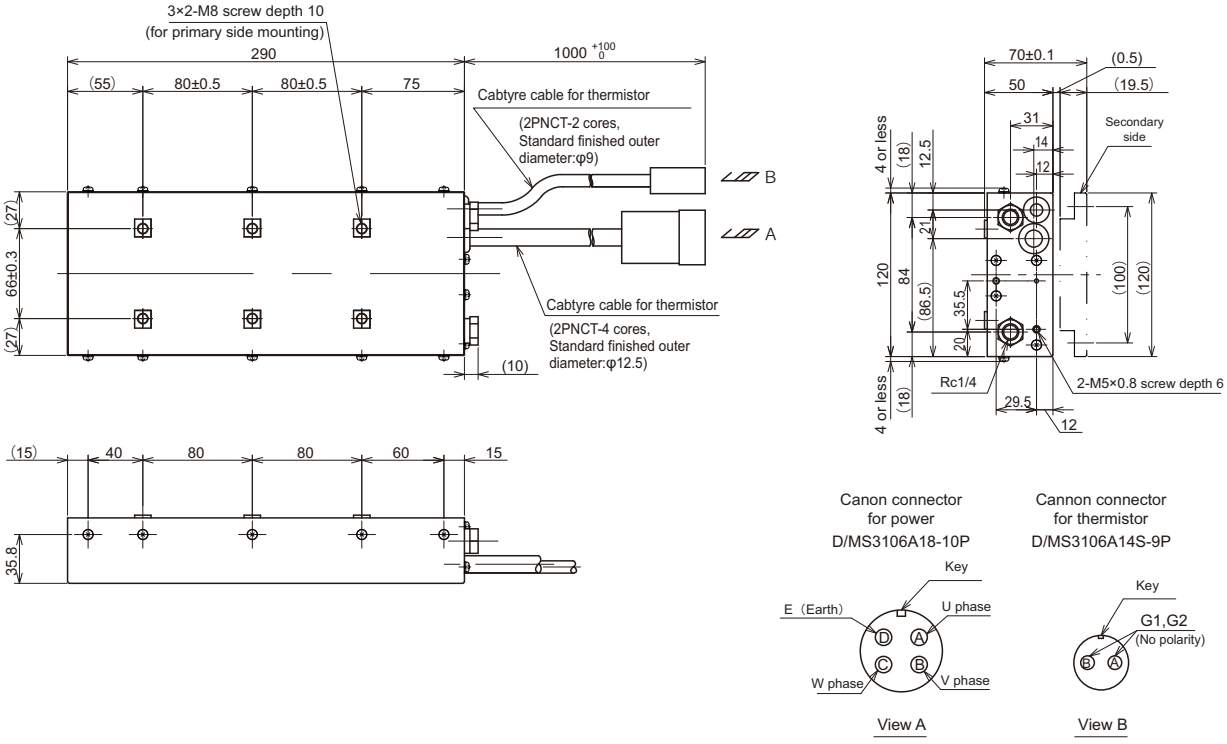
[LM-FP2A-03M-1WW0]

[Unit:mm]



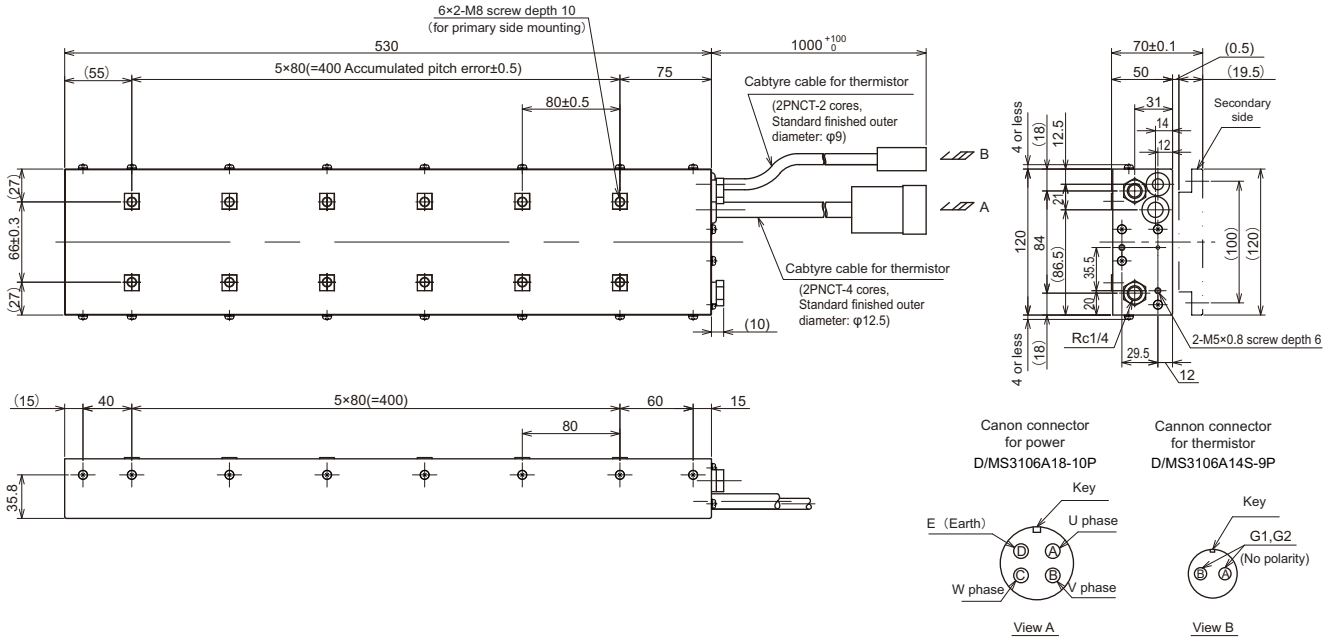
[LM-FP2B-06M-1WW0]

[Unit:mm]



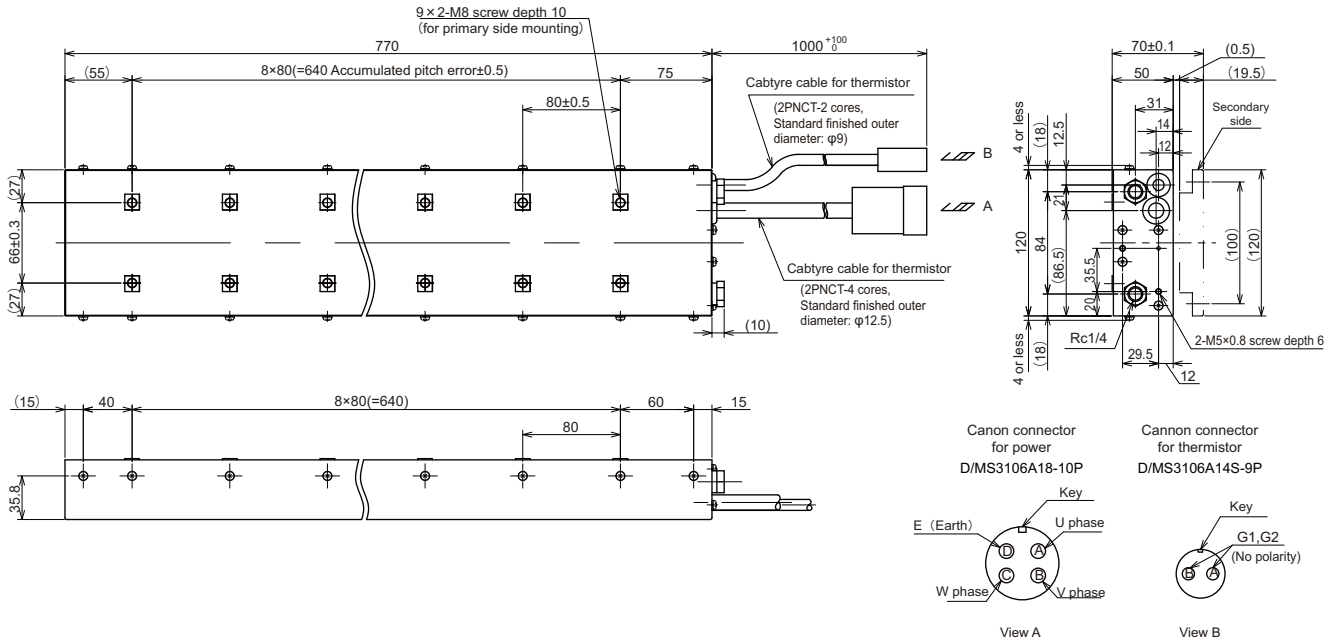
[LM-FP2D-12M-1WW0]

[Unit:mm]



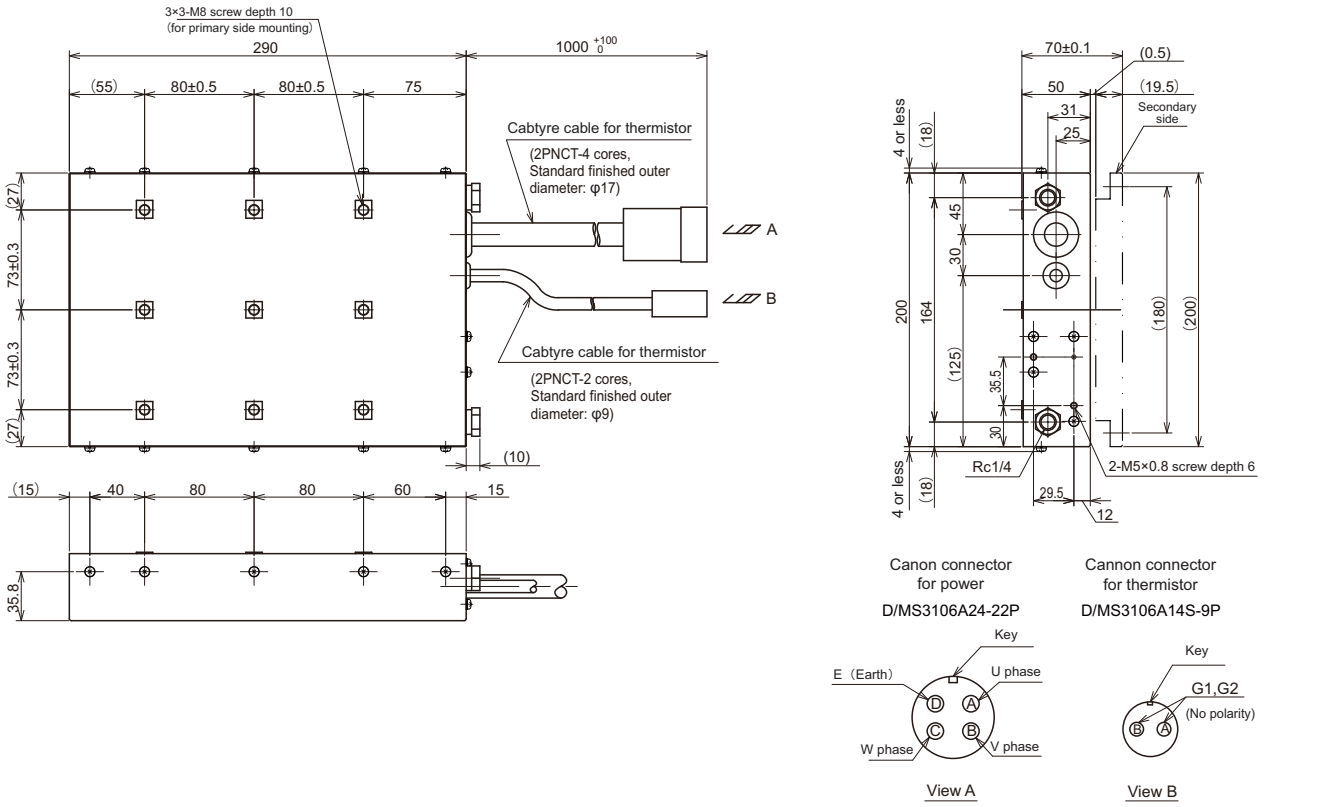
LM-FP2F-18M-1WW0

[Unit:mm]



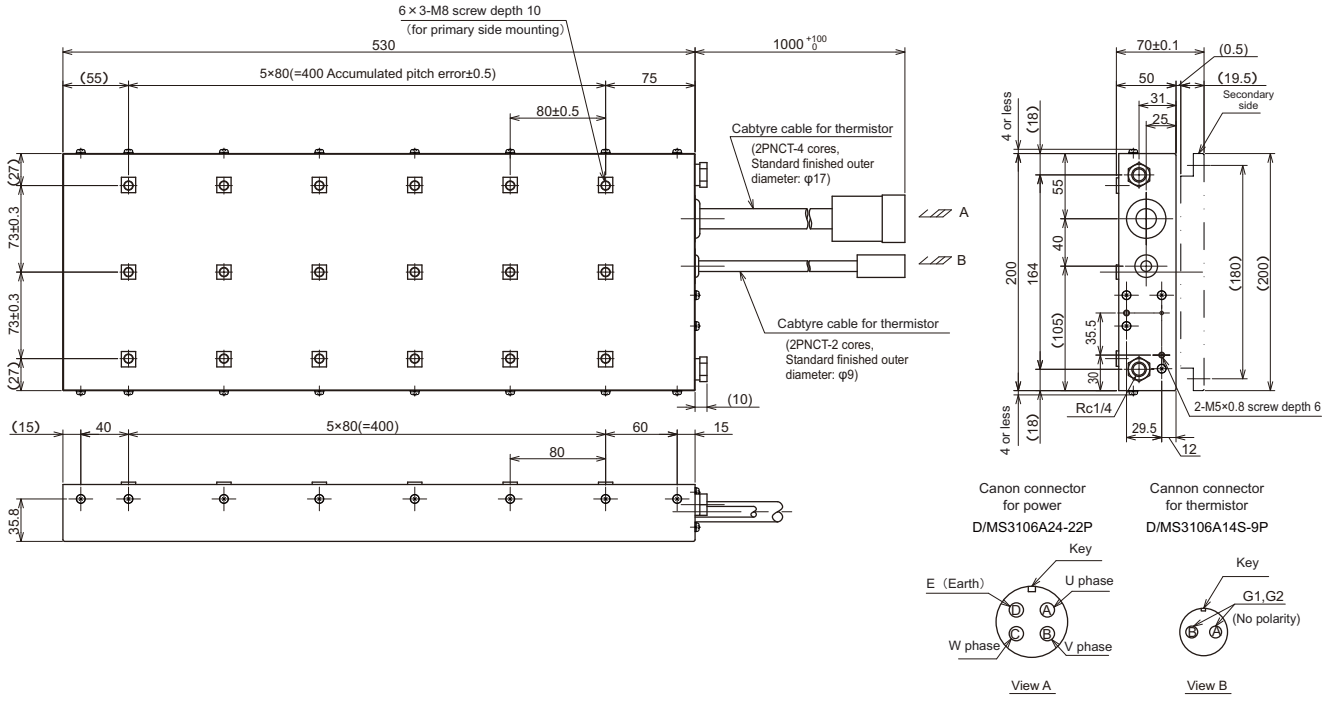
[LM-FP4B-12M-1WW0]

[Unit:mm]



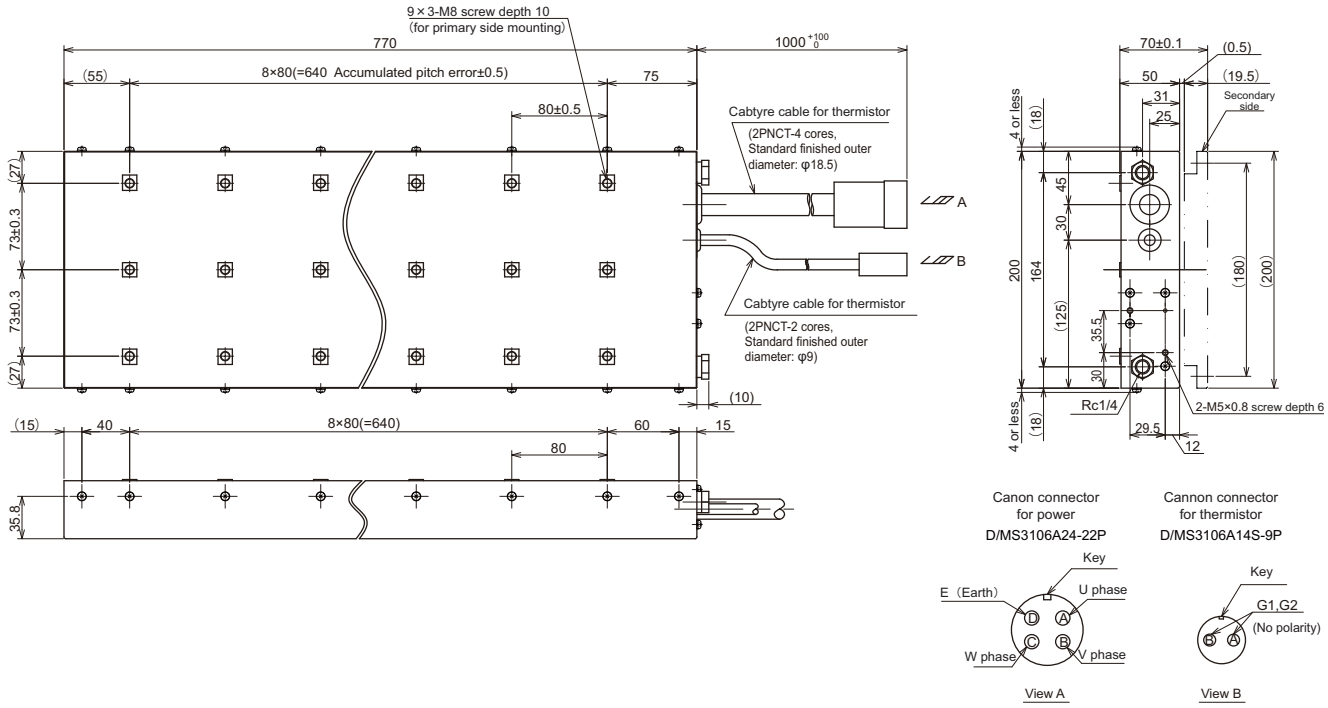
[LM-FP4D-24M-1WW0]

[Unit:mm]



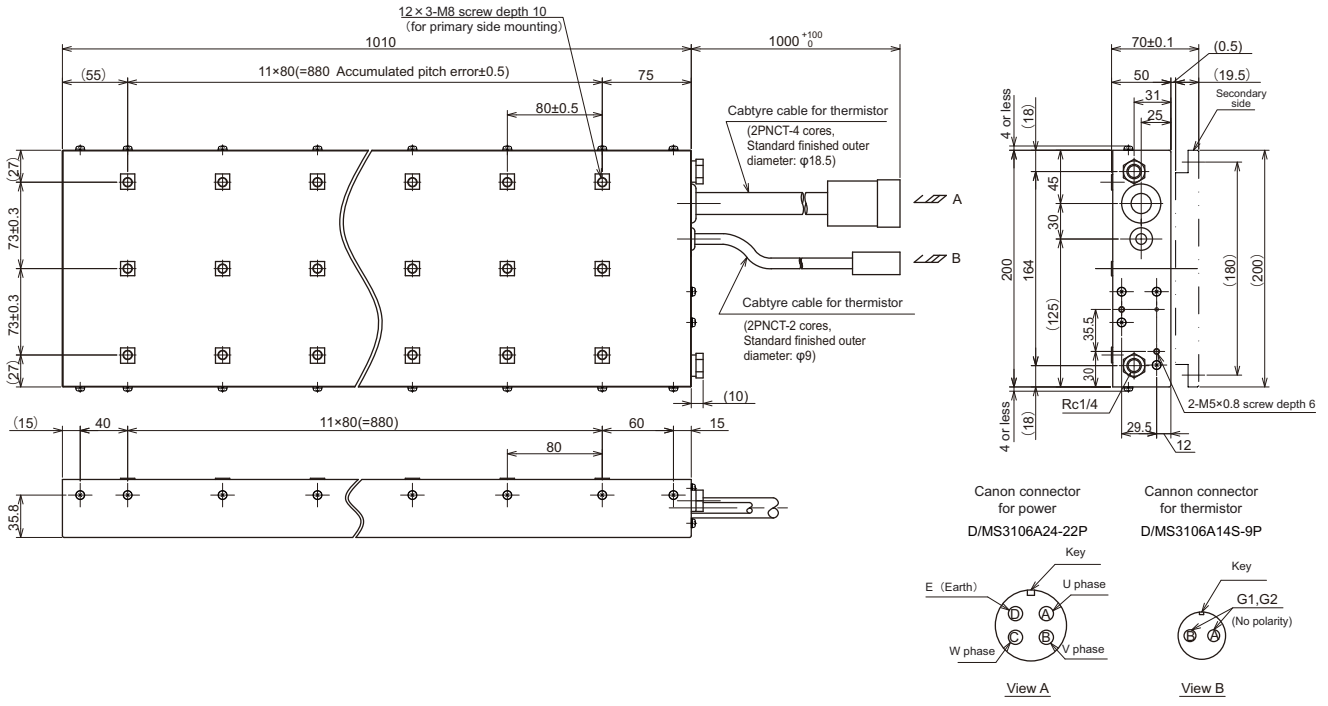
[LM-FP4F-36M-1WW0]

[Unit:mm]



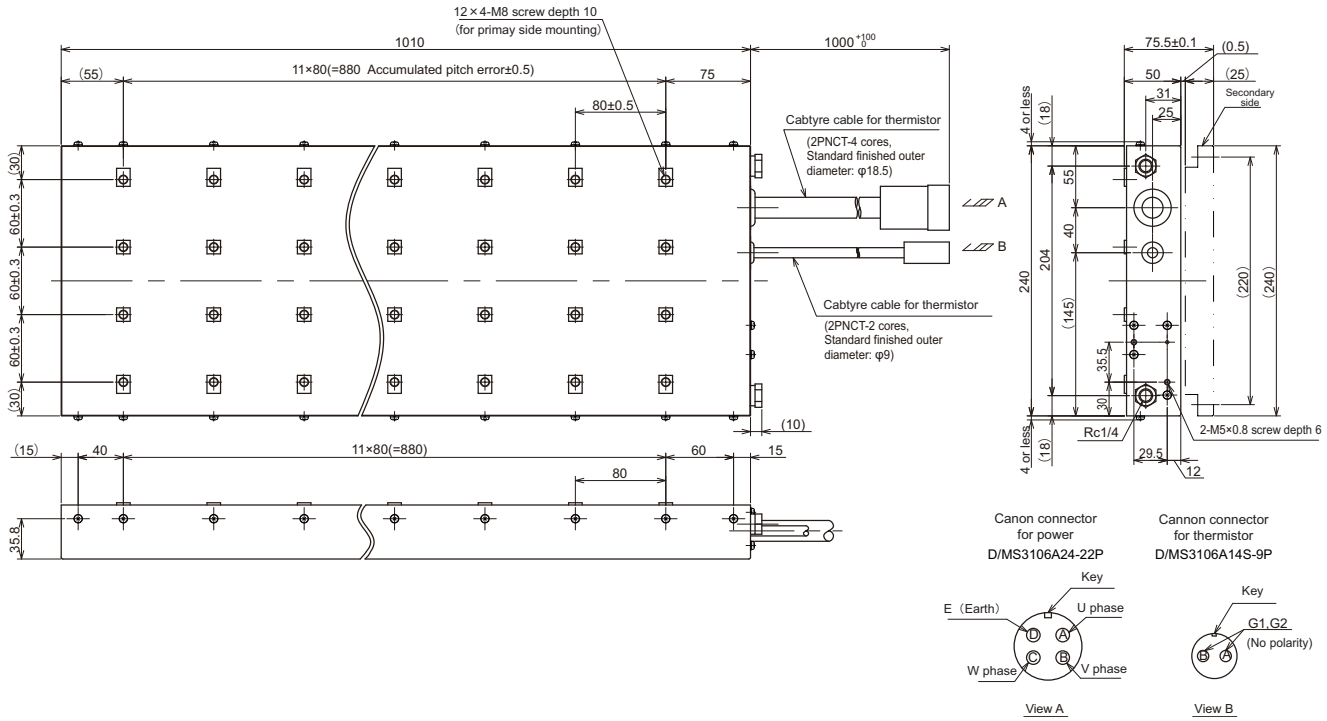
[LM-FP4H-48M-1WW0]

[Unit:mm]



[LM-FP5H-60M-1WW0]

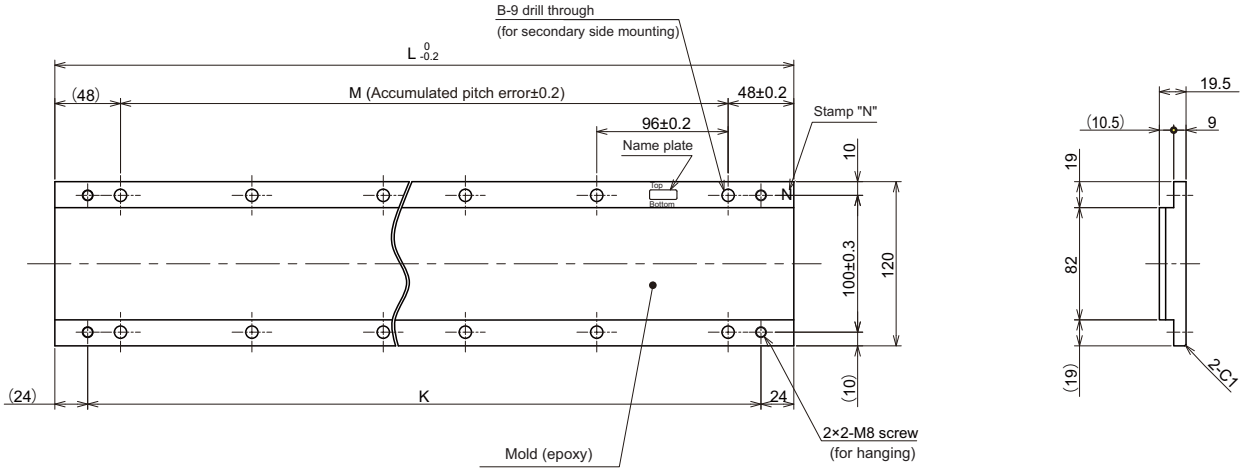
[Unit:mm]



< LM-F Series Secondary side >

[LM-FS20-384-1WW0, LM-FS20-480-1WW0, LM-FS20-576-1WW0]

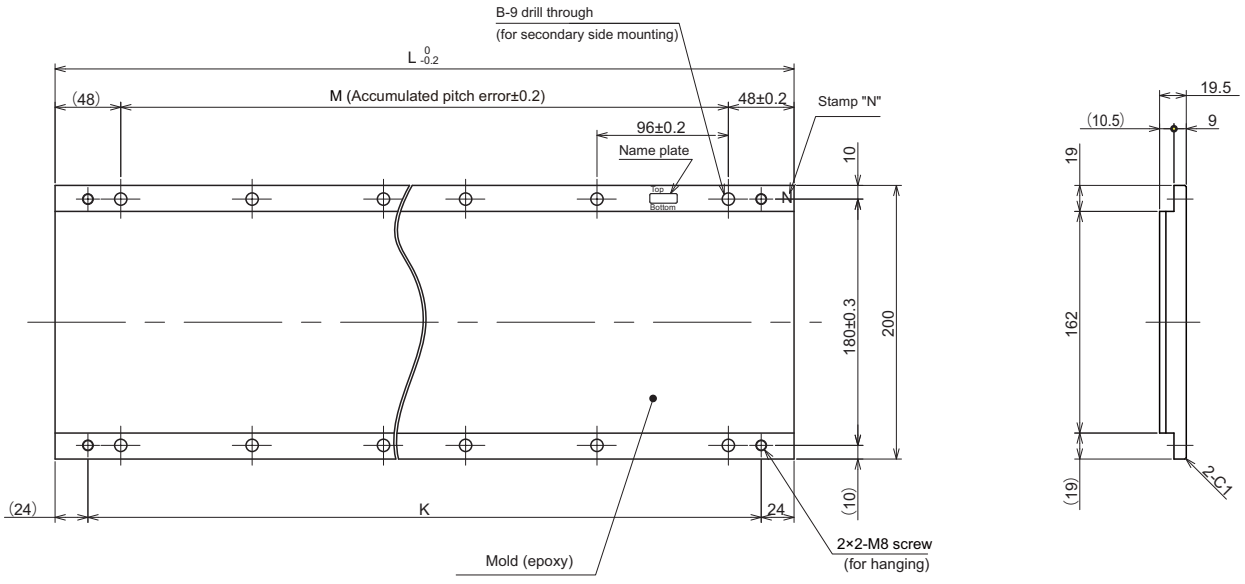
[Unit:mm]



Model	Variable dimensions			
	L	M	K	B
LM-FS20-384-1WW0	384	3X96(=288)	336	4×2
LM-FS20-480-1WW0	480	4X96(=384)	432	5×2
LM-FS20-576-1WW0	576	5X96(=480)	528	6×2

[LM-FS40-480-1WW0, LM-FS40-576-1WW0]

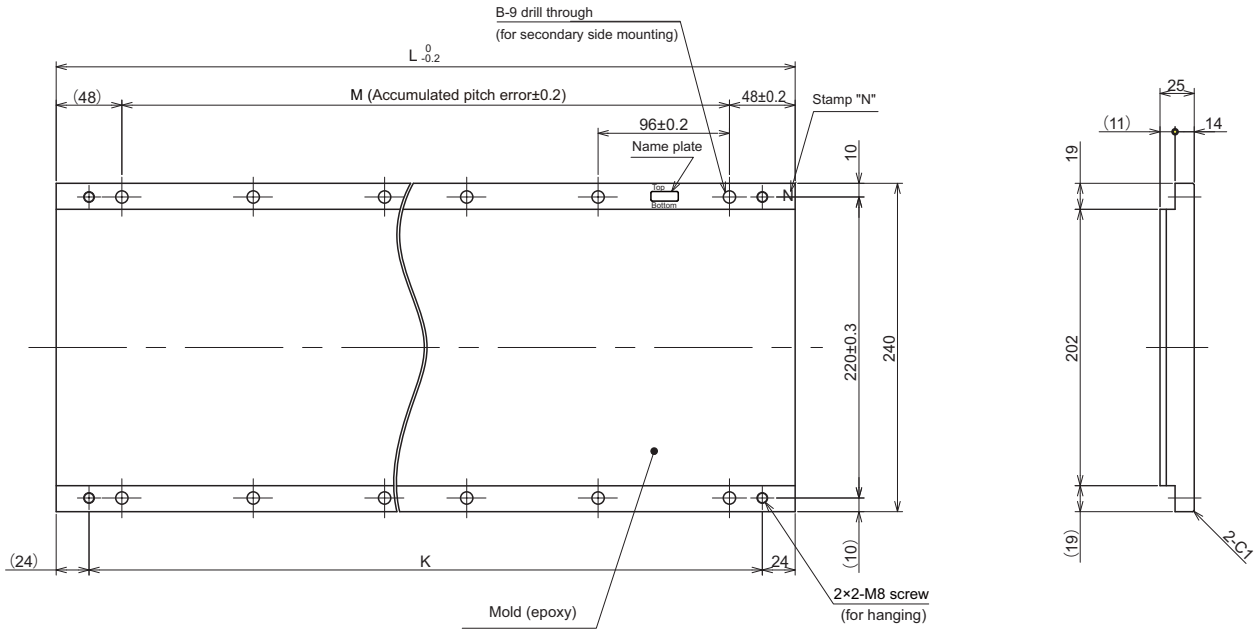
[Unit:mm]



Model	Variable dimensions			
	L	M	K	B
LM-FS40-480-1WW0	480	4X96(=384)	432	5×2
LM-FS40-576-1WW0	576	5X96(=480)	528	6×2

[LM-FS50-480-1WW0, LM-FS50-576-1WW0]

[Unit:mm]



Model	Variable dimensions			
	L	M	K	B
LM-FS50-480-1WW0	480	4X96(=384)	432	5×2
LM-FS50-576-1WW0	576	5X96(=480)	528	6×2

3

Characteristics

3.1 Linear Servo Motor

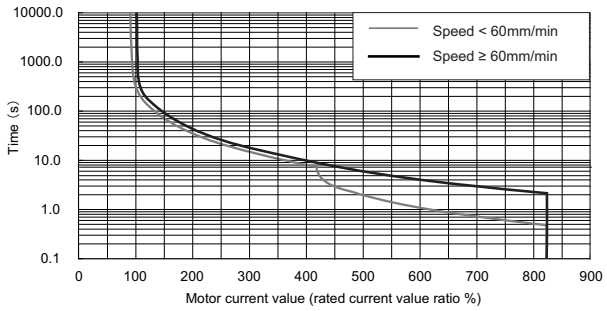
3.1.1 Overload Protection Characteristics

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

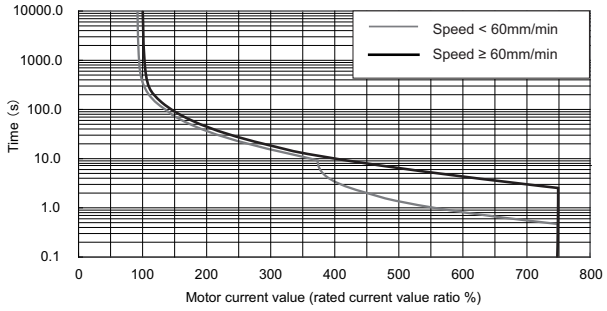
(1) Linear motor overload protection characteristics (For natural-cooling)

< MDS-D2 Series >

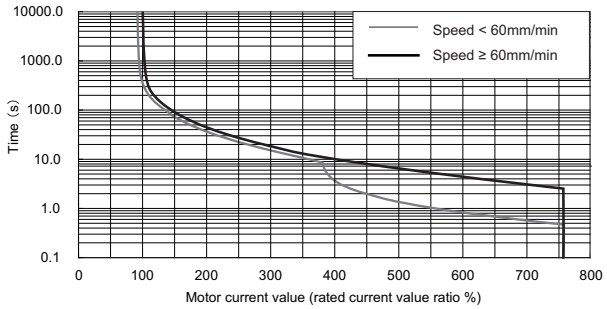
LM-FP2A-03M



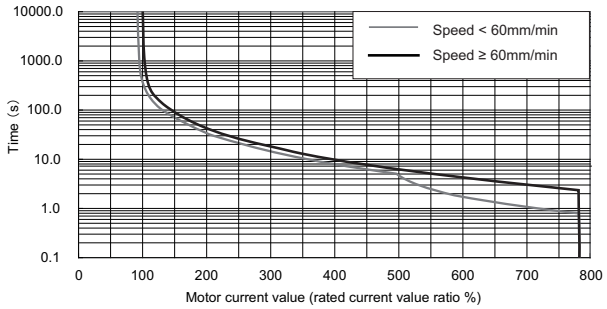
LM-FP2B-06M



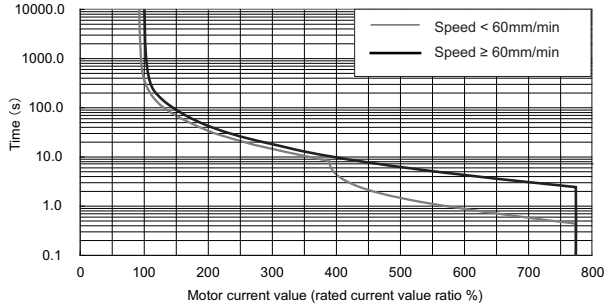
LM-FP2D-12M



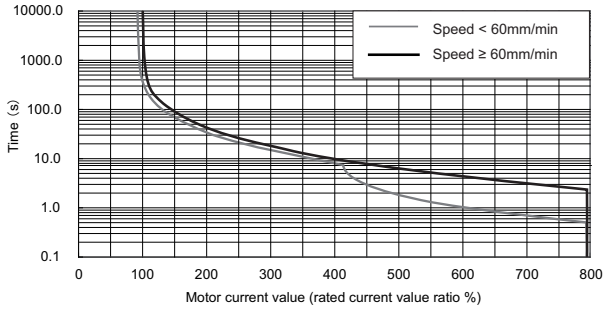
LM-FP2F-18M



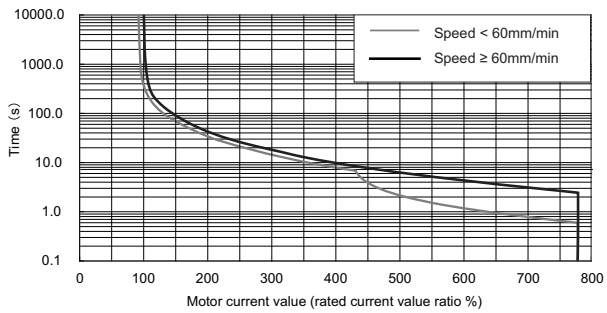
LM-FP4B-12M



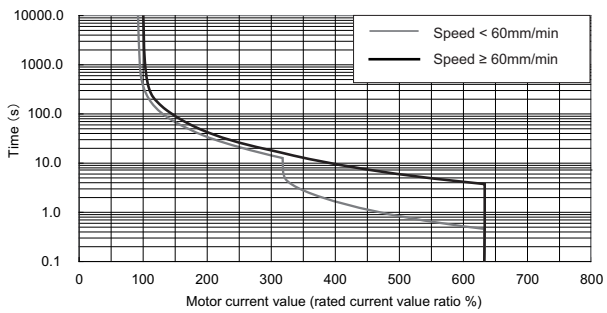
LM-FP4D-24M



LM-FP4F-36M

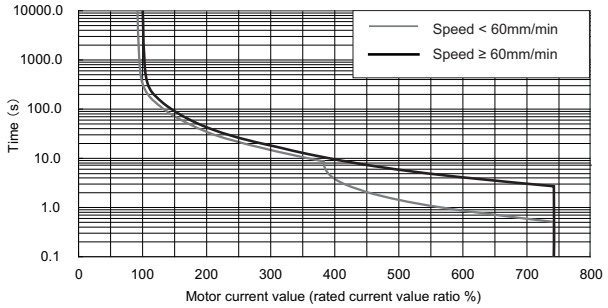


LM-FP4H-48M



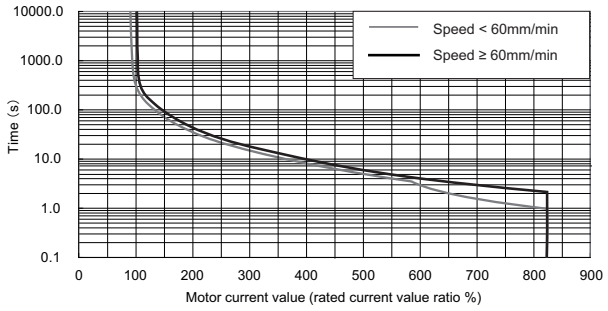
< MDS-DH2 Series >

LM-FP5H-60M

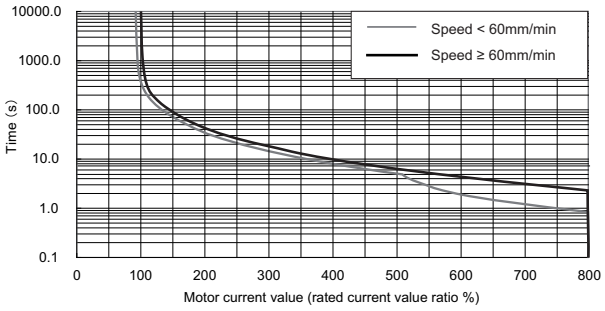


< MDS-DJ Series >

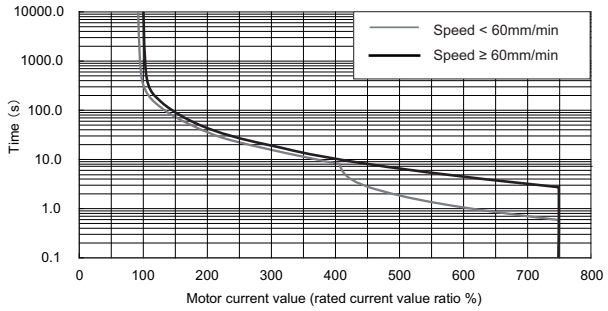
LM-FP2A-03M



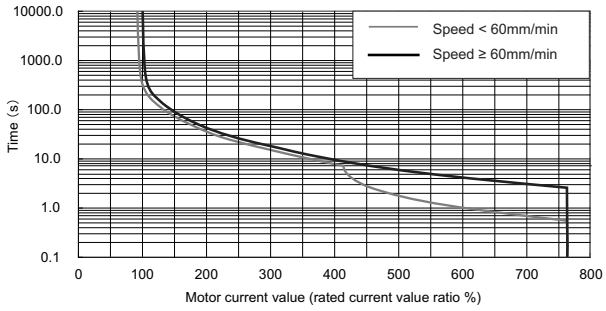
LM-FP2B-06M



LM-FP2D-12M



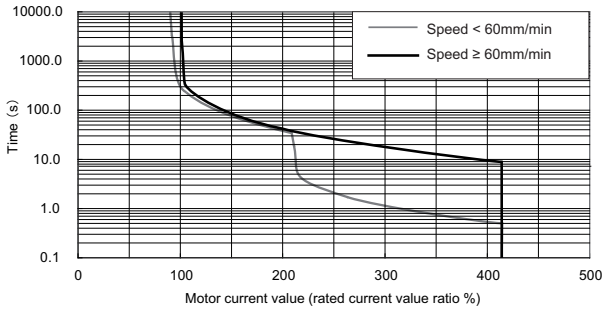
LM-FP4B-12M



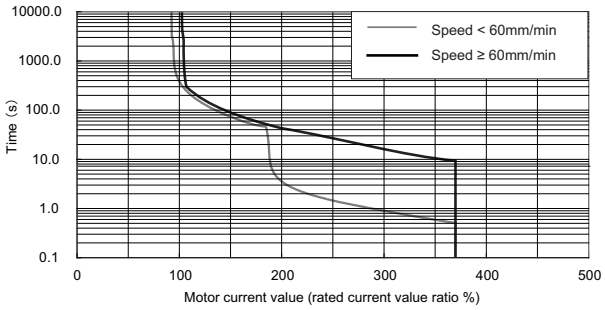
(2) Linear motor overload protection characteristics (For liquid-cooling)

< MDS-D2 Series >

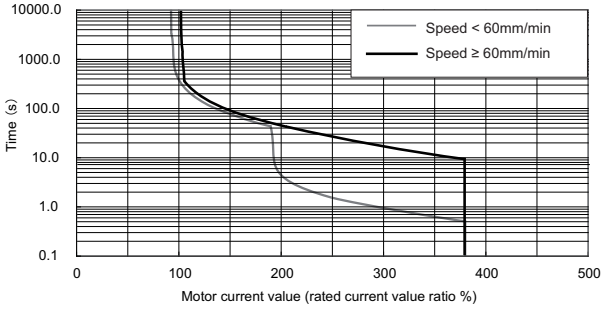
LM-FP2A-03M



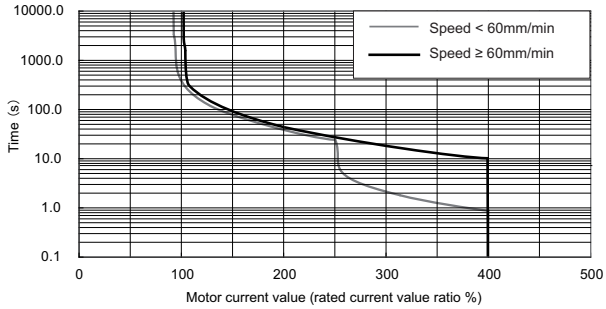
LM-FP2B-06M



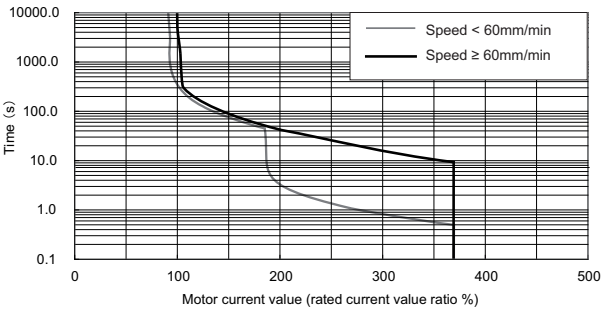
LM-FP2D-12M



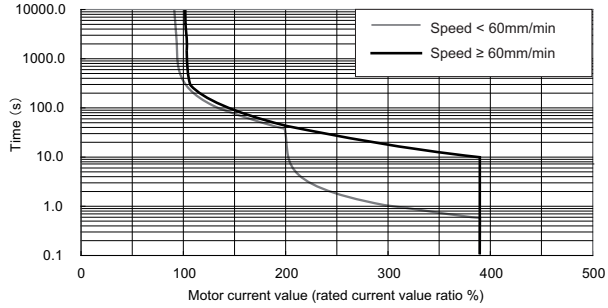
LM-FP2F-18M



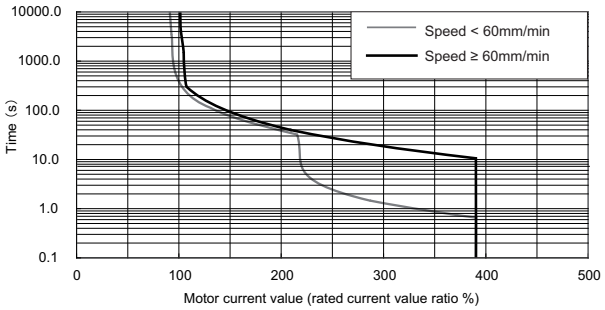
LM-FP4B-12M



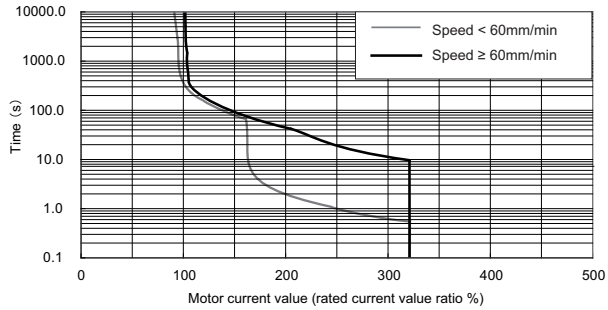
LM-FP4D-24M



LM-FP4F-36M

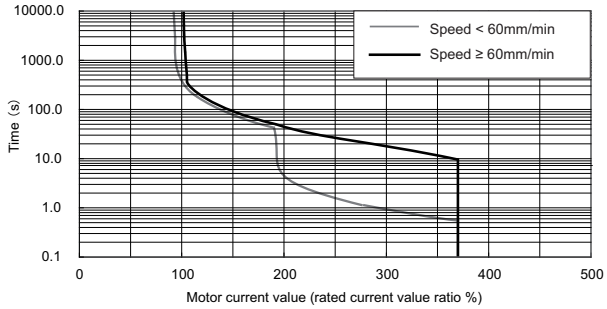


LM-FP4H-48M



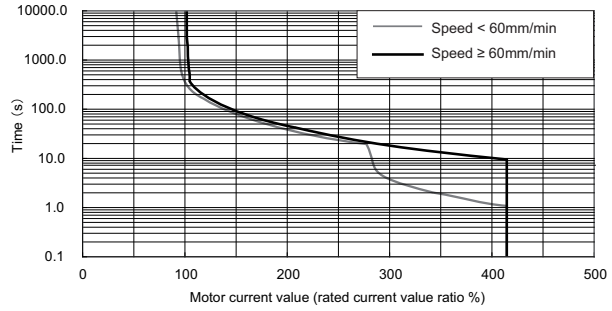
< MDS-DH2 Series >

LM-FP5H-60M

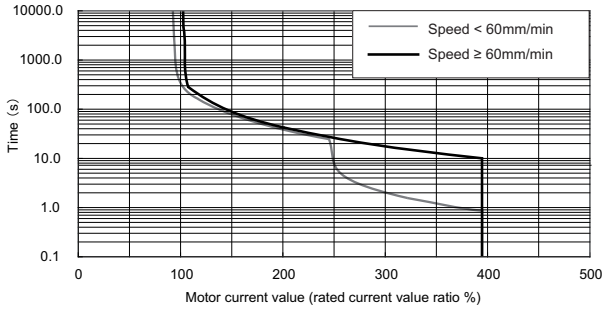


< MDS-DJ Series >

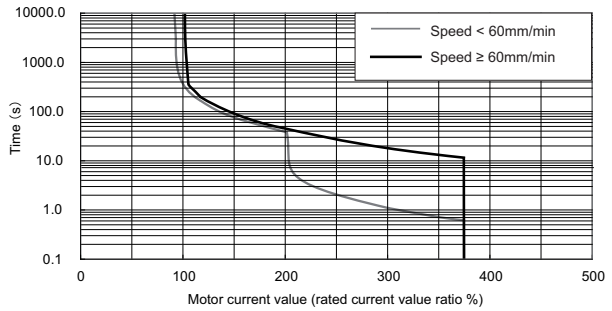
LM-FP2A-03M



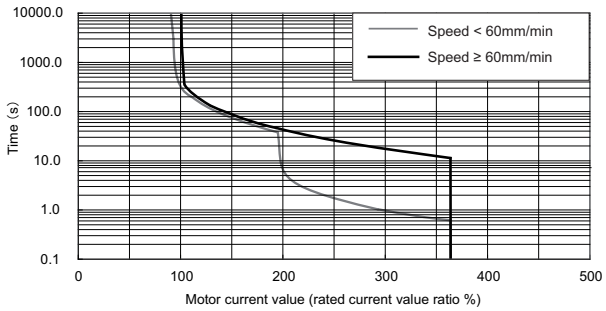
LM-FP2B-06M



LM-FP2D-12M



LM-FP4B-12M



3.1.2 Dynamic Brake Characteristics

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

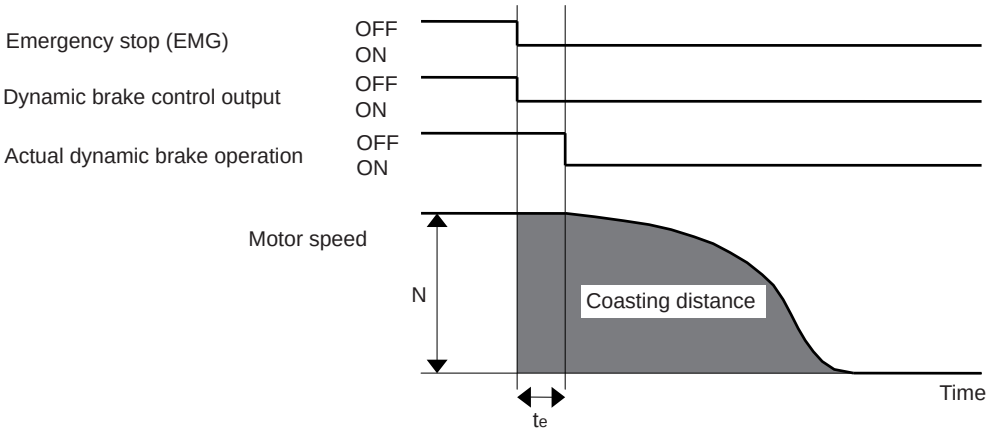
Coasting rotation distance during emergency stop

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

When in position command synchronization system, calculate using one-half of the moving section's total weight (M).

$$L_{MAX} = \frac{F_0}{60} \cdot \{ te + M \cdot (A \cdot F_0^2 + B) \}$$

L_{MAX}	: Coasting distance of machine	[m]
F_0	: Speed during brake operation	[m/min]
M	: Moving section's total weight	[kg]
te	: Brake drive relay delay time	[s](Normally 0.03s)
A	: Coefficient A (Refer to the table below)	
B	: Coefficient B (Refer to the table below)	



Dynamic brake braking diagram

< MDS-D2/DH2 Series >

Coasting amount calculation coefficients table

Standard combination			Combination with one unit and two motor		
Motor type	**A**	**B**	**Motor type**	**A**	**B**
LM-FP2A-03M	10.02×10^{-8}	30.76×10^{-4}	LM-FP2A-03M	13.22×10^{-8}	93.22×10^{-4}
LM-FP2B-06M	6.68×10^{-8}	11.10×10^{-4}	LM-FP2B-06M	9.66×10^{-8}	30.68×10^{-4}
LM-FP2D-12M	2.41×10^{-8}	8.20×10^{-4}	LM-FP2D-12M	4.83×10^{-8}	16.41×10^{-4}
LM-FP2F-18M	1.70×10^{-8}	4.72×10^{-4}	LM-FP2F-18M	1.40×10^{-8}	22.96×10^{-4}
LM-FP4B-12M	2.09×10^{-8}	7.44×10^{-4}	LM-FP4B-12M	4.19×10^{-8}	14.88×10^{-4}
LM-FP4D-24M	1.07×10^{-8}	3.54×10^{-4}	LM-FP4D-24M	0.78×10^{-8}	19.53×10^{-4}
LM-FP4F-36M	0.32×10^{-8}	5.45×10^{-4}			
LM-FP4H-48M	0.19×10^{-8}	5.26×10^{-4}			
LM-FP5H-60M	0.42×10^{-8}	1.29×10^{-4}			

< MDS-DJ Series >

Coasting amount calculation coefficients table

Standard combination			Combination with one unit and two motor		
Motor type	**A**	**B**	**Motor type**	**A**	**B**
LM-FP2A-03M	8.75×10^{-8}	35.19×10^{-4}	LM-FP2A-03M	11.10×10^{-8}	110.97×10^{-4}
LM-FP2B-06M	6.03×10^{-8}	12.29×10^{-4}	LM-FP2B-06M	8.37×10^{-8}	35.42×10^{-4}
LM-FP4B-12M	1.79×10^{-8}	8.69×10^{-4}			
LM-FP2D-12M	2.09×10^{-8}	9.48×10^{-4}			

4

Dedicated Options

4.1 Linear Servo Detectors

4.1.1 Absolute Position Detector

The linear scales available in absolute position detection system are listed below.
All the feedback signals are output via Mitsubishi-protocol serial communication (digital signal).

Manufacturer	Detector type	Interface unit type	Minimum detection resolution	Tolerable maximum speed
Magnescale Co., Ltd	SR77 SR87	Not required	0.1 μm	200m/min
			0.05 μm	
			0.01 μm	
HEIDENHAIN CORPORATION	LC193M LC493M	Not required	0.05 μm	180m/min
			0.01 μm	
	LC195M LC495M	Not required	0.01 μm 0.001 μm	180m/min
	LC215M	Not required	0.01 μm	180m/mim
Mitutoyo Corporation	AT343	Not required	0.05 μm	120m/min
	AT543	Not required	0.05 μm	150m/min
	AT545	Not required	0.00488 (20/4096) μm	150m/min
	ST748	Not required	0.1 μm	300m/s
FAGOR Automation	SAM Series	Not required	0.05 μm	120m/min
	SVAM Series	Not required	0.05 μm	120m/min
	GAM Series	Not required	0.05 μm	120m/min
	LAM Series	Not required	0.1 μm	120m/min
Renishaw plc.	RL40N Series	Not required	0.05 μm	6,000m/min
			0.001 μm	

< Contact information about detector by other manufacturer >
- Magnescale Co., Ltd.: http://www.mgscale.com/mgs/language/english/
- HEIDENHAIN CORPORATION: http://www.heidenhain.com/
- Mitutoyo Corporation: http://www.mitutoyo.co.jp/eng/
- FAGOR Automation : http://www.fagorautomation.com/
- Renishaw plc.: http://www.renishaw.com/

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

⚠ CAUTION

1. The above value does not guarantee the accuracy of the system.
2. The user shall prepare the above-mentioned detector after inquiring of each manufacturer about the specifications and confirm them.

4.1.2 Relative Position Detector

Depending on the output signal specifications, select a relative position detector with which the following (a) or (b) is applied to use with a linear motor.

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

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

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

Manufacturer	Detector type	Interface unit type	Minimum detection resolution	Tolerable maximum speed
Magnescale Co., Ltd	SR75 SR85	Not required	0.1 μm	200m/min
			0.05 μm	
			0.01 μm	
HEIDENHAIN CORPORATION	LS187 LS487	EIB192M A4 20 μm	0.0012 μm	120m/min
		EIB392M A4 20 μm		

< Contact information about detector by other manufacture >

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

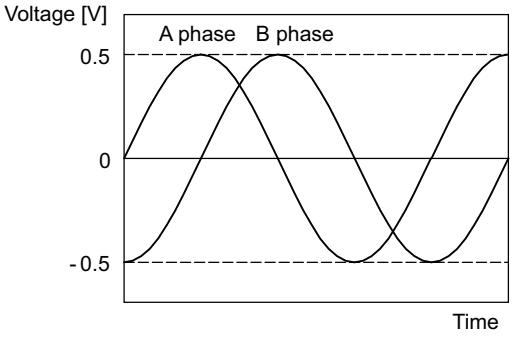
> ⚠ **CAUTION**
>
> The above value does not guarantee the accuracy of the system.

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

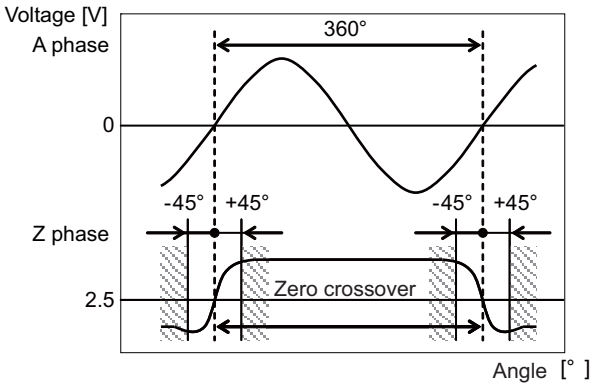
When using a relative position detector that the signal is the SIN wave output, the detector output signal is converted in the detector conversion unit (MDS-B-HR), and then the signal is transmitted to the drive unit in the serial communication. Select a relative position detector with A/B phase SIN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

< Detector output signal >

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



A/B phase output signal waveform during forward run



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

- Combination speed
  In use of linear scale:
  Maximum speed (m/min) = Scale analog signal frequency (m) × 200,000 × 60
  An actual maximum speed is limited by the mechanical specifications and electrical specifications, etc. of the connected scale, so contact the manufacture of the purchased scale.
- Division number 512 divisions per 1 cycle of signal
  In use of linear scale:
  Minimum resolution (m) = Scale analog signal frequency (m) / 512

⚠ CAUTION

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

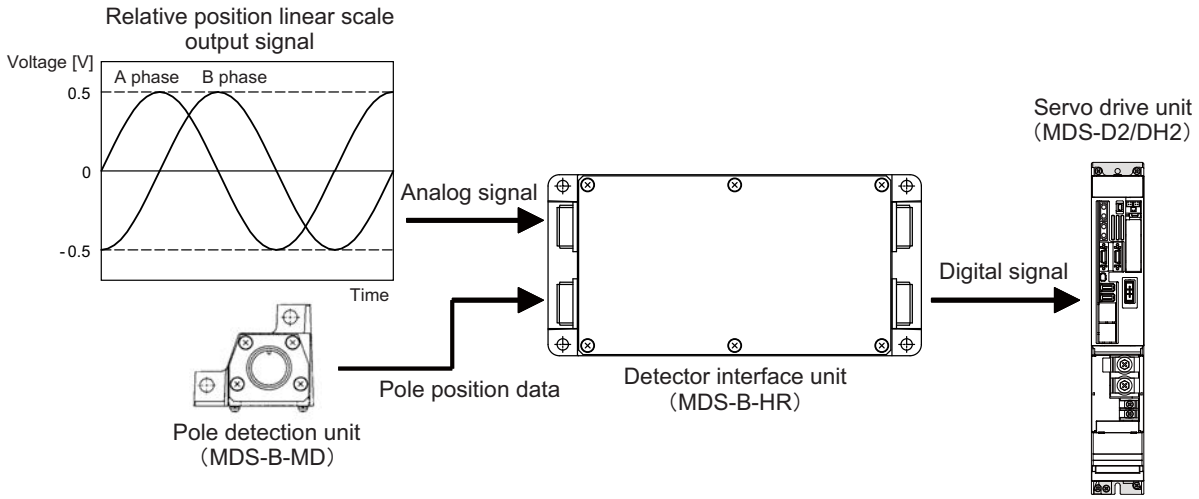
4.2 Detector Interface Unit

4.2.1 Serial Output Interface Unit for ABZ Analog Detector MDS-B-HR

(1) Functions

[1] Convert the analog waves (Phase A and B) output from the relative position linear scale into the Mitsubishi-protocol serial communication (digital) signal.

[2] Add the signal from the magnetic polar detection unit to the linear scale's feedback signal.



> **⚠ CAUTION**
>
> Always connect MDS-B-MD when using MDS-B-HR.

(2) Type configuration

MDS-B-HR-11M (1)

(1) Degree of protection

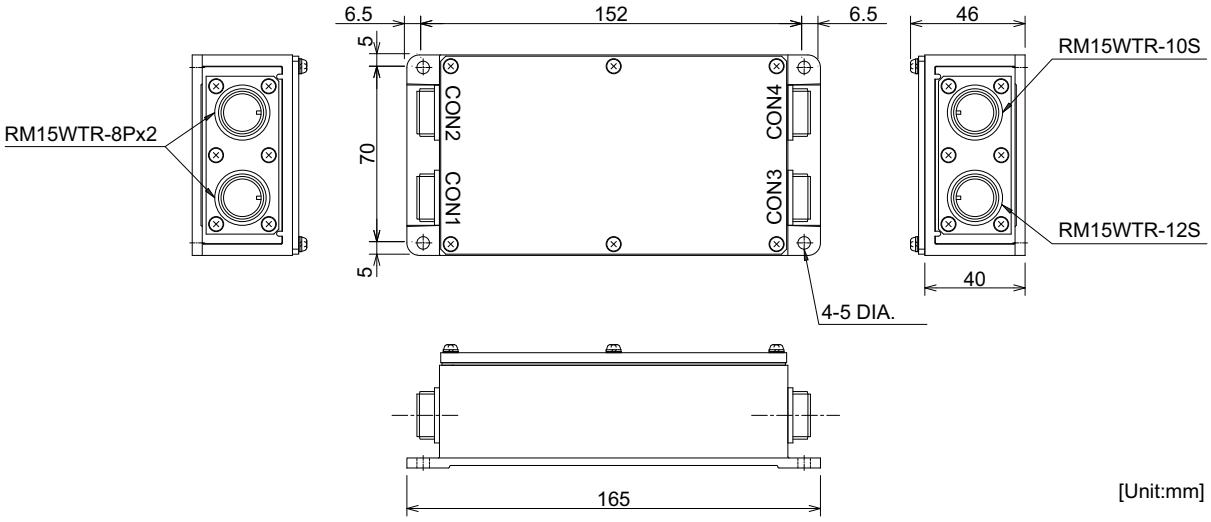
Symbol	Degree of protection
None	IP65
P	IP67

(3) Specifications

Unit Type	MDS-B-HR-	
	11M	11MP
Analog input specifications	A-phase, B-phase, Z-phase 2.5V reference Amplitude $1V_{P-P}$	
Compatible frequency	Analog raw waveform max.200kHz	
Scale resolution	Analog raw waveform/512 division	
Input/output communication style	High-speed serial communication I/F, RS485 or equivalent	
Availability of pole detector	Available	
Working ambient temperature	0 to 55°C	
Operation ambient relative humidity	90%RH or less (with no dew condensation)	
Atmosphere	No toxic gases	
Tolerable vibration	98 m/s^2 (10G)	
Tolerable impact	294 m/s^2 (30G)	
Tolerable power voltage	DC5V ± 5%	
Maximum heating value	2W	
Mass	0.5kg or less	
Degree of protection	IP65	IP67

(4) Outline dimension drawings

MDS-B-HR



[Unit:mm]

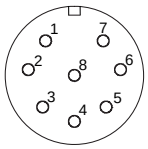
(5) Explanation of connectors

Connector name	Application	Remarks
CON1	For connection with servo drive unit (2nd system)	Not provided for 1-part system specifications
CON2	For connection with servo drive unit	
CON3	For connection with scale	
CON4	For connection with pole detection unit (MDS-B-MD)	

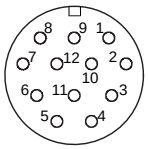
CON1		CON2		CON3		CON4	
Pin No.	Function	**Pin No.**	Function	**Pin No.**	Function	**Pin No.**	Function
1	RQ+ signal	**1**	RQ+ signal	**1**	A+ phase signal	**1**	A phase signal
2	RQ- signal	**2**	RQ- signal	**2**	A- phase signal	**2**	REF signal
3	SD+ signal	**3**	SD+ signal	**3**	B+ phase signal	**3**	B phase signal
4	SD- signal	**4**	SD- signal	**4**	B- phase signal	**4**	REF signal
5	P5	**5**	P5	**5**	Z+ phase signal	**5**	P24
6	P5	**6**	P5	**6**	Z- phase signal	**6**	MOH signal
7	GND	**7**	GND	**7**	-	**7**	P5
8	GND	**8**	GND	**8**	-	**8**	P5
				9	-	**9**	TH signal
				10	-	**10**	GND
				11	P5		
				12	GND		

< Connector pin layout >

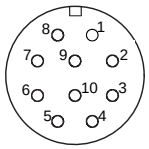
Connector	Type
CON1	RM15WTR- 8P (Hirose Electric)
CON2	
CON3	RM15WTR-12S (Hirose Electric)
CON4	RM15WTR-10S (Hirose Electric)



CON1
CON2



CON3



CON4

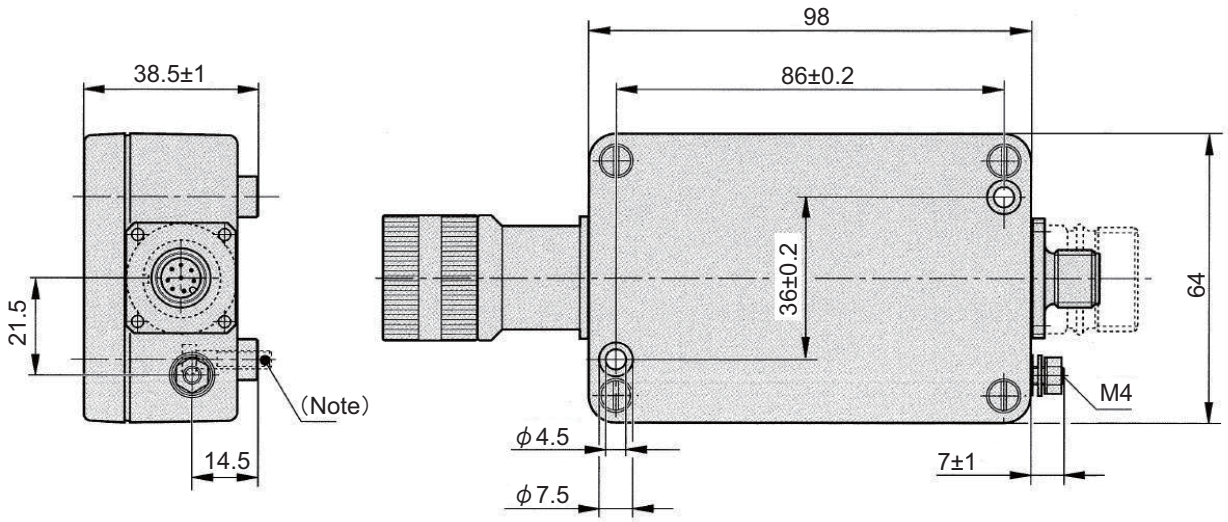
4.2.2 Serial Output Interface Unit for ABZ Analog Detector EIB192M (Other Manufacturer's Product)

(1) Appearance

(2) Specifications

Type	EIB192M A4 20μm	EIB192M C4 1200	EIB192M C4 2048
Manufacturer	HEIDENHAIN CORPORATION		
Input signal	A-phase, B-phase: SIN wave 1Vpp, Z-phase		
Maximum input frequency	400kHz		
Output signal	Mitsubishi high-speed serial signal (MITSU02-4)		
Interpolation division number	Maximum 16384 divisions		
Compatible detector	LS187, LS487	ERM280 1200	ERM280 2048
Minimum detection resolution	0.0012μm	0.0000183° (19,660,800p/rev)	0.0000107° (33,554,432p/rev)
Working temperature	0°C to 70°C		
Degree of protection	IP65		
Mass	300g		

(3) Outline dimension drawings



（Note）Two fixing screws（M4×16 DIN 912/ISO 4762）　　[Unit : mm]

> **⚠ CAUTION**
>
> These are other manufacturer's products. When purchasing these products, refer to the manufacturer's information materials for the product specifications.

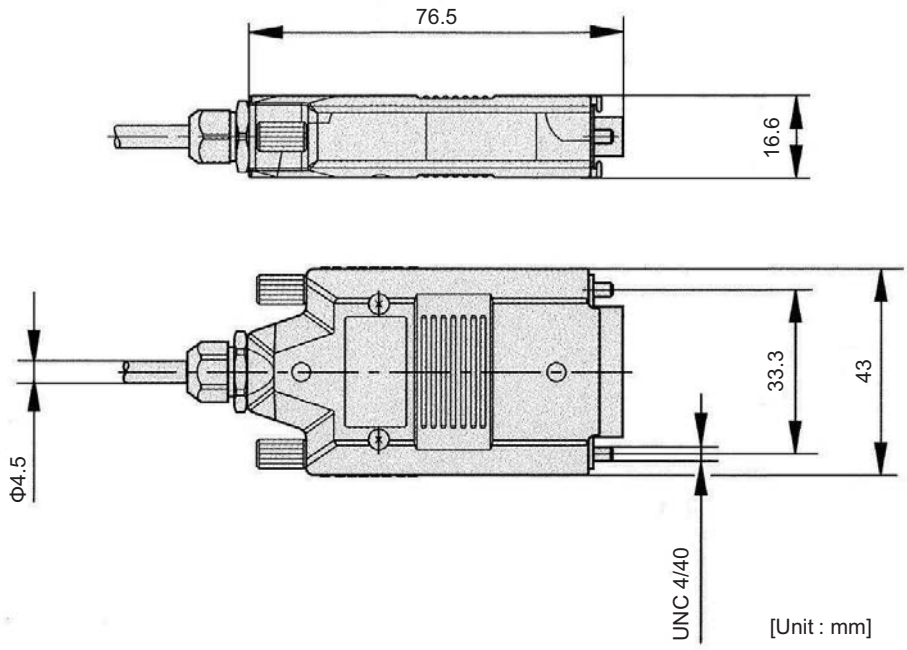
4.2.3 Serial Output Interface Unit for ABZ Analog Detector EIB392M (Other Manufacturer's Product)

(1) Appearance

(2) Specifications

Type	EIB392M A4 20 μm	EIB392M C4 1200	EIB392M C4 2048
Manufacturer	HEIDENHAIN CORPORATION		
Input signal	A-phase, B-phase: SIN wave 1Vpp, Z-phase		
Maximum input frequency	400kHz		
Output signal	Mitsubishi high-speed serial signal (MITSU02-4)		
Interpolation division number	Maximum 16384 divisions		
Compatible detector	LS187, LS487	ERM280 1200	ERM280 2048
Minimum detection resolution	0.0012 μm	0.0000183˚ (19,660,800p/rev)	0.0000107˚ (33,554,432p/rev)
Working temperature	0˚ C to 70˚ C		
Degree of protection	IP40		
Mass	140g		

(3) Outline dimension drawings



> **⚠ CAUTION**
>
> These are other manufacturer's products. When purchasing these products, refer to the manufacturer's information materials for the product specifications.

4.3 Pole Detection Unit (MDS-B-MD)

(1) Functions

Detect the magnetic pole of the linear motor's secondary side magnet, and output it as an analog signal.
When you use a relative position specification scale in combination with MDS-B-HR, you don't have to adjust the magnetic pole when the power is turned ON. Thus, attach this unit instead.

(2) Type configuration

MDS-B-MD-480 (1)

(1) Degree of protection

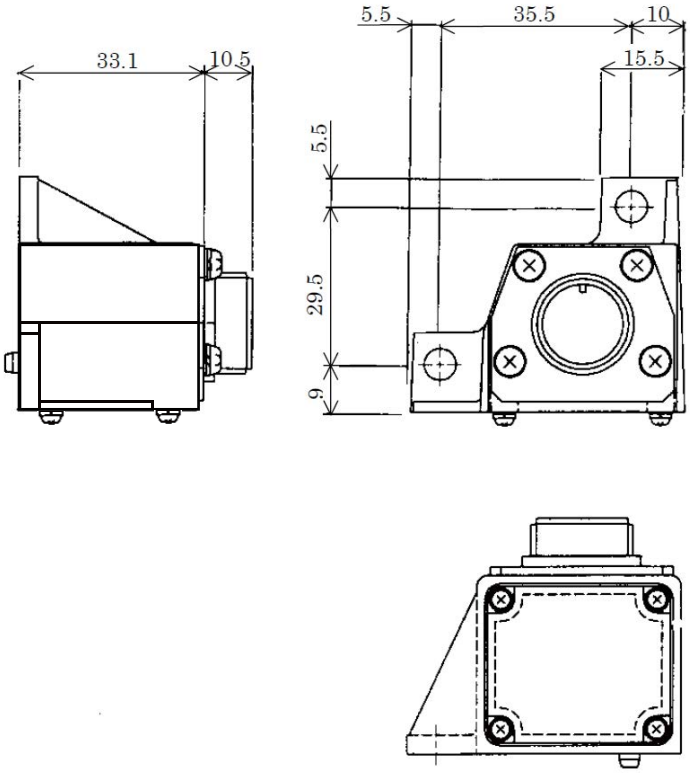
Symbol	Degree of protection
None	IP65
P	IP67

(3) Specifications

Unit type	MDS-B-MD	
	480	480P
Working ambient temperature	0 to 55°C	
Operation ambient relative humidity	90%RH or less (with no dew condensation)	
Atmosphere	No toxic gases	
Tolerable vibration	98m/s^2	
Tolerable impact	294m/s^2	
Tolerable power voltage	DC5V ± 5%	
Maximum heating	1W or less	
Mass	0.1 kg or less	
Degree of protection	IP65	IP67

(4) Outline dimension drawings

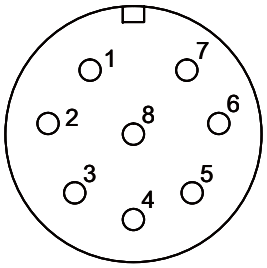
[Unit:mm]



(5) Explanation of connector

Connector name	Application	Remarks
CON1	Detect the magnetic pole of the linear servo motor's secondary side magnet, and output it as an analog signal.	Connect to the scale interface unit (MDS-B-HR).

CON1	
Pin No.	**Function**
1	A-phase signal
2	REF signal
3	B-phase signal
4	REFsignal
5	TH signal
6	P5(5Vdc)
7	P5(5Vdc)
8	GND



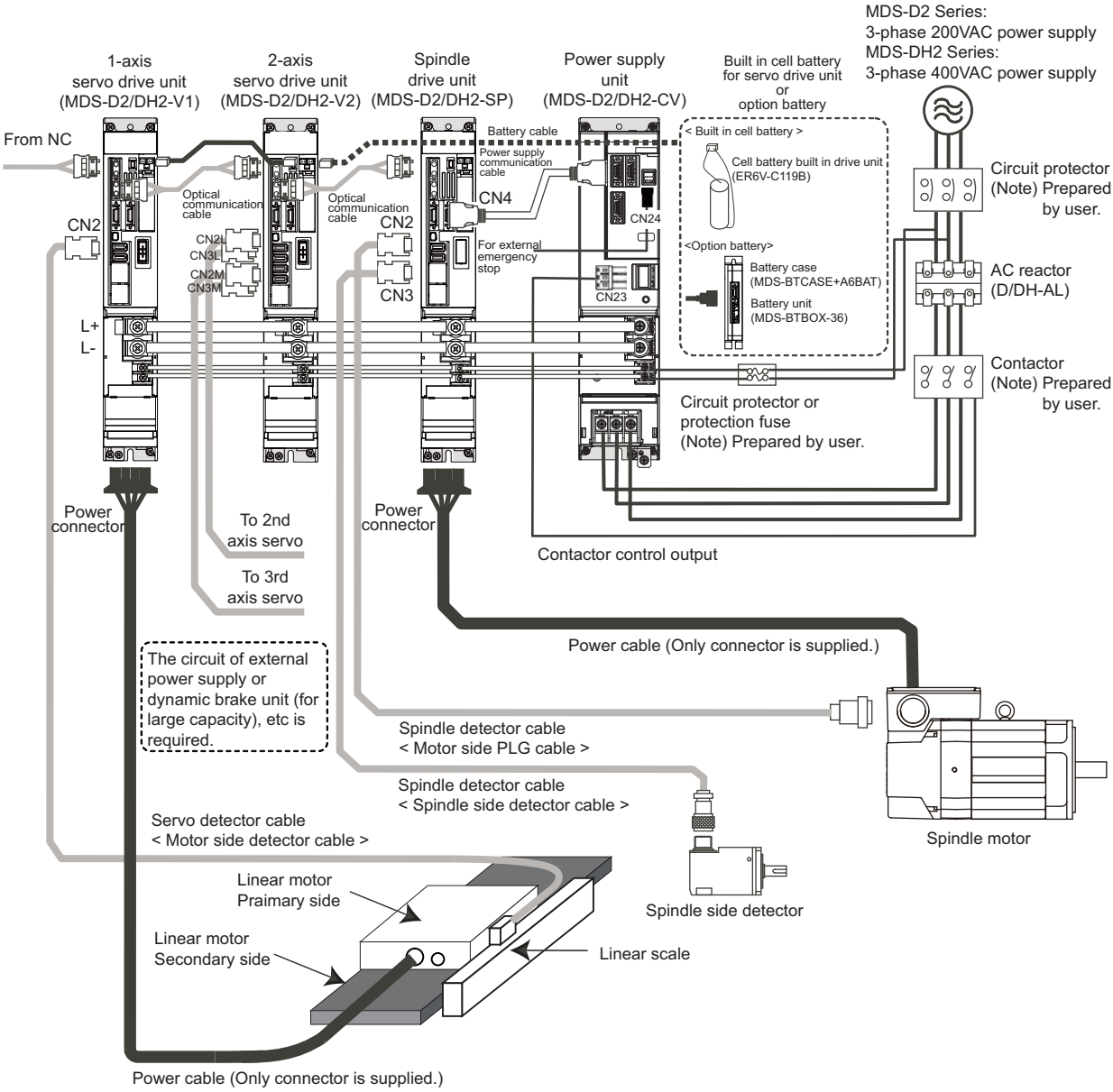
Connector to be used
RM15WTR-8P(Hirose Electric)

4.4 Cables and Connectors

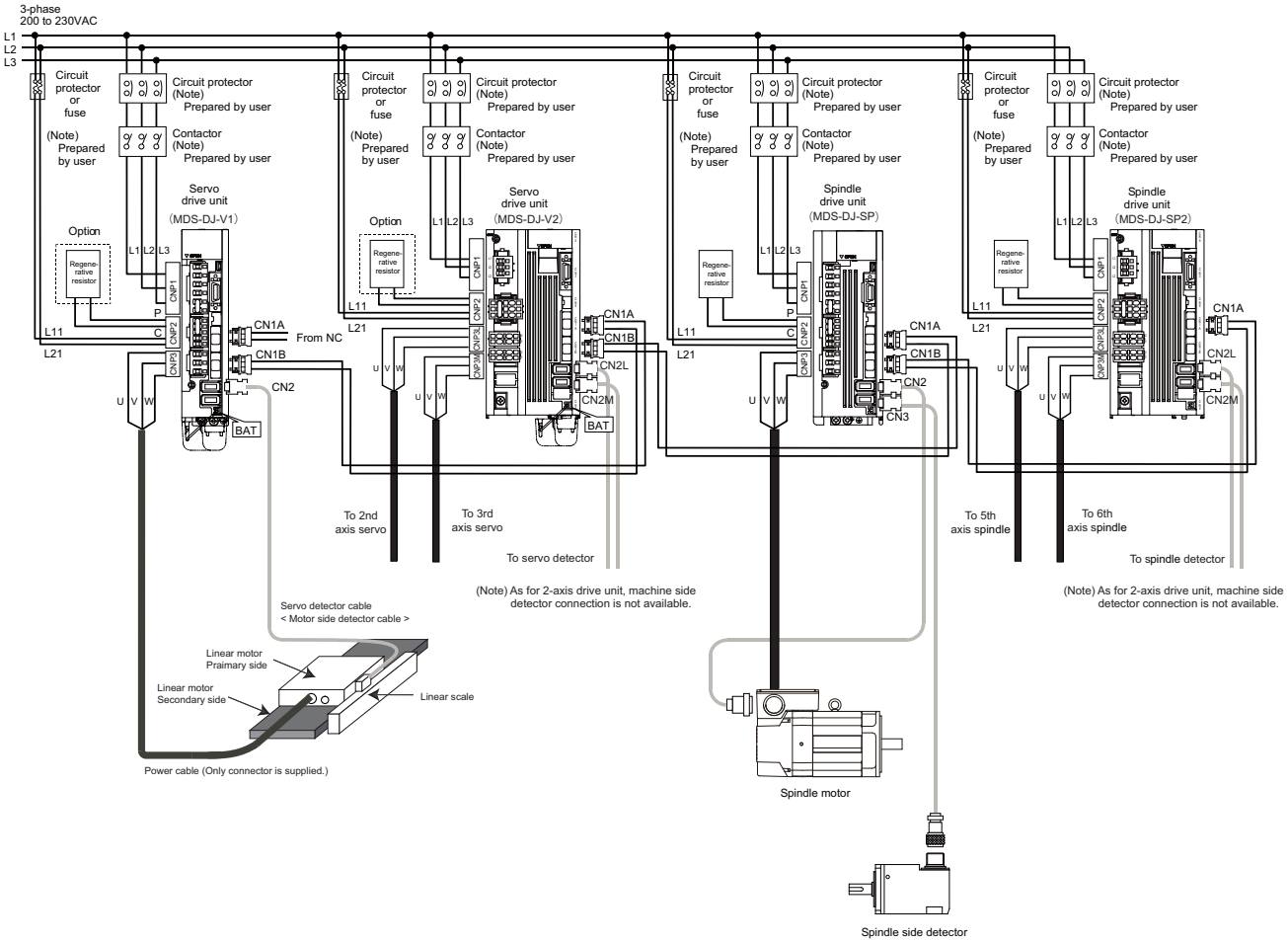
4.4.1 Cable Connection Diagram

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

< MDS-D2/DH2 Series >

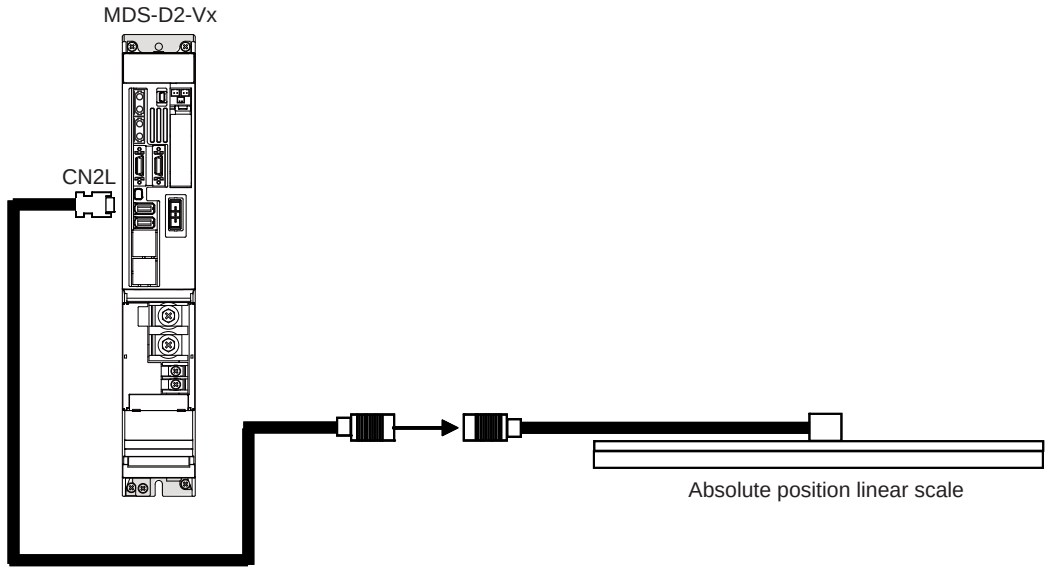


< MDS-DJ Series >

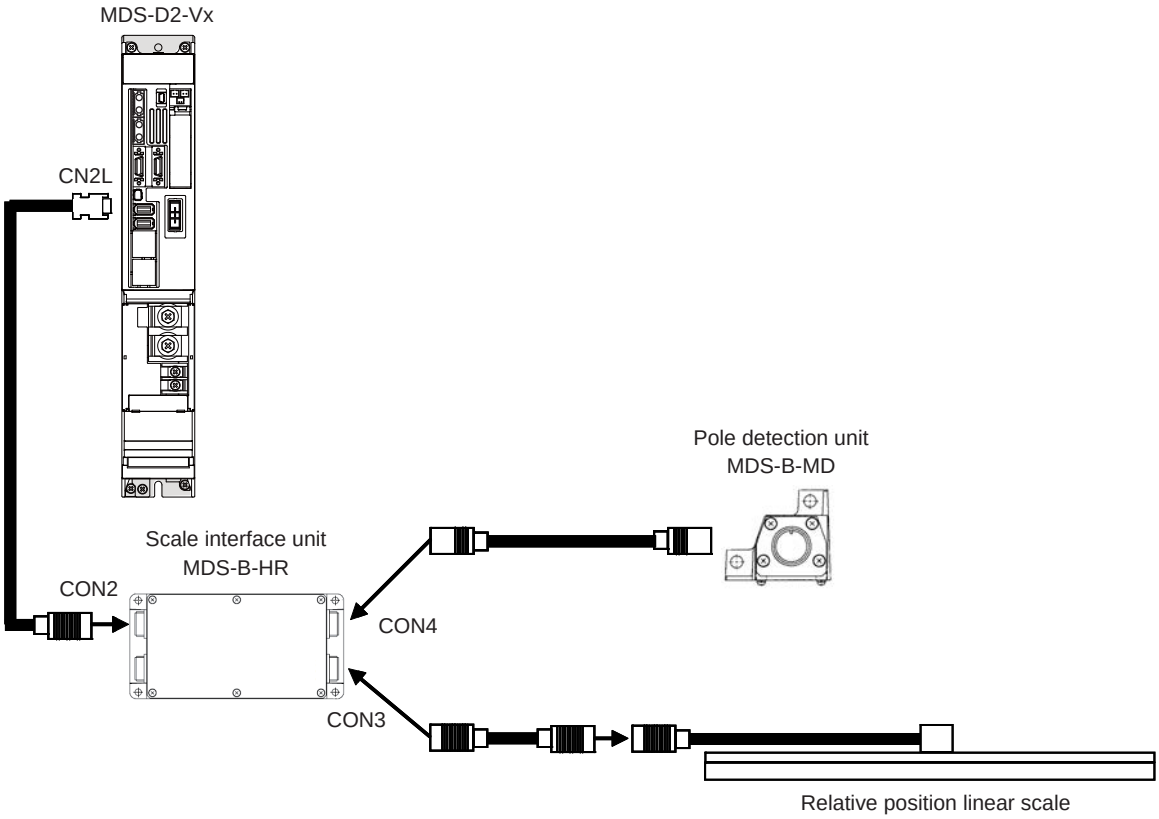


4.4.2 Example of the Detector Conversion Unit Connection

(1) For the absolute position detector connection

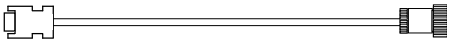
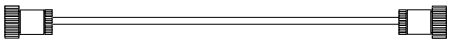


(2) For the relative position detector connection



4.4.3 List of Cables and Connectors

< Servo detector cable and connector >

Item		Model	Contents
For CN2	MDS-B-HR unit cable	CNV2E-HP- ☐ M ☐ : Length 2, 3, 4, 5, 7, 10, 15, 20, 25, 30m	Servo drive unit side connector (3M) Receptacle : 36210-0100PL Shell kit : 36310-3200-008 (MOLEX) Connector set: 54599-1019 MDS-B-HR unit side connector (Hirose Electric) Plug : RM15WTP-8S Clamp : RM15WTP-CP (10) 
	Pole detection unit connection cable	CNLH4MD	MDS-B-HR unit side connector (Hirose Electric) Connector: RM15WTP-10P Clamp: RM15WTP-CP(10) MDS-B-MD unit side connector (Hirose Electric) Connector: RM15WTP-8S Clamp: RM15WTP-CP(10) 
For MDS-B-HR unit	MDS-B-HR connector	CNEHRS(10) Applicable cable outline ø8.5 to 11mm	MDS-B-HR unit side connector (Hirose Electric) Plug : RM15WTP-8S (for CON1, 2) RM15WTP-10P(for CON4) RM15WTP-12P (for CON3) Clamp : RM15WTP-CP (10) 
For CN2	Servo detector connector	CNU2S(AWG18)	Servo drive unit side connector (3M) Receptacle : 36210-0100PL Shell kit : 36310-3200-008 (MOLEX) Connector set: 54599-1019 

< Brake connector >

Item		Model	Contents
For CN20	Brake connector for motor brake control output	CNU20S(AWG14)	Servo drive unit side connector (DDK) Connector : DK-3200S-03R Contact: DK-3REC2LLP1-100 

< Power connector >

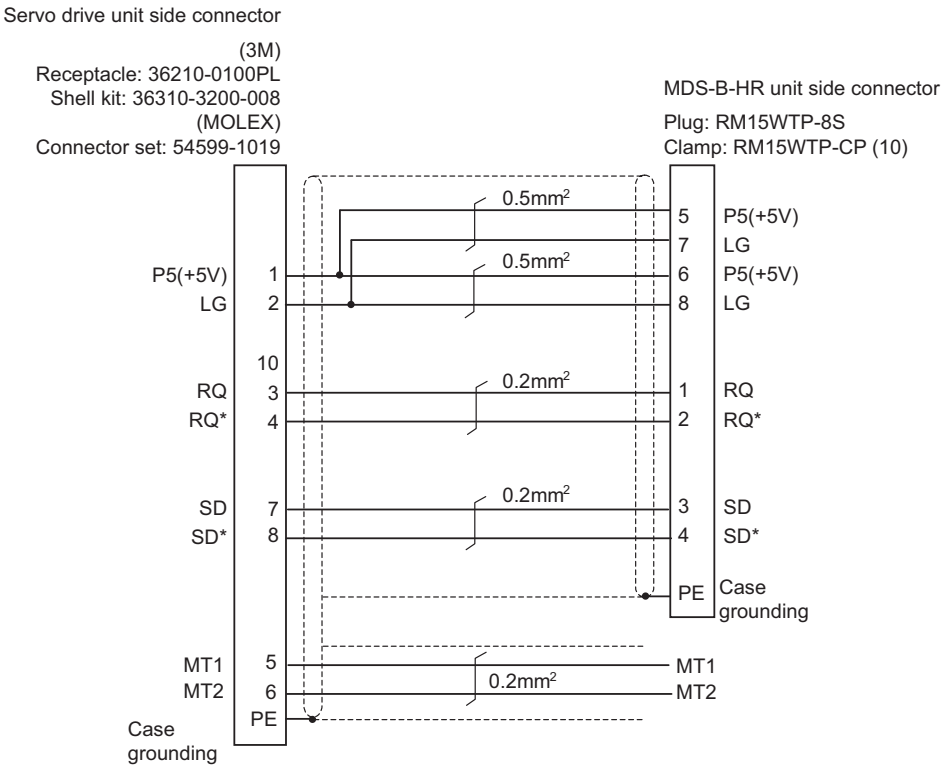
Item		Model	Contents
For motor power	Power connector for LM-FP2A-03M LM-FP2B-06M LM-FP2D-12M LM-FP2F-18M	Applicable cable outline ø10.5 to 14mm	Linear motor side power connector (DDK) Receptacle: D/MS3101A18-10P Clamp: D/MS3057-10A 
	Power connector for LM-FP4B-12M LM-FP4D-24M LM-FP4F-36M LM-FP4H-48M LM-FP5H-60M	Applicable cable outline ø12.5 to 16mm	Linear motor side power connector (DDK) Receptacle: D/MS3101A24-22P Clamp: D/MS3057-16A 
For thermistor	Thermistor connector for LM-FP	Applicable cable outline ø6.8 to 10mm	Linear motor side power connector (DDK) Receptacle:D/MS3101A14S-9P Receptacle:D/MS3057-6A 
For TE1	Power connector for MDS-D2-V1-20 to 80	CNU1S(AWG14)	Drive unit side power connector (DDK) Housing: DK-5200S-04R Contact: DK-5RECSLP1-100 
	Power connector for MDS-D2-V1-160	CNU1S(AWG10)	Drive unit side power connector (DDK) Housing: DK-5200S-04R Contact: DK-5RECMLP1-100 

4.4.4 Cable Connection Diagram

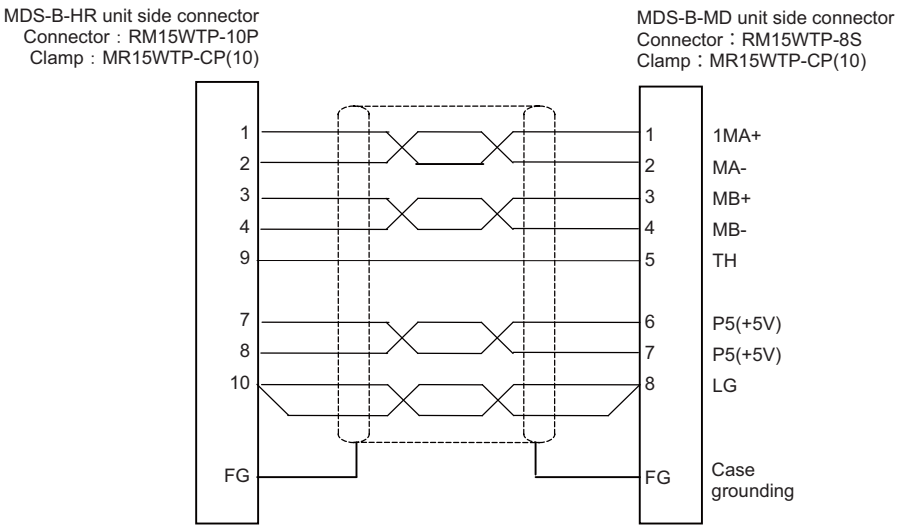
> **⚠ CAUTION**
>
> 1. Take care not to mistake the connection when manufacturing the detector cable. Failure to observe this could lead to faults, runaway or fire.
> 2. When manufacturing the cable, do not connect anything to pins which have no description.

Servo detector cable

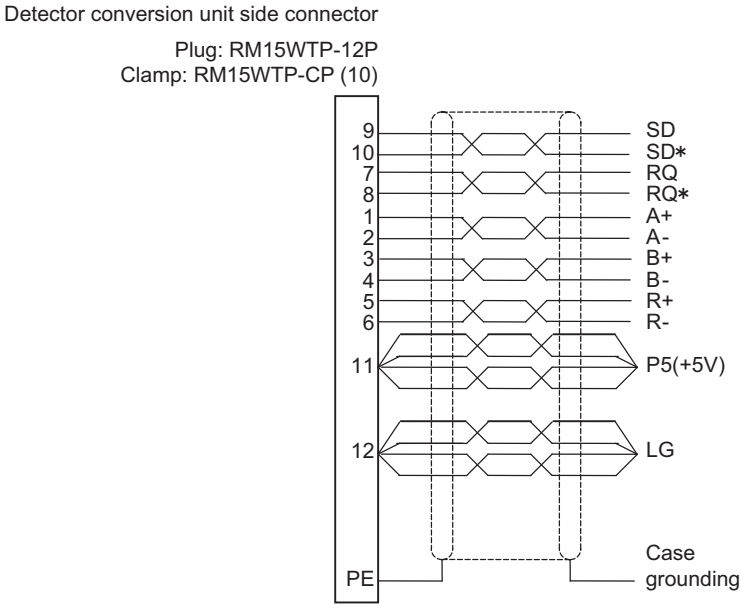
< Connection diagram between servo drive unit and scale interface unit >



< Cable connection diagram between scale interface unit and magnetic pole detection unit (CNLH4MD) >

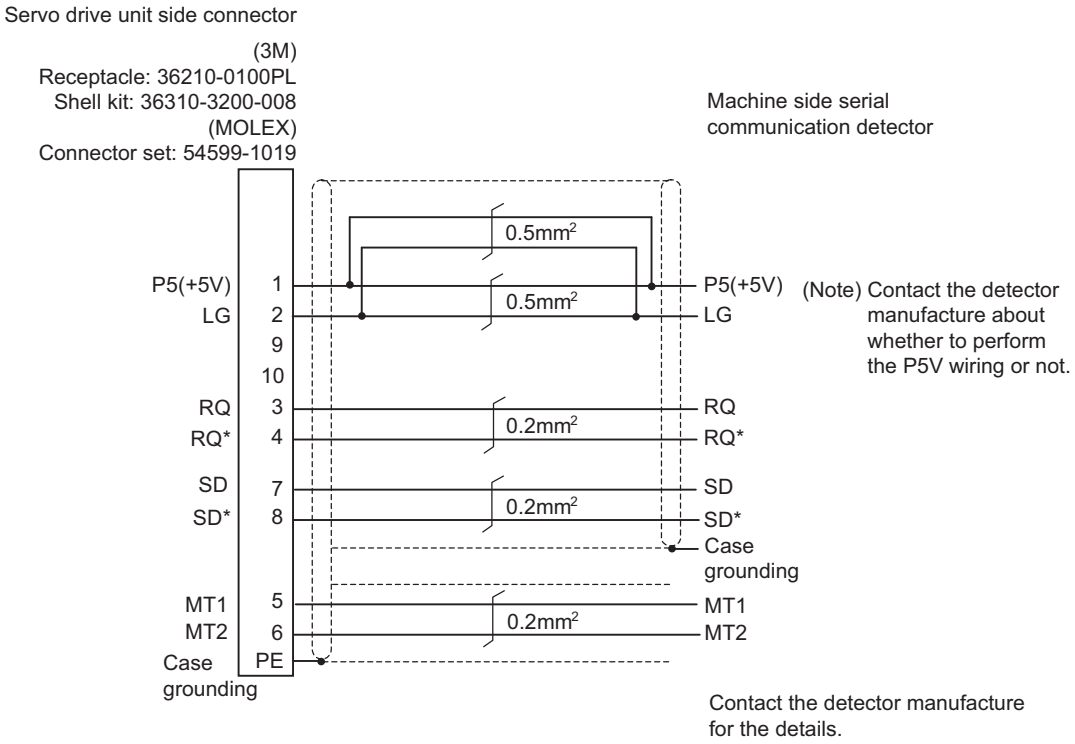


< Cable connection diagram between scale interface unit and scale (CNLH3 cable, etc.) >



(Note) This cable must be prepared by the user.

< Serial communication detector (linear scale, etc.) cable connection diagram >



(Note) This cable must be prepared by the user.

POINT

For compatible detector, refer to the section "Dedicated Options".

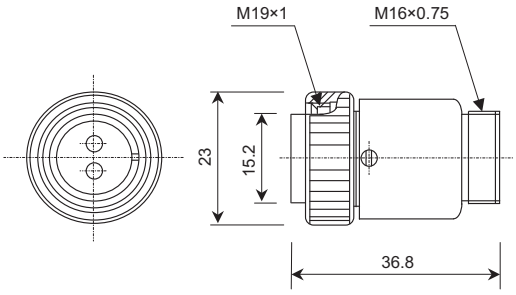
4.4.5 Connector Outline Dimension Drawings

(1) Servo detector connector

MDS-B-HR connector

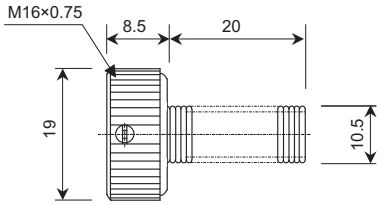
[Unit: mm]

Manufacturer: Hirose Electric
<Type>
Plug:
RM15WTP-8S (for CON1, 2)
RM15WTP-12P (for CON3)



[Unit: mm]

Manufacturer: Hirose Electric
<Type>
Clamp: RM15WTP-CP(10)

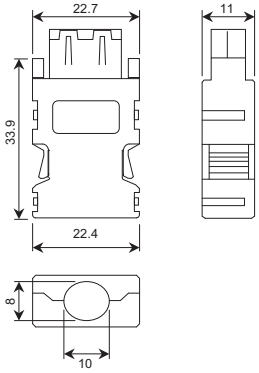


Servo drive unit connector for CN2/3

[Unit: mm]

Manufacturer: 3M
<Type>
Receptacle: 36210-0100PL
Shell kit: 36310-3200-008

Manufacturer: MOLEX
<Type>
Connector set: 54599-1019

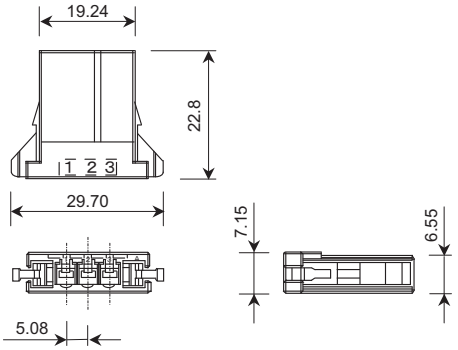


(2) Brake connector

Brake connector for motor brake control output

[Unit: mm]

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

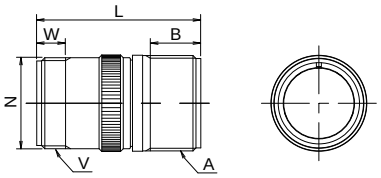


(3) Power connector

Motor power connector

[Unit: mm]

Manufacturer: DDK

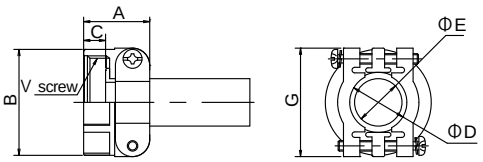


Receptacle:

Type	Overall screw	Avail. screw length	Total length	Outer dia.	Cable clamp fitting screw	Avail. screw length
	A	B or more	L ± 1.5	ΦN ± 0.5	V	W or more
D/MS3101A14S-9P	7/8-20UNEF	9.53	37.5	22.29	3/4-20UNEF	9.53
D/MS3101A18-10P	1 1/8-18UNEF	15.88	51.1	28.64	1-20UNEF	9.53
D/MS3101A24-22P	1 1/2-18UNEF	15.88	57.2	38.17	1 7/16-18UNEF	9.53

[Unit: mm]

Manufacturer: DDK



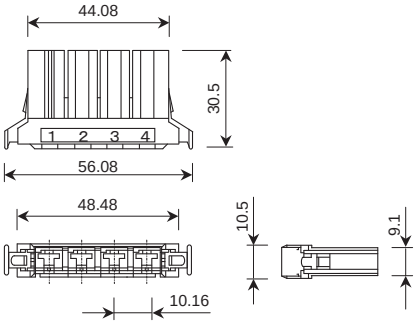
Clamp:

Type	A ± 0.7	B ± 0.7	C	D	E	G ± 0.7	V screw	Provided bushing type
D/MS3057-6A	22.2	24.6	10.3	11.2	7.9	27.0	3/4-20UNEF	AN3420-6
D/MS3057-10A	23.8	30.1	10.3	15.9	14.3	31.7	1-20UNEF	AN3420-10
D/MS3057-16A	23.8	35.0	10.3	19.0	15.9	37.3	1 3/16-18UNEF	AN3420-12

Power connector for drive unit TE1

[Unit: mm]

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



5

Selection

5.1 Selection of the Linear Servo Motor

It is important to select a linear servo motor matched to the purpose of the machine that will be installed. If the linear servo motor and machine to be installed do not match, the motor performance cannot be fully realized, and it will also be difficult to adjust the parameters. Be sure to understand the linear servo motor characteristics in this chapter to select the correct motor.

5.1.1 Max. Feedrate

The max. feedrate for the LM-F Series linear servo motor is 120m/min. However, there are systems that cannot reach the max. speed 120m/min depending on the linear scale being used.

5.1.2 Selection of Linear Servo Motor Capacity

The following three elements are used to determine the linear motor capacity.

1. Load weight ratio
2. Short time characteristics (acceleration/deceleration torque)
3. Continuous thrust

Carry out appropriate measures, such as increasing the motor capacity, if any of the above conditions is not fulfilled.

(1) Load weight ratio

Each linear motor has an appropriate load weight ratio. The control becomes unstable when the load weight ratio is too large, and the servo parameter adjustment becomes difficult. It becomes difficult to improve the surface precision in the feed axis, and the positioning time cannot be shortened in the positioning axis because the settling time is longer.
If the load weight ratio exceeds the recommended value in the section "2.1 Linear Servo Motor", increase the motor capacity, and select so that the load inertia ratio is within the recommended range.
Note that the recommended value for the load inertia ratio is strictly one guideline. This does not mean that controlling of the load weight exceeding the recommended value is impossible.

POINT

When selecting feed axis servo motors for NC unit machine tools, place importance on the surface precision during machining. To do this, always select a servo motor with a load weight ratio within the recommended value. Select the lowest value possible within that range.

(2) Short time characteristics

In addition to the continuous operation range, the linear motor has the short time operation range that can be used only in a short time such as acceleration/deceleration. If the motor is a natural-cooling type, a thrust that is approx. 6-fold can be output. For an oil-type motor, a thrust that is approx. 3-fold can be output. This range is expressed by the maximum thrust and the thrust characteristics. The maximum thrust or the thrust characteristics differ according to each motor, so confirm the specifications in section "2.1 Linear Servo Motor".
The thrust required for the linear motor's acceleration/deceleration differs according to the CNC's command pattern or the servo's position control method.
Determine the required maximum motor thrust from the following expression, and select the linear motor capacity.

(a) Selection with the maximum thrust characteristics
In a low-speed operation range (approximately less than half of the linear motor maximum speed), the linear acceleration/deceleration time constant "ta" that can be driven depends on the motor maximum thrust. That can be approximated from the machine specifications using the expression (5-1).

$$ta = \frac{N \times 10^{-2} \times (J_L + J_M)}{(T_{MAX} \times \eta / 100 + T_L)} \quad (ms) \quad \bullet\bullet\bullet (5\text{-}1)$$

N	: Motor reach speed	(m/s)
J_L	: Motor load mass (except motor primary side)	(kg)
J_M	: Motor primary side mass	(kg)
η	: Drive system efficiency (Normally 0.8 to 0.95)	
T_{MAX}	: Maximum motor thrust	(N)
T_L	: Motor shaft conversion load (friction) force	(N)

Using the approximate linear acceleration/deceleration time constant "ta" calculated above, confirm the thrust characteristics of the high-speed rotation range in the CNC's command pattern or the servo's position control method.

(b) Approximation when using the NC command linear acceleration/deceleration pattern + servo standard position control

This is a normal command pattern or servo standard position control method.

Using the expression (5-2) and (5-3), approximate the maximum torque "Ta1" and maximum torque occurrence speed "Nm" required for this acceleration/deceleration pattern.

$$Ta1 = \frac{N \times 10^{-2} \times (J_L + J_M)}{ta} \times (1 - e^{\frac{-Kp \times ta}{1000}}) + T_L \quad (N) \qquad \bullet\bullet\bullet (5\text{-}2)$$

$$Nm = N \times \{1 - \frac{1000}{Kp \times ta} \times (1 - e^{\frac{-Kp \times ta}{1000}})\} \quad (m/s) \qquad \bullet\bullet\bullet (5\text{-}3)$$

N	: Motor reach speed	(m/s)
J_L	: Motor load mass (except motor primary side)	(kg)
J_M	: Motor primary side mass	(kg)
η	: Drive system efficiency (Normally 0.8 to 0.95)	
T_{MAX}	: Maximum motor thrust	(N)
T_L	: Motor shaft conversion load (friction) force	(N)

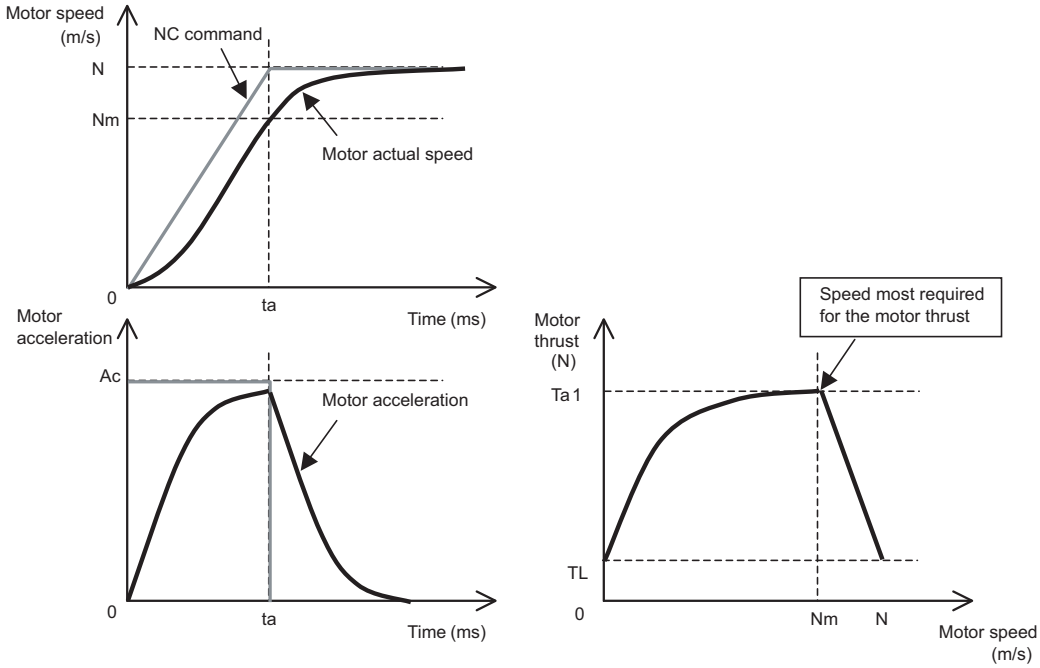


Fig.1 Speed, acceleration and thrust characteristics when using the NC command linear acceleration/deceleration pattern + servo standard position control

(c) Approximation when using the NC command linear acceleration/deceleration pattern + servo SHG control (option)
This is a servo's position control method to achieve a normal command pattern and high precision. SHG control improves the position loop gain by stably controlling a delay of the position loop in the servo system. This allows the settling time to be reduced and a high precision to be achieved.
Using the expression (5-4) and (5-5), approximate the maximum torque "Ta1" and maximum torque occurrence speed "Nm" required for this acceleration/deceleration pattern.

$$Ta1 = \frac{N \times 10^{-2} \times (J_L + J_M)}{ta} \times (1 - 0.58 \times e^{\frac{-2 \times Kp \times ta}{1000}}) + T_L \quad (N) \qquad \bullet\bullet\bullet (5\text{-}4)$$

$$Nm = N \times \{1 - \frac{1000}{1.3 \times Kp \times ta} \times (1 - 1.5 \times e^{\frac{-2 \times Kp \times ta}{1000}})\} \quad (m/s) \qquad \bullet\bullet\bullet (5\text{-}5)$$

N	: Motor reach speed	(m/s)
J_L	: Motor load mass (except motor primary side)	(kg)
J_M	: Motor primary side mass	(kg)
η	: Drive system efficiency (Normally 0.8 to 0.95)	
T_{MAX}	: Maximum motor thrust	(N)
T_L	: Motor shaft conversion load (friction) force	(N)

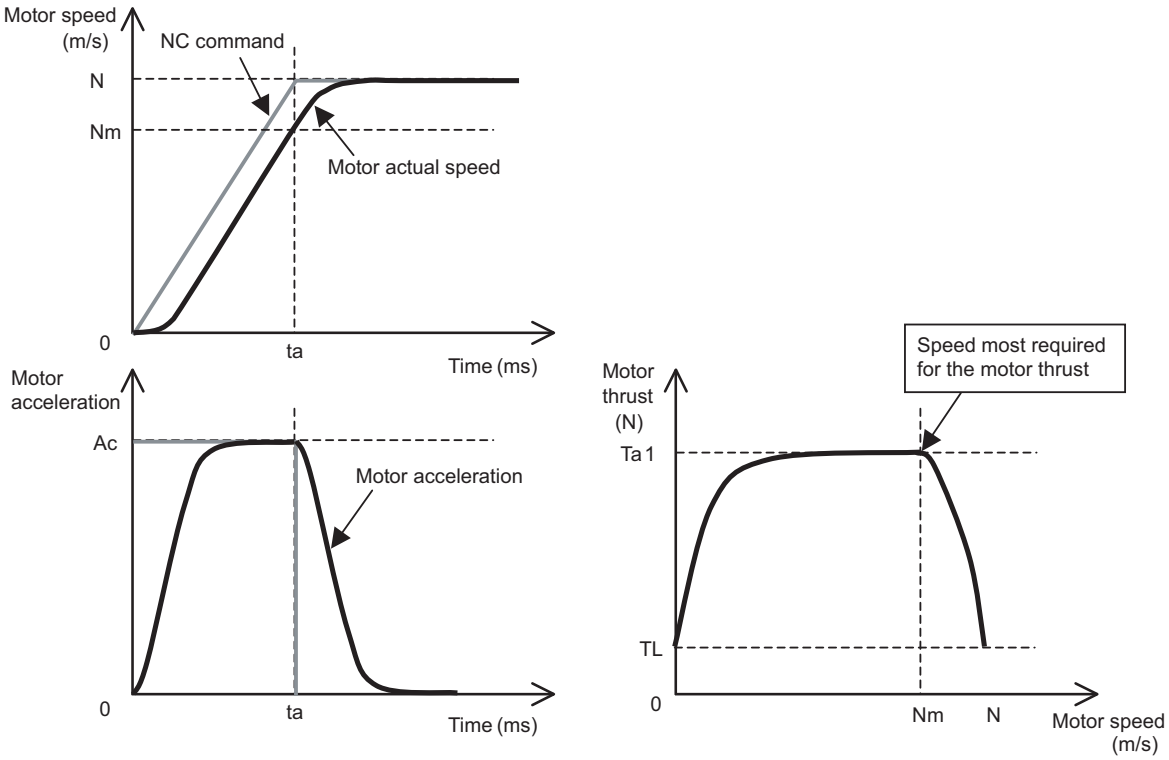


Fig.2 Speed, acceleration and thrust characteristics when using the NC command linear acceleration/deceleration pattern + servo SHG control

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

If the feed forward amount is set properly, the delay of the servo position loop is guaranteed. Therefore, this command acceleration pattern can be approximated to the NC command and does not depend on the servo position control method.

Using the expression (5-6) and (5-7), approximate the maximum torque "Ta1" and maximum torque occurrence speed "Nm" required for this acceleration/deceleration pattern.

$$Ta1 = \frac{N \times 10^{-2} \times (J_L + J_M)}{ta} + T_L \quad (N) \qquad \bullet\bullet\bullet (5\text{-}6)$$

$$Nm = N \times \left(1 - \frac{1}{2} \times \frac{tb}{ta}\right) \quad (m/s) \qquad \bullet\bullet\bullet (5\text{-}7)$$

ta	: Linear acceleration/deceleration time constant	(ms)
tb	: Acceleration/deceleration time constant	(ms)
Kp	: Position loop gain	(rad/sec)
N	: Motor reach speed	(m/s)
J_L	: Motor load mass (except motor primary side)	(kg)
J_M	: Motor primary side mass	(kg)
η	: Drive system efficiency (Normally 0.8 to 0.95)	
T_L	: Motor shaft conversion load (friction) force	(N)

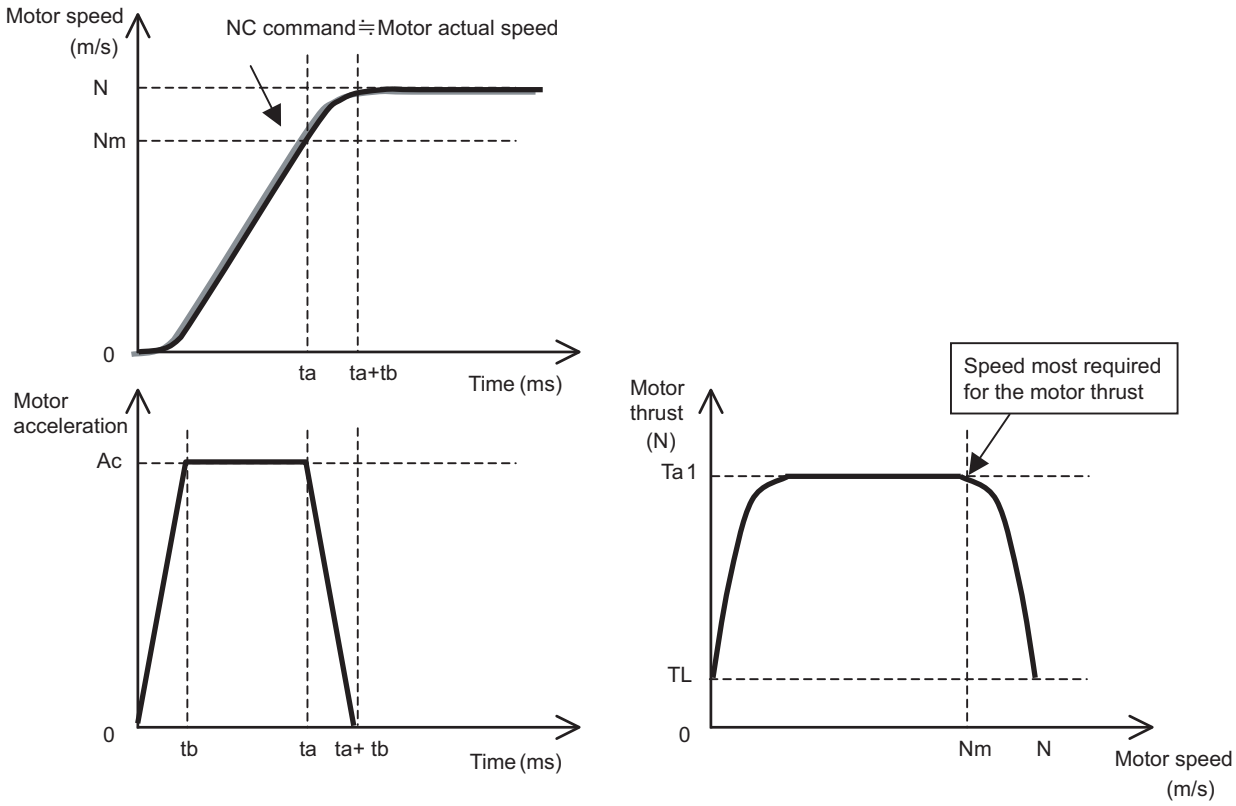
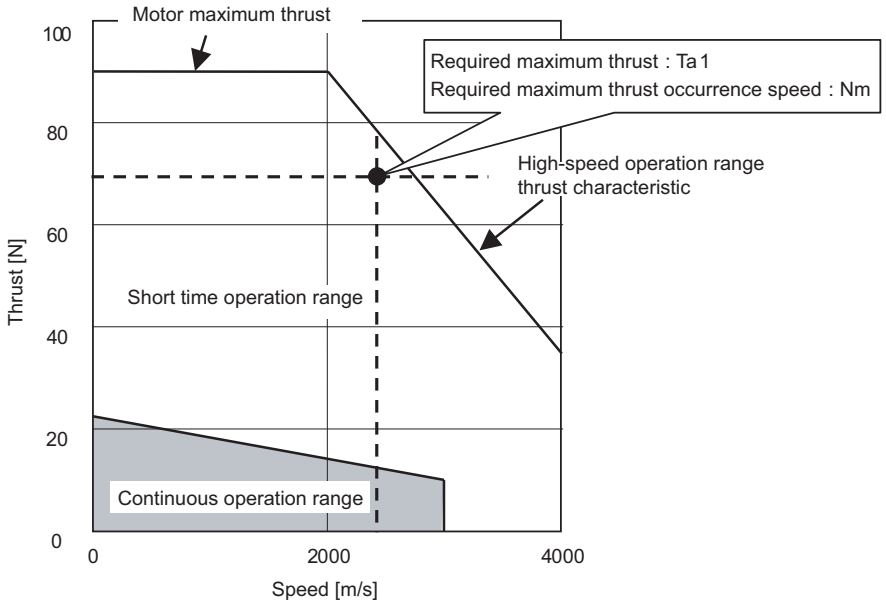


Fig 3. Speed, acceleration and thrust characteristic when using the NC command soft acceleration/deceleration pattern + feed forward (high-speed accuracy) control

(e) Confirmation in the thrust characteristics
Confirm whether the maximum thrust "Ta1" and maximum thrust occurrence speed "Nm" required for this acceleration/deceleration pattern calculated in the item "(b)" to "(d)" are in the short time operation range of the thrust characteristics.



Motor thrust characteristics

If they are not in the short time operation range, return to the item "(b)" to "(d)" and make the linear acceleration/deceleration time constant "ta" large.
If the acceleration specification cannot be changed (the linear acceleration/deceleration time constant cannot be increased), reconsider the selection, such as increasing the motor capacity.

POINT

1. In selecting the maximum thrust "Ta1" required for this acceleration/deceleration pattern, the measure of it is 80% of the motor maximum thrust "T_{MAX} "
2. In high-speed rotation range, confirm that the maximum thrust "Ta1" and maximum thrust occurrence speed "Nm" required for this acceleration/deceleration is in the short time operation range.
3. The drive system efficiency is normally approx. 0.95 in the ball screw mechanism and approx. 0.8 in the gear mechanism
4. For the thrust characteristics in the motor high-speed operation range, the AC input voltage is 200V (200V series) or 380V (400V series). If the input voltage is low or if the power wire connecting the linear motor and drive unit is long (20m length), the short time operation range is limited. In this case, an allowance must be provided for the selection of the high-speed operation range.

5.1.3 Continuous Thrust

A typical operation pattern is assumed, and the motor's continuous effective load thrust (Frms) is calculated from the load force. If numbers (1) to (8) in the following drawing were considered a one cycle operation pattern, the continuous effective load thrust is obtained from the root mean square of the thrust during each operation, as shown in the expression (5-8).

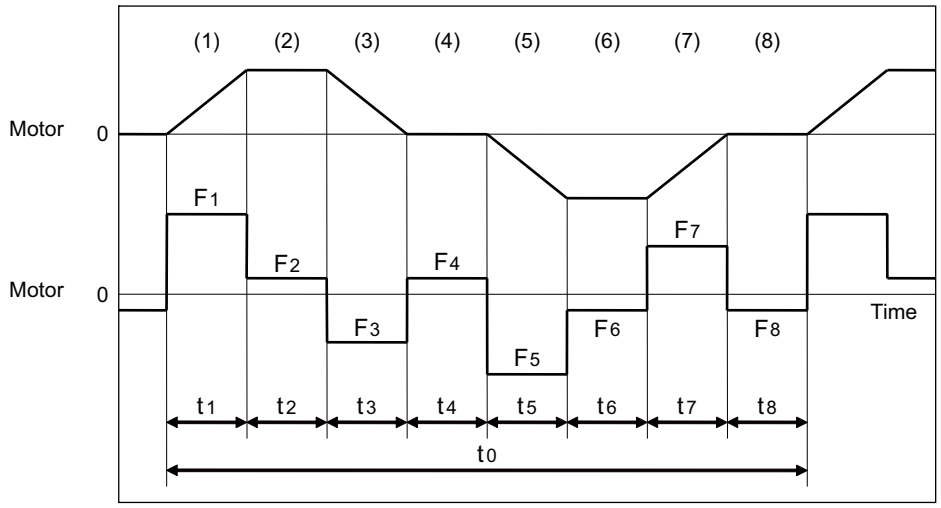


Fig. 5-1Continuous operation pattern

$$F_{rms} = \sqrt{\frac{F_1^2 \cdot t_1 + F_2^2 \cdot t_2 + F_3^2 \cdot t_3 + F_4^2 \cdot t_4 + F_5^2 \cdot t_5 + F_6^2 \cdot t_6 + F_7^2 \cdot t_7 + F_8^2 \cdot t_8}{t_0}} \cdots (5\text{-}8)$$

Select a motor so that the continuous effective load thrust (Frms) is 80% or less of the motor rated thrust (Fs).

Frms ≦ 0.8 × Fs …(5-9)

(1) Horizontal axis load thrust

When operations (1) to (8) are for a horizontal axis, calculate so that the following thrusts are required in each period.

Table 5-1 Load thrusts of horizontal axes

Period	Load thrust calculation method	Explanation
(1)	(Amount of acceleration thrust) + (Kinetic friction force)	Normally the acceleration/deceleration time constant is calculated so this thrust is 80% of the maximum thrust of the motor.
(2)	(Kinetic friction force) + (Cutting force)	
(3)	(Amount of deceleration thrust) +(Kinetic friction force)	The signs for the amount of acceleration thrust and amount of deceleration thrust are reversed when the absolute value is the same value.
(4)	(Static friction force)	Calculate so that the static friction force is always required during a stop.
(5)	- (Amount of acceleration thrust) - (Kinetic friction force)	The signs are reversed with period (1) when the kinetic friction does not change according to movement direction.
(6)	- (Kinetic friction force) - (Cutting force)	The signs are reversed with period (2) when the kinetic friction does not change according to movement direction.
(7)	- (Amount of deceleration thrust) - (Kinetic friction force)	The signs are reversed with period (3) when the kinetic friction does not change according to movement direction.
(8)	- (Static friction force)	Calculate so that the static friction force is always required during a stop.

(2) Max. cutting thrust and max. cutting duty

If the max. cutting force and max. cutting duty (%/min) are known, the following expression can be used for the selection conditions.

$$0.8 \times Fs \geqq Fc \times \sqrt{\frac{D}{100}} \quad \text{…(5-10)}$$

Fs : Motor continuous thrust (N)
Fc : Max. cutting force during operation (N)
D : Max. cutting duty (%/min)

(3) Unbalance axis

> **⚠ CAUTION**
>
> 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.

5.2 Selection of the Power Supply Unit (Only MDS-D2/DH2)

Compared to the normal rotary motor, when using the linear servo system, the instantaneous output, such as the acceleration/deceleration, is large in respect to the continuous operation. Furthermore, this system is used in applications where acceleration/deceleration is carried out frequently, so the selection differs from the methods for selecting the conventional power supply unit.

Power supply unit capacity > Σ (Spindle motor output)
+ Σ (Capacity of servo drive unit driving linear motor)
+ 0.7 × Σ (Rotary servo motor output) …(5-11)
* When using two or more axes with the rotation motor

Select a power supply unit capacity having the minimum lineup capacity that satisfies expression (5-11).

(Caution) With the linear servo axis, this is used for an axis with a high acceleration/deceleration frequency compared to that multiplied by 0.7 when using two or more axes with the rotation motor, so the value does not need to be multiplied by 0.7.

> **⚠ CAUTION**
>
> With the linear servo axis, this is used for an axis with a high acceleration/deceleration frequency compared to that multiplied by 0.7 when using two or more axes with the rotation motor, so the value does not need to be multiplied by 0.7.

For details on the calculation method of motor output and selecting method for motors other than a linear motor, refer to "MDS-D2/DH2 Series Specifications Manual" (IB-1501124(ENG)).

5.2.1 Calculation of Linear Motor

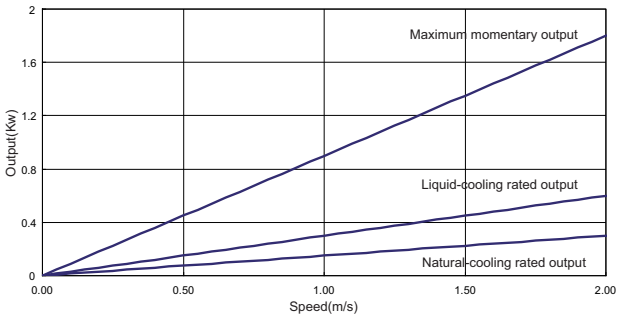
(1) Selection with rated output

(2) Selection with maximum momentary output

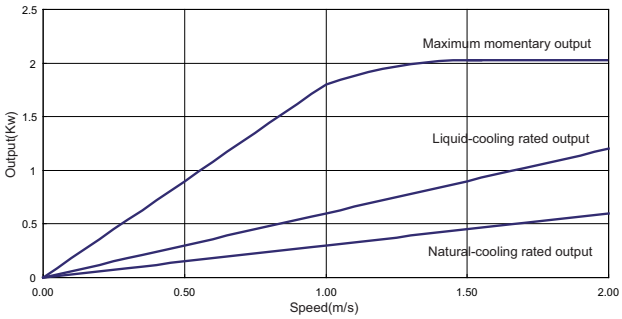
For the rated output and maximum momentary output at the maximum speed of the linear motor, calculate from the output characteristics of each motor.

< Output characteristics >

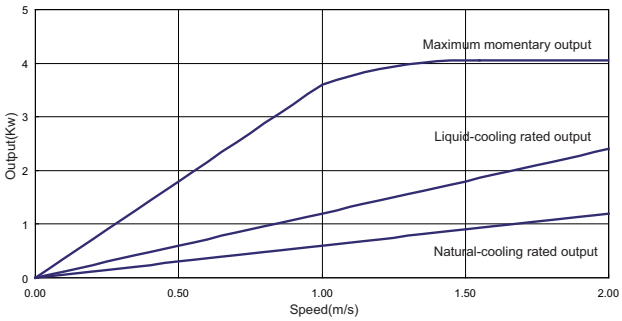
LM-FP2A-03M



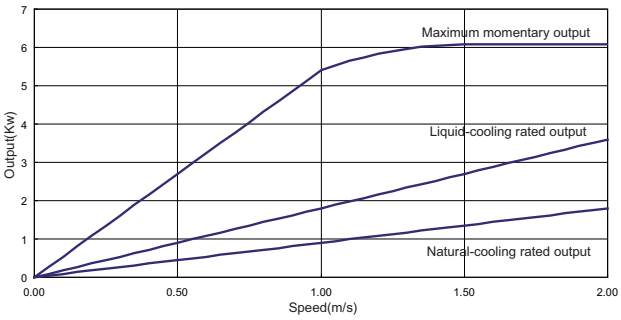
LM-FP2B-06M



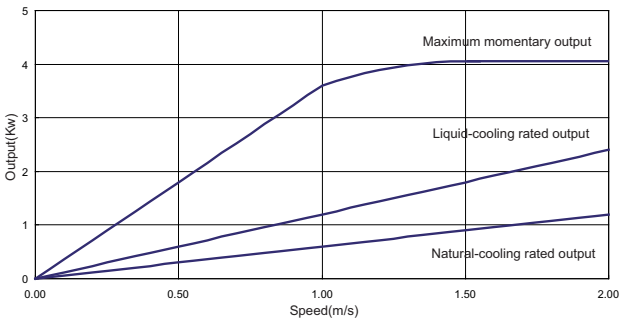
LM-FP2D-12M



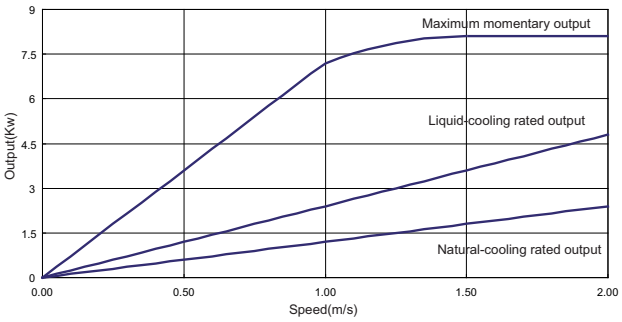
LM-FP2F-18M



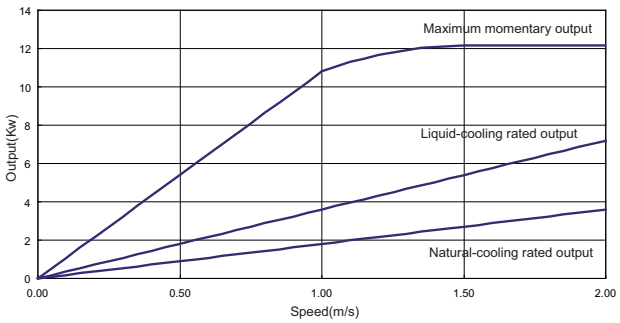
LM-FP4B-12M



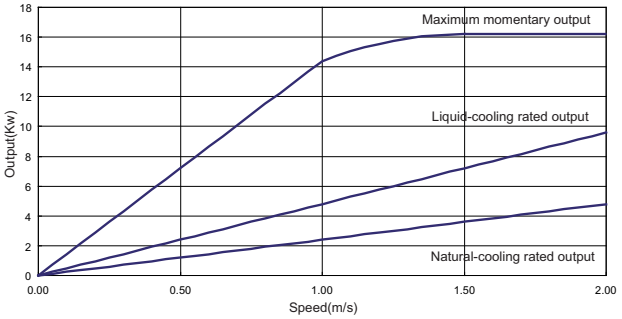
LM-FP4D-24M



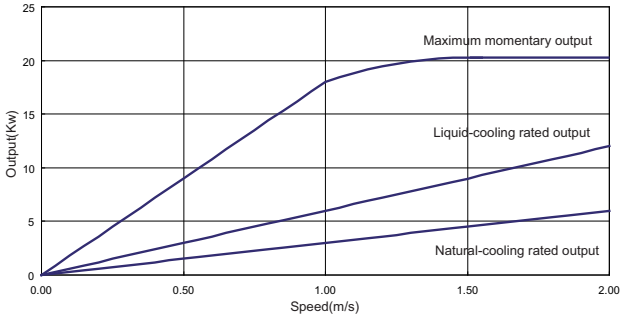
LM-FP4F-36M



LM-FP4H-48M



LM-FP5H-60M



5.3 Selection of the Regenerative Resistor (Only MDS-DJ)

5.3.1 Calculation of the Regenerative Energy

Calculate the regenerative energy for stopping from each axis' rapid traverse rate, and select a regenerative resistor having a capacity that satisfies the positioning frequency determined from the machine specifications.

(1) For linear servo axis

The regenerative energy ER consumed by the regenerative resistor can be calculated from expression (5-12). If the ER value is negative, all of the regenerative energy is absorbed by the capacitor in the drive unit (capacitor regeneration), and the energy consumed by the regenerative resistor is zero (ER= 0).

$$E_R = 0.5 \times \eta \times M \times N^2 - Ec \quad (J) \quad \cdots(5\text{-}12)$$

η	:Motor reverse efficiency	
M	:Weight load	(kg)
N	:Motor speed	(m/s)
Ec	:Unit charging energy	(J)

(Example)

When a load weight of 10 times the motor primary side is connected to the LM-FP2D-12M, determine the regenerative energy to stop from the maximum speed. Note that the drive unit is MDS-DJ-V1-40 in this case.

According to expression (5-12), the regenerative energy ER is:

$E_R = 0.5 \times 0.9 \times 180 \times 2.0^2 - 36 = 288$ (J)

Drive unit charging energy

Drive unit	Charging energy Ec (J)	Drive unit	Charging energy Ec (J)
MDS-DJ-V1-40	36	**MDS-DJ-V1-80**	36

Motor reverse efficiency

Motor	Motor reverse efficiency η	Motor	Motor reverse efficiency η
LM-FP2A-03M	0.85	**LM-FP2D-12M**	0.90
LM-FP2B-06M	0.85	**LM-FP4B-12M**	0.90

POINT

The charging energy values apply when the unit input power voltage is 220V. If the input voltage is higher, the charging energy decreases, and the regenerative energy increases.

5.3.2 Calculation of the Positioning Frequency

Select the regenerative resistor so that the positioning frequency DP (times/minute) calculated from the regenerative resistor capacity PR (W) and regenerative energy ER (J) consumed by the regenerative resistor is within the range shown in expression (5-13).

$$DP < 48 \cdot \frac{PR}{ER} \text{ (times/minute)} \quad \cdots(5\text{-}13)$$

List of servo regenerative resistor correspondence

Corresponding servo drive unit	Standard built-in regenerative resistor		External option regenerative resistor						
			MR-RB032	MR-RB12	MR-RB32	MR-RB30	MR-RB50	MR-RB31	MR-RB51
				GZG200W39 OHMK	GZG200W120 OHMK × 3 units	GZG200W39 OHMK × 3 units	GZG300W39 OHMK × 3 units	GZG200W20 OHMK × 3 unit	GZG300W20 OHMK × 3 unit
	Parameter setting value		1200h	1300h	1400h	1500h	1600h	1700h	1800h
	Regenerative capacity		30W	100W	300W	300W	500W	300W	500W
		Resistance value	40Ω	40Ω	40Ω	13Ω	13Ω	6.7Ω	6.7Ω
MDS-DJ-V1-10	10W	100Ω	○	○					
MDS-DJ-V1-15	10W	100Ω	○	○					
MDS-DJ-V1-30	20W	40Ω	○	○	○				
MDS-DJ-V1-40	100W	13Ω				○	○		
MDS-DJ-V1-80	100W	9Ω						○	○
MDS-DJ-V1-100	100W	9Ω						○	○
MDS-DJ-V2-3030	100W	9Ω				○	○		

Corresponding servo drive unit	Standard built-in regenerative resistor		External option regenerative resistor						
			FCUA-RB22	FCUA-RB37	FCUA-RB55	FCUA-RB75/2 (1 unit)	R-UNIT2	FCUA-RB55 2 units connected in parallel	FCUA-RB75/2 2 units connected in parallel
	Parameter setting value		2400h	2500h	2600h	2700h	2900h	2E00h	2D00h
	Regenerative capacity		155W	185W	340W	340W	700W	680W	680W
		Resistance value	40Ω	25Ω	20Ω	30Ω	15Ω	10Ω	15Ω
MDS-DJ-V1-10	10W	100Ω							
MDS-DJ-V1-15	10W	100Ω							
MDS-DJ-V1-30	20W	40Ω	○						
MDS-DJ-V1-40	100W	13Ω		○	○	○	○		○
MDS-DJ-V1-80	100W	9Ω					○	○	○
MDS-DJ-V1-100	100W	9Ω						○	
MDS-DJ-V2-3030	100W	9Ω		○	○				

6

Installation

⚠ CAUTION

1. The linear servo system uses a powerful magnet on the secondary side. Thus, caution must be taken not only by the person installing the linear motor, but also the machine operators. For example, persons wearing a pacemaker, etc., must not approach the machine.
2. The person installing the linear motor and the machine operator must not have any items (watch or calculator, etc.) which could malfunction or break due to the magnetic force on their body.
3. Always use nonmagnetic tools for installing the linear motor or during work in the vicinity of the linear motor.
   (Example of nonmagnetic tool)
   Explosion-proof beryllium copper alloy safety tool: Nihon Gaishi
4. Install the servo drive unit or motor on noncombustible material. Direct installation on combustible material or near combustible materials could lead to fires.
5. Follow this Instruction Manual and install the unit in a place where the weight can be borne.
6. Do not get on top of or place heavy objects on the unit.
   Failure to observe this could lead to injuries.
7. Always use the unit within the designated environment conditions.
8. The servo drive unit and linear servo motor are precision devices, so do not drop them or apply strong impacts to them.
9. Do not install or run a servo drive unit or linear servo motor that is damaged or missing parts.
10. When storing for a long time, please contact your dealer.

6.1 Installation of the Linear Servo Motor

⚠ CAUTION

1. Securely fix the linear servo motor onto the machine. insufficient fixing could cause the servo motor to come off during operation, and lead to injuries.
2. The motor must be replaced when damaged. (The connectors and cooling ports cannot be repaired or replaced.)
3. Use nonmagnetic tools during installation.
4. An attraction force is generated in the magnetic body by the secondary side permanent magnet. Take care not to catch hands.
   Take special care when installing the primary side after the secondary side.
5. Install the counterbalance and holding brakes for the vertical axis on the machine side.
   The balance weight cannot track at 9.8m/s^2 or more, so use a pneumatic counterbalance, etc., having high trackability.
6. Always install an electrical and mechanical stopper at the stroke end.
7. Take measure to prevent iron-based cutting chips from being attracted to the secondary side permanent magnet.
8. Oil-proofing and dust-proofing measures higher than for the motor must be taken for the linear scale.
9. The cable enclosed with the motor is not a movable cable, so fix the cable to the machine to prevent it from moving.
   For the moving sections, select a cable that matches the operation speed and bending radius, etc.
10. Use hexagon socket bolts (material SCM435, lower yield point 900[N/mm^2] or more) for the installation of the motor.
11. Fix the hexagonal part of the coolant pipe with a wrench when piping to the coolant pipe.
    The tightening torque should be 3.0 to 3.5[N•m].
12. The electroless nickel plating (kanigen plating) is processed on the metal surface.
13. When dust etc. are adhered to the secondary side mold surface, wipe them off with wastes soaked with acetone.

POINT

1. Make the machine's rigidity as high as possible.
2. Keep the moving sections as light as possible, and the base section as heavy and rigid as possible.
3. Securely fix the base section onto the foundation with anchor bolts.
4. Keep the primary resonance frequency of the entire machine as high as possible.
   (Should be 200Hz or more.)
5. Install the motor so that the thrust is applied on the center of the moving sections. If the force is not applied on the center of the moving parts, a moment will be generated.
6. Use an effective cooling method such as circulated cooling oil.
7. In consideration of the cooling properties, select a motor capacity that matches the working conditions.
8. Create a mechanism that can withstand high speeds and high acceleration/deceleration.

6.1.1 Environmental Conditions

Environment	Conditions
Ambient temperature	0˚ C to +40˚ C (with no freezing), Storage: -15˚ C to 55˚ C (with no freezing)
Ambient humidity	80% RH or less (with no dew condensation), Storage: 90% RH or less (with no dew condensation)
Atmosphere	Indoors (no direct sunlight), No corrosive gas, inflammable gas, oil mist or dust
Altitude	1000m or less above sea level

6.1.2 Quakeproof Level

Motor type	Vibration
LM-FP2A-03M	49 m/s^2 or less
LM-FP2B-06M	
LM-FP2D-12M	
LM-FP2F-18M	
LM-FP4B-12M	
LM-FP4D-24M	
LM-FP4F-36M	
LM-FP4H-48M	
LM-FP5H-60M	

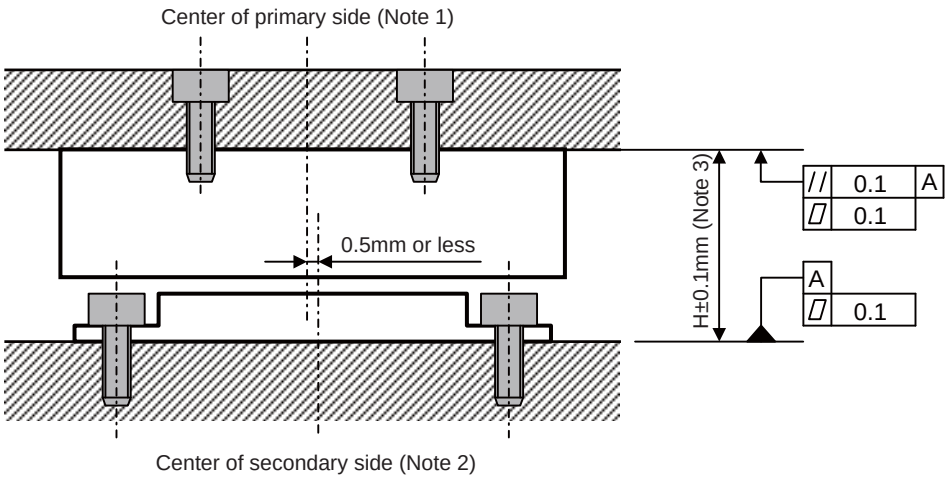
6.1.3 Installing the Linear Servo Motor

⚠ CAUTION

1. Securely fix the linear servo motor onto the machine. Incomplete fixing could cause the servo motor to come off during operation, and lead to injuries.
2. The connectors and cooling ports cannot be repaired or replaced. The entire servo motor must be replaced, so take special care when handling.
3. Use nonmagnetic tools during installation.
4. An attraction force is generated in the magnetic body by the secondary side permanent magnet. Take care not to catch fingers or hands. Take special care when installing the primary side after the secondary side.
5. Install the counterbalance for the vertical axis and the holding brakes on the machine side. The balance weight cannot track at 9.8m/s^2 or more, so use a pneumatic counterbalance, etc., having high trackability.
6. Always install an electrical and mechanical stopper at the stroke end.
7. Take measure to prevent metal cutting chips from being attracted to the secondary side permanent magnet.
8. Oil-proofing and dust-proofing measures must be provided for the linear scale.

(1) Installing the primary side

Dimensions for tie-in with secondary side



(Note 1) The center of the primary side (coil) comes to the middle of the distance between the installation screws.

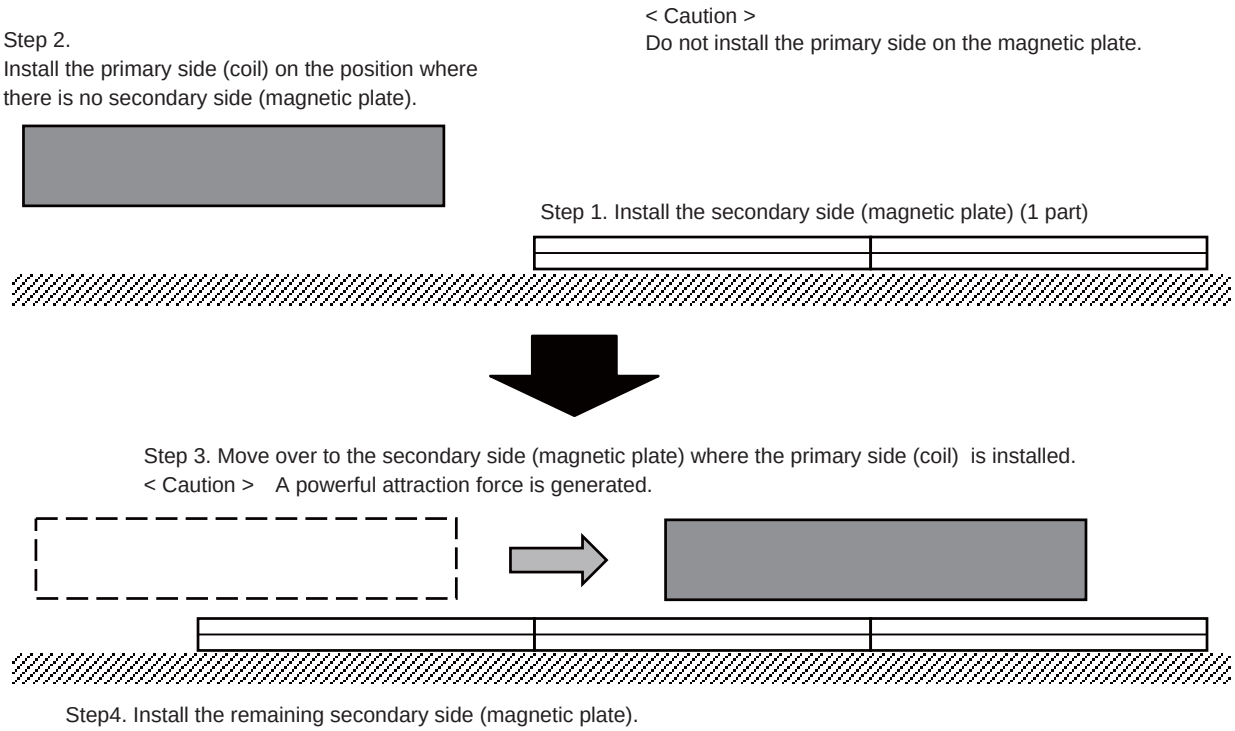
(Note 2) The center of the secondary side (magnetic plate) comes to the middle of the distance between the installation screws.

(Note 3) The installation interval accuracy is the accuracy necessary for the whole movable part.

(Note 4) The H dimension = (primary side height dimensions) + (secondary side height dimensions) + (clearance length: 0.5[mm]).

Example of installation procedures

An example of the installation procedures is shown below.



⚠ CAUTION

1. Installing the primary side on the position where there is no secondary side, as shown above, is recommended to avoid risks posed by the attraction force of the permanent magnet between the primary side and secondary side.
2. If the primary side must be installed over the secondary side, use a material handling device, such as a crane, which can sufficiently withstand the load such as the attraction force.
3. If the primary side is over the magnetic plate, the magnetic attraction force is generated and it is attracted to the magnetic plate side, so take special care when installing.
4. As a strong magnetic attraction force will be produced, make sure to fix the magnetic plate and the primary side (coil) with all the screws securely.

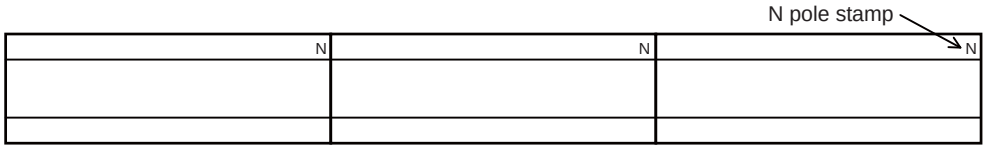
POINT

1. Keep the moving sections (primary side) as light as possible, and the base section (secondary side) as heavy and rigid as possible.
2. Make the machine's rigidity as high as possible.
3. Securely fix the base section (secondary side) onto the foundation with anchor bolts.
4. Keep the primary resonance frequency of the entire machine as high as possible. (Should be 200Hz or more.) Install the servo motor so that the thrust is applied on the center of the moving sections. If the force is not applied on the center of the moving parts, a moment will be generated.
5. Use an effective cooling method such as circulated cooling oil.
6. Select a motor capacity that matches the working conditions.
7. Create a mechanism that can withstand high speeds and high acceleration/deceleration.

(2) Installing the secondary side

Direction

When using multiple secondary sides, lay the units out so that the N pole stamps on the products all face the same direction in order to maintain the pole arrangement.

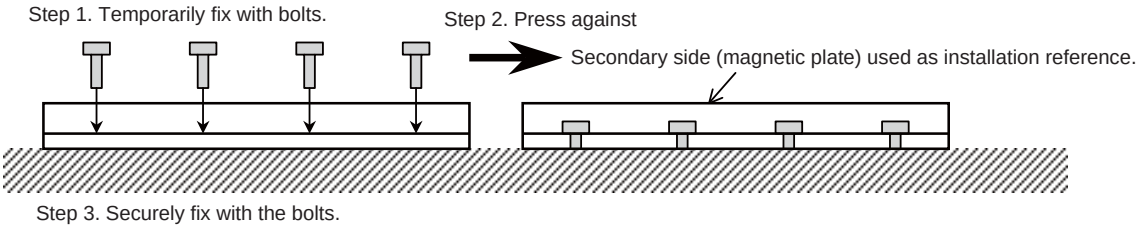


⚠ CAUTION

When installing the secondary side (magnetic plate), take it out from the package one by one, and install it to the device. It is very dangerous to leave the secondary side (magnetic plate) unattended after taking it out from the package. Furthermore, it is highly dangerous to leave the secondary sides (magnetic plates) unattended together, therefore never do so.

Procedures

Install with the following procedure to eliminate clearances between the secondary sides.



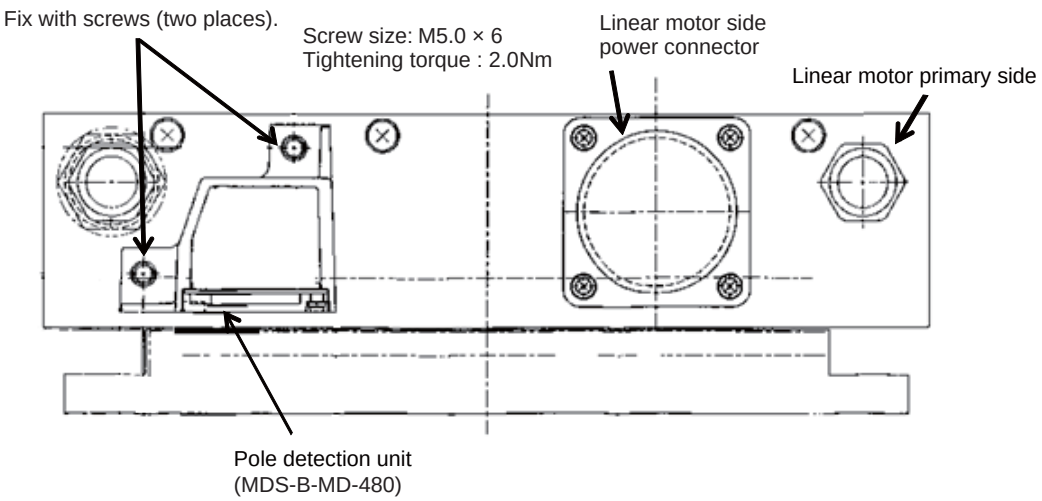
⚠ CAUTION

1. Use nonmagnetic tools when installing the secondary side.
2. When placing the secondary side onto the installation surface, use the screw holes for hanging tool, and suspend with eye bolts, etc.
3. To install two or more secondary sides (magnetic plates), install the additional secondary side after completely fixing the one already installed with bolts. Never install two or more secondary sides at once because it is highly dangerous.

(3) Installing the pole detection unit

Procedures

Install the pole detection unit with the fixing screw attached next to the linear motor side power connector on the linear motor primary side.



6.1.4 Cooling of Linear Servo Motor

Type	Required cooling ability (W)	Cooling liquid amount (L/min at 20° C)
LM-FP2A-03M	100	5L/min
LM-FP2B-06M	100	
LM-FP2D-12M	400	
LM-FP2F-18M	700	
LM-FP4B-12M	400	
LM-FP4D-24M	700	
LM-FP4F-36M	1000	
LM-FP4H-48M	1300	
LM-FP5H-60M	2000	

⚠ CAUTION

1. The required cooling ability (W) is not a specified value, but a reference value.
2. Customer is responsible for designing the cooling system, including piping to the coolant pipe embedded in the primary (coil) side, installing the pipes, and selecting parts, cooling device (chiller) and coolants.
3. Make sure to add an equipment, such as a filter, to the flow path to avoid foreign matters from flowing in the coolant pipe.
4. Customer should select appropriate liquid-cooling pipes and joints so that no leakage will occur. For the liquid-cooling pipes, select the ones that have enough bending tolerance.
5. We recommend that the liquid poured into the coolant pipe be at room temperature (around 20 degree C) or below. When the temperature is lower, the cooling effect will be enhanced, but dew condensation may be caused.
6. The coolant pipes are made of copper, so select a rust-preventive agent that won't cause copper corrosion, and add it to the coolant.

7

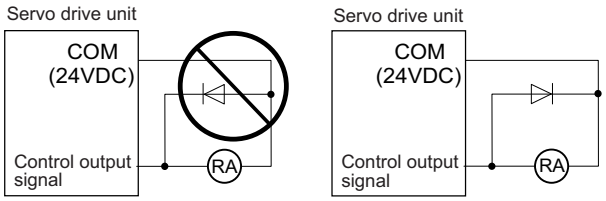
Wiring and Connection

⚠ 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 linear/servo/spindle motor.
4. Wire the drive units and linear/servo/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

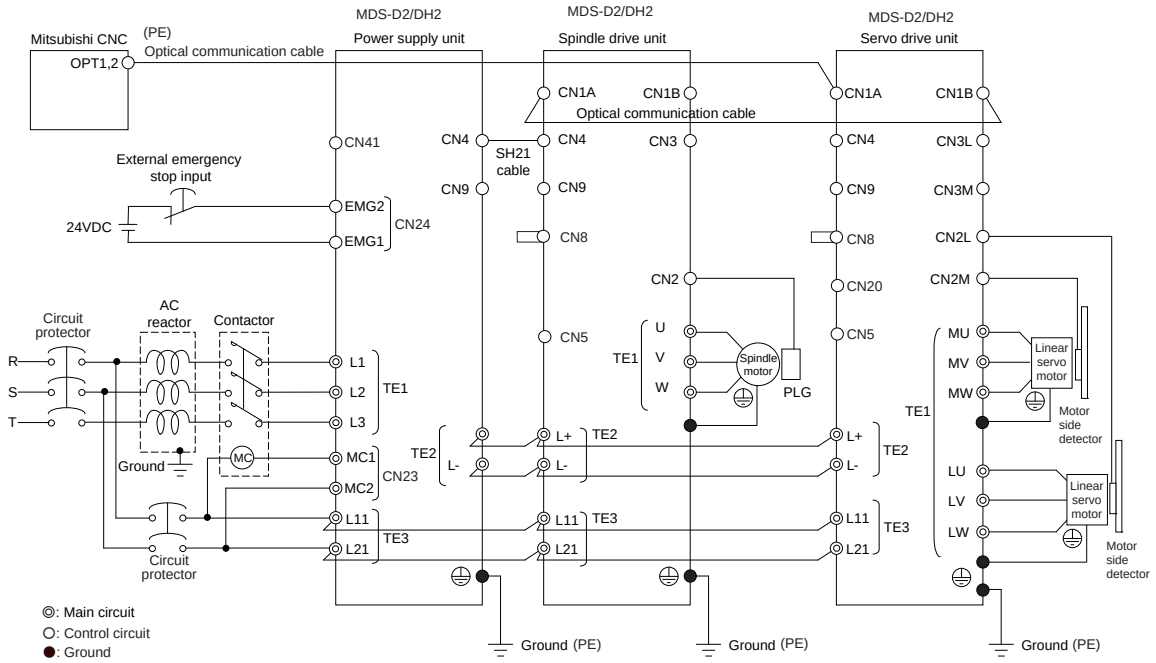
1. Correctly and securely perform the wiring. Failure to do so could result in runaway of the linear/servo/spindle motor or injury.
2. Do not mistake the terminal connections.
3. Do not mistake the polarity (+ , -). Failure to observe this item could lead to ruptures or damage, etc.
4. Do not mistake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



5. Electronic devices used near the drive units may receive magnetic obstruction. Reduce the effect of magnetic obstacles by installing a noise filter, etc.
6. Do not install a phase advancing capacitor, surge absorber or radio noise filter on the power line (U, V, W) of the linear/servo/spindle motor.
7. Do not modify this unit.
8. If the connectors are connected incorrectly, faults could occur. Make sure that the connecting position and the connection are correct.
9. 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.

7.1 Part System Connection Diagram

< MDS-D2/DH2 Series >



(Note 1) The total length of the optical communication cable from the NC must be within 30m and the minimum-bending radius within 80mm.

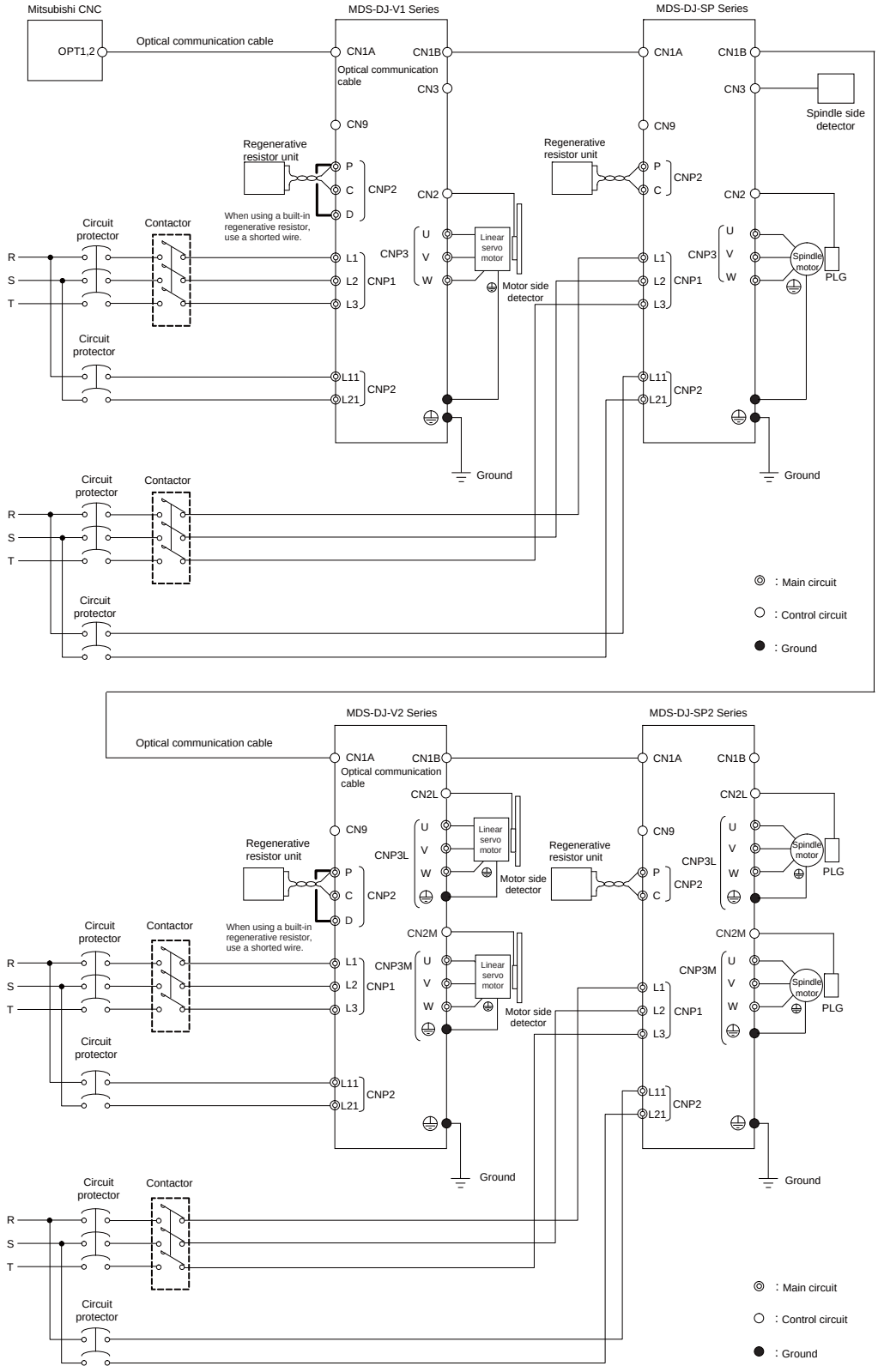
(Note 2) The connection method will differ according to the used motor.

(Note 3) Battery for the detector 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.

< MDS-DJ Series >



(Note 1) The total length of the optical communication cable from the NC must be within 30m and the minimum-bending radius within 80mm.

(Note 2) The connection method will differ according to the used motor.

(Note 3) Install the dedicated battery for the detector back up outside of the drive unit's bottom surface.

(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 for MDS-DJ-V1/SP Series, and to the ground terminal of CN3L or CN3M connector for MDS-DJ-V2/SP2 Series.

7.2 Motor and Detector Connection

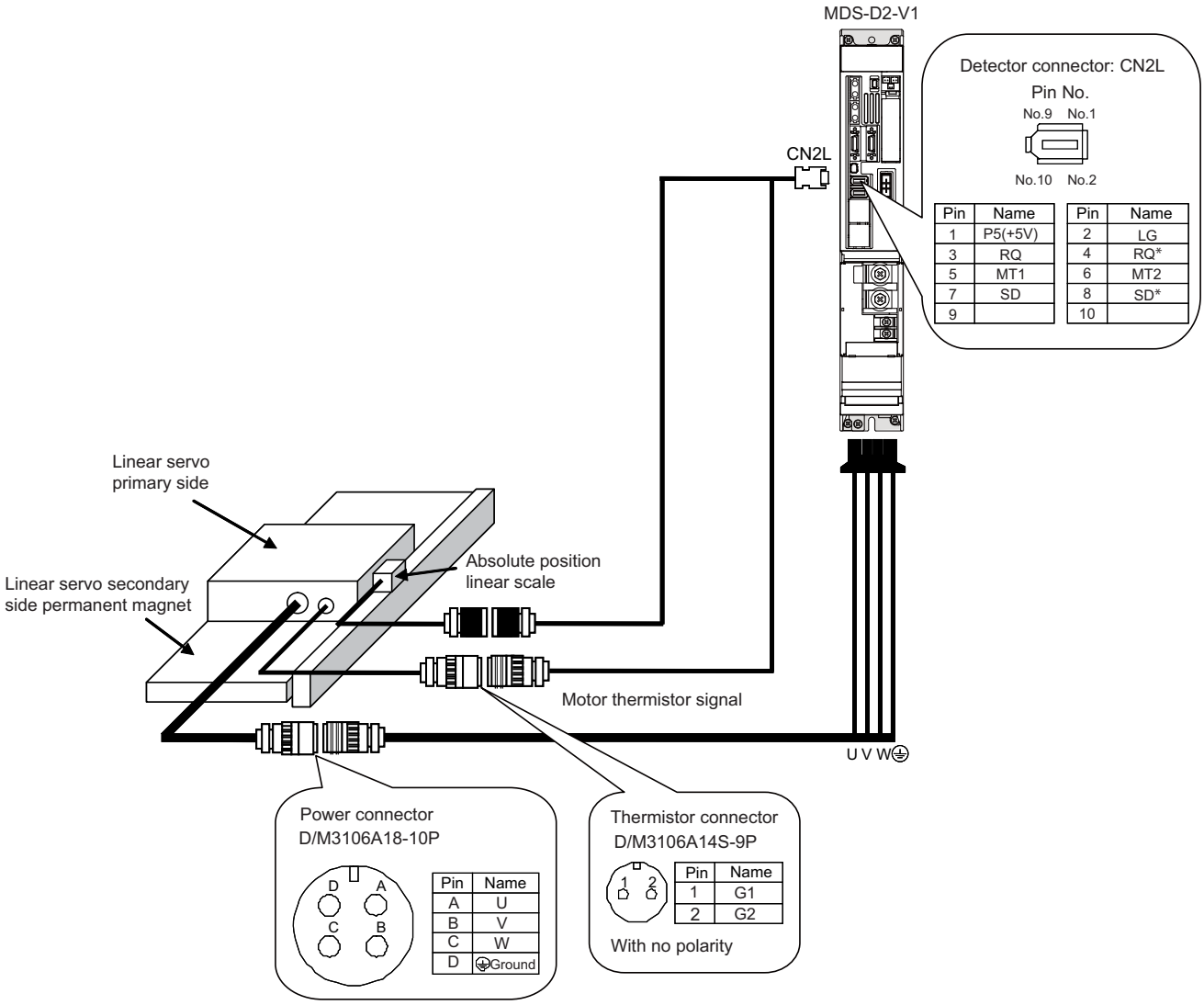
7.2.1 Linear Motor Connection

(1) Standard absolute position system

< When the motor power supply output of the servo drive unit is a connector type >

Connecting the following linear motors

LM-FP2A-03M
LM-FP2B-06M
LM-FP2D-12M
LM-FP2F-18M
LM-FP4B-12M
LM-FP4D-24M



Pin	Name	Pin	Name
1	P5(+5V)	2	LG
3	RQ	4	RQ*
5	MT1	6	MT2
7	SD	8	SD*
9		10	

Pin	Name
A	U
B	V
C	W
D	⏚Ground

Pin	Name
1	G1
2	G2

(2) Standard absolute position system

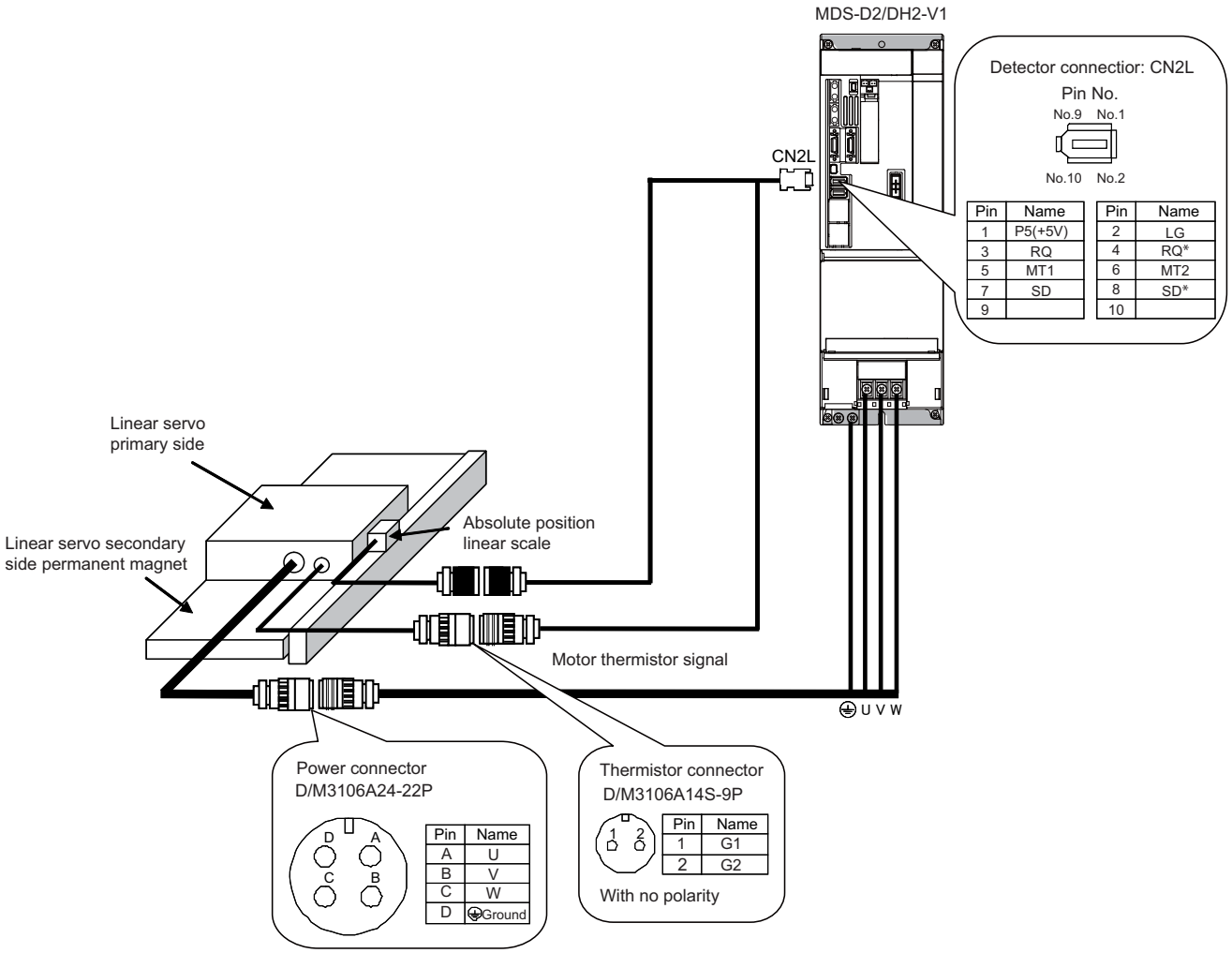
< When the power supply output of the servo drive unit is a terminal type >

Connecting the following linear motors

LM-FP4F-36M

LM-FP4H-48M

LM-FP5H-60M



Pin	Name	Pin	Name
1	P5(+5V)	2	LG
3	RQ	4	RQ*
5	MT1	6	MT2
7	SD	8	SD*
9		10	

Pin	Name
A	U
B	V
C	W
D	⏚Ground

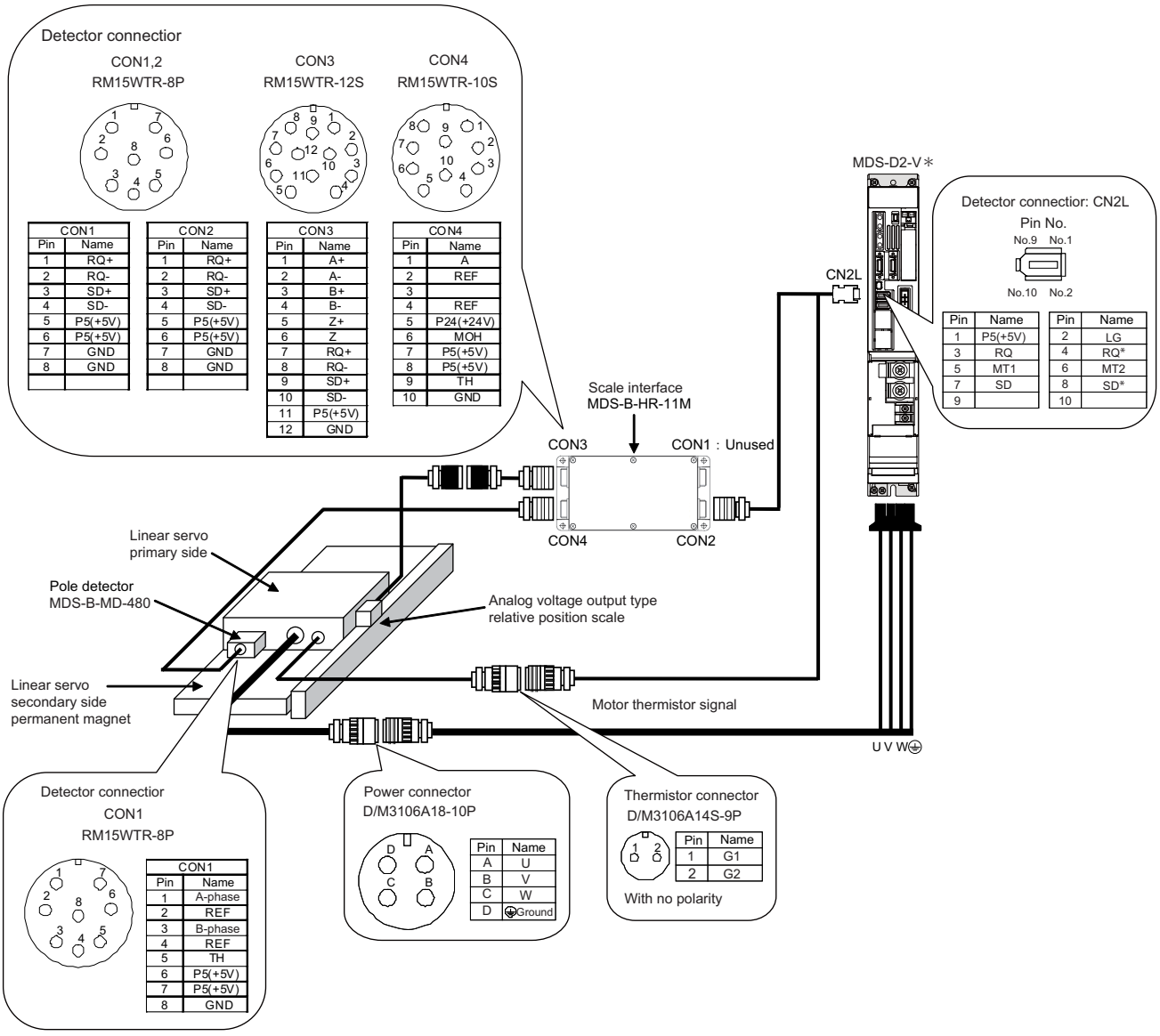
Pin	Name
1	G1
2	G2

(3) Standard relative position system

< When the motor power supply output of the servo drive unit is a connector type >

Connecting the following linear motors

LM-FP2A-03M
LM-FP2B-06M
LM-FP2D-12M
LM-FP2F-18M
LM-FP4B-12M
LM-FP4D-24M



(4) Standard relative position system

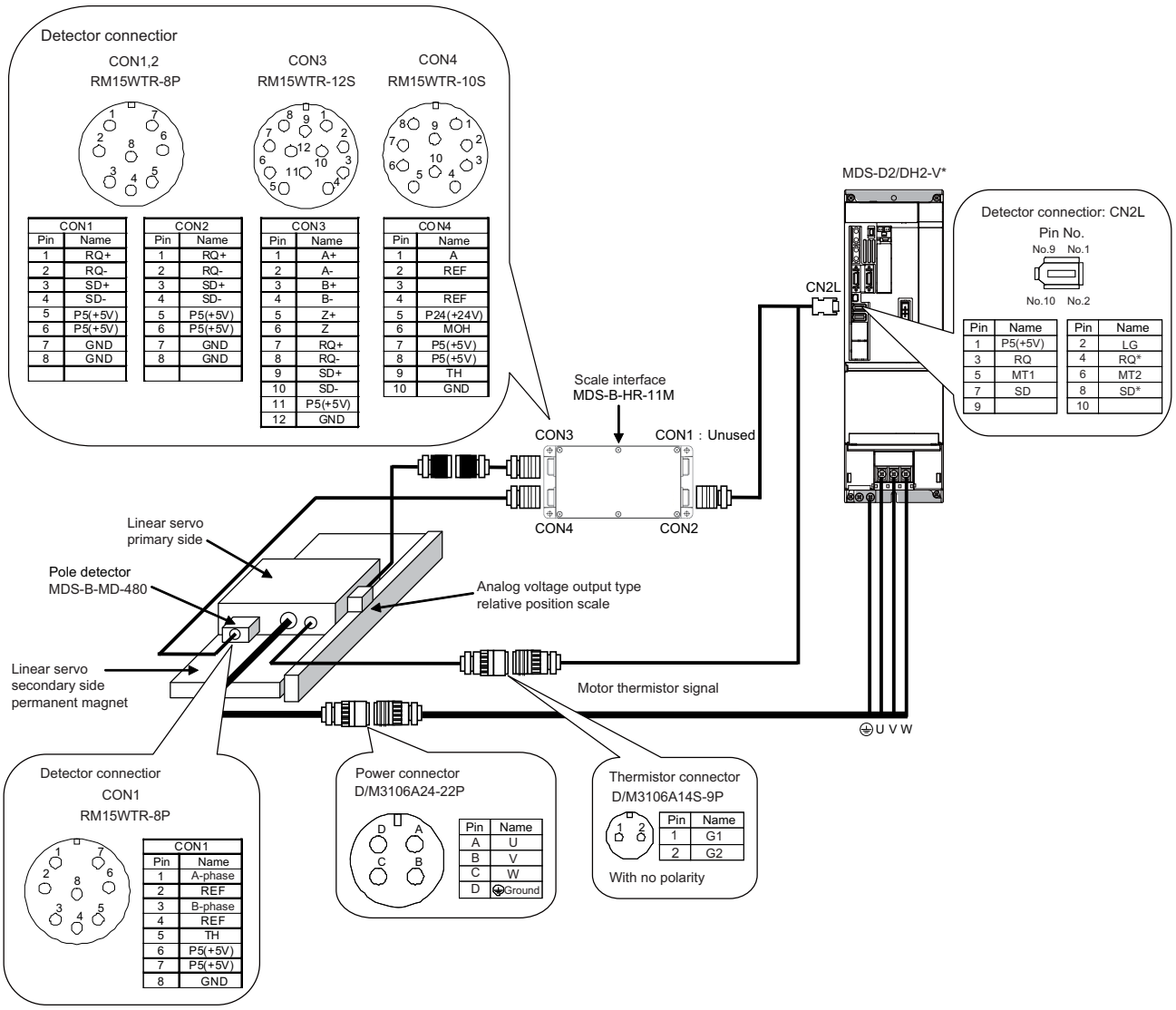
< When the power supply output of the servo drive unit is a terminal type >

Connecting the following linear motors

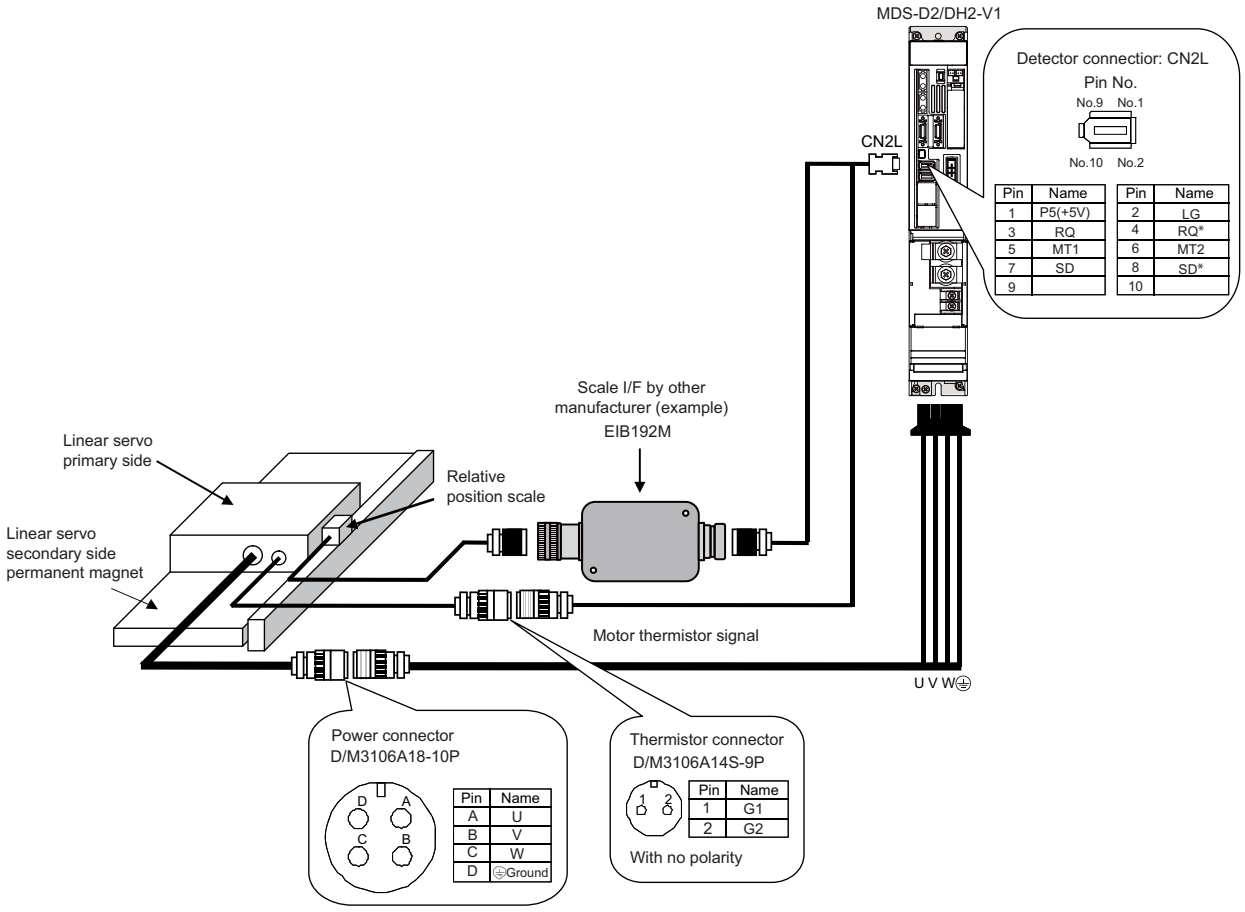
LM-FP4F-36M

LM-FP4H-48M

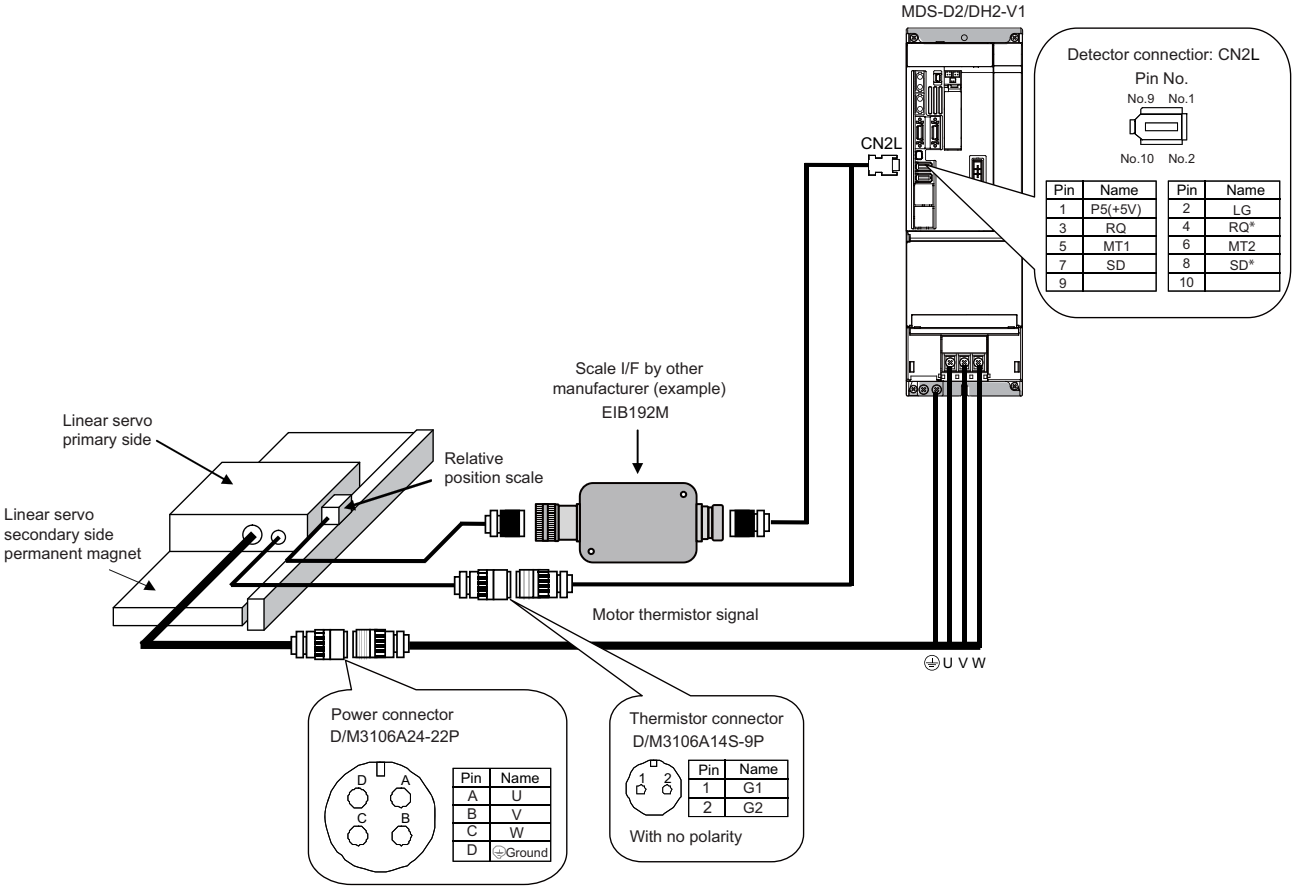
LM-FP5H-60M



(5) Standard relative position system (when using an I/F converter by other manufacturer)
< When the motor power supply output of the servo drive unit is a connector type >
Connecting the following linear motors
LM-FP2A-03M
LM-FP2B-06M
LM-FP2D-12M
LM-FP2F-18M
LM-FP4B-12M
LM-FP4D-24M



(6) Standard relative position system (when using an I/F converter by other manufacturer)
< When the power supply output of the servo drive unit is a terminal type >
Connecting the following linear motors
LM-FP4F-36M
LM-FP4H-48M
LM-FP5H-60M



8

Setup

8.1 Setting the Initial Parameters for the Linear Motor

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

<For linear motor system>

(1) Set the standard parameters in the section "8.1.2 List of Standard Parameters for Each Linear Motor".
(2) "8.1.1 Setting of Detector Related Parameter"

> **⚠ CAUTION**
>
> Do not release the emergency stop even after setting the above initial parameters. The initial setup (refer to the section "8.2 Initial Setup for the Absolute Position Detection System") is always required to enable the test operation for the linear motor (Ex. manual pulse feed, low-speed JOG feed).

8.1.1 Setting of Detector Related Parameters

Set the detector related parameters below depending on the detector connected.
#2219(SV019), #2220(SV020), #2317(SV117), #2318(SV118)

Mitsubishi serial signal output detector (Absolute position)

Manufacturer	Detector type	Interface unit type	Control resolution	#2219 (SV019)	#2220 (SV020)	#2317 (SV117)	#2318 (SV118)
Magnescale Co., Ltd.	SR77 SR87	Not required	0.1μm	480		0	
			0.05μm	960		0	
			0.01μm	4800		0	
HEIDENHAIN CORPORATION	LC193M LC493M	Not required	0.05μm	960		0	
			0.01μm	4800		0	
	LC195M LC495M	Not required	0.01μm	4800		0	
			0.001μm	27648		732	
	LC215M	Not required	0.01μm	4800		0	
Mitsutoyo Corporation	AT343	Not required	0.05μm	960		0	
	AT543	Not required	0.05μm	960		0	
	AT545	Not required	0.05μm	960		0	
	ST748	Not required	0.1μm	480		0	
FAGOR	SAM Series	Not required	0.05μm	960		0	
	SVAM Series	Not required	0.05μm	960		0	
	GAM Series	Not required	0.05μm	960		0	
	LAM Series	Not required	0.1μm	480		0	
Renishaw plc.	RL40N Series	Not required	0.05μm	960		0	
			0.001μm	27648		732	

(Note) The communication specification of LC195M/LC495M/LC215M is “MITSU03-4”.

Mitsubishi serial signal output detector (Relative position)

Manufacturer	Detector type	Interface unit type	Control resolution	#2219 (SV019)	#2220 (SV020)	#2317 (SV117)	#2318 (SV118)
Magnescale Co., Ltd.	**SR75** **SR85**	Not required	**0.1μm**	7		21248	
			0.05μm	14		42496	
			0.01μm	73		15872	
HEIDENHAIN CORPORATION	LS187 LS487	**EIB192M A4 20μm**	0.0012μm	0		600	
		EIB392M A4 20μm	(Signal cycle:20μm/16384)				
Other manufacturers	SIN wave output linear scale	MDS-B-HR	Signal cycle μm/512	{48 × 1000 / (Signal cycle/ 512)} / 65536 remainder		quotient	

(Note) If the NC is C70 and SV019 is greater than 32767, enter the (negative) value obtained by subtracting 65536 from the above remainder in SV019.

【#2219(PR)】 SV019 RNG1 Sub side detector resolution

Set the number of pulses per magnetic pole pitch in one "kp" increments.

Note that the value must be input in increments of 10K pulses (the 1st digit of the setting value is "0").
If any restriction is imposed due to the above condition, also set SV117 in one pulse increments.

【#2220(PR)】 SV020 RNG2 Main side detector resolution

Set the same value as SV019.

【#2317(PR)】 SV117 RNG1ex Expansion sub side detector resolution

To set the resolution of the motor side detector in one pulse increments, set the number of pulses of the detector by 4-byte data in total to SV117 (high-order 16bit) and SV019 (low-order 16bit).

SV117= Quotient of the number of pulses divided by 65536 (If the quotient is 0, set SV117 to -1).
SV019= Remainder of the number of pulses divided by 65536
(SV019 can be set in one pulse increments).

If the NC is C70 and SV019 is greater than 32767, enter the (negative) value obtained by subtracting 65536 from the above remainder in SV019.

【#2318(PR)】 SV118 RNG2ex Expansion main side detector resolution

Set the same value as SV117.

8.1.2 List of Standard Parameters for Each Linear Motor

(1) Linear motor LM-FP Series (MDS-D2/DH2-V1)

Parameter			Motor	200/400V linear motor LM-FP Series								
				2A03M	2B06M	2D12M	2F18M	4B12M	4D24M	4F36M	4H48M	5H60M
No.	Abbrev.	Details	MDS-D2-V1-	40	40	80	160	80	160	320	320	-
			MDS-DH2-V1-	-	-	-	-	-	-	-	-	200
SV001	PC1	Motor side gear ratio		1	1	1	1	1	1	1	1	1
SV002	PC2	Machine side gear ratio		1	1	1	1	1	1	1	1	1
SV003	PGN1	Position loop gain 1		33	33	33	33	33	33	33	33	33
SV004	PGN2	Position loop gain 2		0	0	0	0	0	0	0	0	0
SV005	VGN1	Speed loop gain 1		100	100	100	100	100	100	100	100	100
SV006	VGN2	Speed loop gain 2		0	0	0	0	0	0	0	0	0
SV007	VIL	Speed loop delay compensation		0	0	0	0	0	0	0	0	0
SV008	VIA	Speed loop lead compensation		1364	1364	1364	1364	1364	1364	1364	1364	1364
SV009	IQA	Current loop q axis lead compensation		10240	20480	20480	20480	20480	20480	20480	20480	20480
SV010	IDA	Current loop d axis lead compensation		10240	20480	20480	20480	20480	20480	20480	20480	20480
SV011	IQG	Current loop q axis gain		2048	4096	4096	6144	4096	4096	6144	4096	3072
SV012	IDG	Current loop d axis gain		2048	4096	4096	6144	4096	4096	6144	4096	3072
SV013	ILMT	Current limit value		800	800	800	800	800	800	800	800	800
SV014	ILMTsp	Current limit value in special control		800	800	800	800	800	800	800	800	800
SV015	FFC	Acceleration rate feed forward gain		0	0	0	0	0	0	0	0	0
SV016	LMC1	Lost motion compensation 1		0	0	0	0	0	0	0	0	0
SV017	SPEC1	Servo specification 1		6000	6000	6000	6000	6000	6000	6000	6000	8000
SV018	PIT	Ball screw pitch/Magnetic pole pitch		48	48	48	48	48	48	48	48	48
SV019	RNG1	Sub side detector resolution		-	-	-	-	-	-	-	-	-
SV020	RNG2	Main side detector resolution		-	-	-	-	-	-	-	-	-
SV021	OLT	Overload detection time constant		60	60	60	60	60	60	60	60	60
SV022	OLL	Overload detection level		150	150	150	150	150	150	150	150	150
SV023	OD1	Excessive error detection width during servo ON		6	6	6	6	6	6	6	6	6
SV024	INP	In-position detection width		50	50	50	50	50	50	50	50	50
SV025	MTYP	Motor/Detector type		AAFF	AAB0	AAB1	AAB2	AAB3	AAB4	AAB5	AAB6	AAFF
SV026	OD2	Excessive error detection width during servo OFF		6	6	6	6	6	6	6	6	6
SV027	SSF1	Servo function 1		4000	4000	4000	4000	4000	4000	4000	4000	4000
SV028	MSFT	Magnetic pole shift amount		0	0	0	0	0	0	0	0	0
SV029	VCS	Speed at the change of speed loop gain		0	0	0	0	0	0	0	0	0
SV030	IVC	Voltage non-sensitive band compensation		0	0	0	0	0	0	0	0	0
SV031	OVS1	Overshooting compensation 1		0	0	0	0	0	0	0	0	0
SV032	TOF	Torque offset		0	0	0	0	0	0	0	0	0
SV033	SSF2	Servo function 2		0000	0000	0000	0000	0000	0000	0000	0000	0000
SV034	SSF3	Servo function 3		0000	0000	0000	0000	0000	0000	0000	0000	0000
SV035	SSF4	Servo function 4		0000	0000	0000	0000	0000	0000	0000	0000	0000
SV036	PTYP	Power supply type/ Regenerative resistor type		0000	0000	0000	0000	0000	0000	0000	0000	0000
SV037	JL	Load inertia scale		0	0	0	0	0	0	0	0	0
SV038	FHz1	Notch filter frequency 1		0	0	0	0	0	0	0	0	0
SV039	LMCD	Lost motion compensation timing		0	0	0	0	0	0	0	0	0
SV040	LMCT	Lost motion compensation non-sensitive band		0	0	0	0	0	0	0	0	0
SV041	LMC2	Lost motion compensation 2		0	0	0	0	0	0	0	0	0
SV042	OVS2	Overshooting compensation 2		0	0	0	0	0	0	0	0	0
SV043	OBS1	Disturbance observer filter frequency		0	0	0	0	0	0	0	0	0
SV044	OBS2	Disturbance observer gain		0	0	0	0	0	0	0	0	0
SV045	TRUB	Friction torque		0	0	0	0	0	0	0	0	0
SV046	FHz2	Notch filter frequency 2		0	0	0	0	0	0	0	0	0
SV047	EC	Inductive voltage compensation gain		100	100	100	100	100	100	100	100	100
SV048	EMGrt	Vertical axis drop prevention time		0	0	0	0	0	0	0	0	0
SV049	PGN1sp	Position loop gain 1 in spindle synchronous control		15	15	15	15	15	15	15	15	15
SV050	PGN2sp	Position loop gain 2 in spindle synchronous control		0	0	0	0	0	0	0	0	0
SV051	DFBT	Dual feedback control time constant		0	0	0	0	0	0	0	0	0
SV052	DFBN	Dual feedback control non-sensitive band		0	0	0	0	0	0	0	0	0
SV053	OD3	Excessive error detection width in special control		0	0	0	0	0	0	0	0	0
SV054	ORE	Overrun detection width in closed loop control		0	0	0	0	0	0	0	0	0
SV055	EMGx	Max. gate off delay time after emergency stop		0	0	0	0	0	0	0	0	0
SV056	EMGt	Deceleration time constant at emergency stop		0	0	0	0	0	0	0	0	0
SV057	SHGC	SHG control gain		0	0	0	0	0	0	0	0	0
SV058	SHGCsp	SHG control gain in spindle synchronous control		0	0	0	0	0	0	0	0	0
SV059	TCNV	Collision detection torque estimated gain		0	0	0	0	0	0	0	0	0
SV060	TLMT	Collision detection level		0	0	0	0	0	0	0	0	0
SV061	DA1NO	D/A output ch1 data No. for initial DC excitation level		0	0	0	0	0	0	0	0	0
SV062	DA2NO	D/A output ch2 data No. for final DC excitation level		0	0	0	0	0	0	0	0	0
SV063	DA1MPY	D/A output ch1 output scale for initial DC excitation time		0	0	0	0	0	0	0	0	0
SV064	DA2MPY	D/A output ch2 output scale		0	0	0	0	0	0	0	0	0
SV065	TLC	Machine end compensation gain		0	0	0	0	0	0	0	0	0

Parameter			Motor	200/400V linear motor LM-FP Series								
				2A03M	2B06M	2D12M	2F18M	4B12M	4D24M	4F36M	4H48M	5H60M
No.	Abbrev.	Details	MDS-D2-V1-	40	40	80	160	80	160	320	320	-
			MDS-DH2-V1-	-	-	-	-	-	-	-	-	200
(System parameter area)												
SV073	FEEDout	Specified speed output speed		0	0	0	0	0	0	0	0	0
(System parameter area)												
SV081	SPEC2	Servo specification 2		0200	0200	0200	0200	0200	0200	0200	0200	0200
SV082	SSF5	Servo function 5		0000	0000	0000	0000	0000	0000	0000	0000	0000
SV083	SSF6	Servo function 6		0000	0000	0000	0000	0000	0000	0000	0000	0000
SV084	SSF7	Servo function 7		0000	0000	0000	0000	0000	0000	0000	0000	0000
SV085	LMCk	Lost motion compensation 3 spring constant		0	0	0	0	0	0	0	0	0
SV086	LMCc	Lost motion compensation 3 viscous coefficient		0	0	0	0	0	0	0	0	0
SV087	FHz4	Notch filter frequency 4		0	0	0	0	0	0	0	0	0
SV088	FHz5	Notch filter frequency 5		0	0	0	0	0	0	0	0	0
SV089				0	0	0	0	0	0	0	0	0
SV090				0	0	0	0	0	0	0	0	0
SV091	LMC4G	Lost motion compensation 4 gain		0	0	0	0	0	0	0	0	0
SV092				0	0	0	0	0	0	0	0	0
SV093				0	0	0	0	0	0	0	0	0
SV094	MPV	Magnetic pole position error detection speed		1005	1005	1005	1005	1005	1005	1005	1005	1005
SV095	ZUPD	Vertical axis pull up distance		0	0	0	0	0	0	0	0	
SV096				0	0	0	0	0	0	0	0	
SV097				0	0	0	0	0	0	0	0	
SV098				0	0	0	0	0	0	0	0	
SV099				0	0	0	0	0	0	0	0	
SV100				0	0	0	0	0	0	0	0	
SV101				0	0	0	0	0	0	0	0	
:				:	:	:	:	:	:	:	:	
SV160				0	0	0	0	0	0	0	0	0
SV161	POLE	Motor unique constants		2	0	0	0	0	0	0	0	2
SV162	IS	Motor unique constants		-6902	0	0	0	0	0	0	0	-4221
SV163	IP	Motor unique constants		-2611	0	0	0	0	0	0	0	1420
SV164	NR	Motor unique constants		1200	0	0	0	0	0	0	0	1200
SV165	JM	Motor unique constants		-4802	0	0	0	0	0	0	0	-6701
SV166	RDQ	Motor unique constants		-9403	0	0	0	0	0	0	0	-4903
SV167	LQ	Motor unique constants		-8795	0	0	0	0	0	0	0	-4465
SV168	LD	Motor unique constants		0	0	0	0	0	0	0	0	0
SV169	KE	Motor unique constants		-1451	0	0	0	0	0	0	0	-5051
SV170	KT	Motor unique constants		-4401	0	0	0	0	0	0	0	1430
SV171	OLT3	Motor unique constants		1500	0	0	0	0	0	0	0	1500
SV172				0	0	0	0	0	0	0	0	0
:				:	:	:	:	:	:	:	:	:
SV176				0	0	0	0	0	0	0	0	0
SV177	ATYP	Motor unique constants		400	0	0	0	0	0	0	0	2000
SV178				0	0	0	0	0	0	0	0	0
SV179				0	0	0	0	0	0	0	0	0
SV180				0	0	0	0	0	0	0	0	0
SV181				0	0	0	0	0	0	0	0	0
SV182				0	0	0	0	0	0	0	0	0
SV183				0	0	0	0	0	0	0	0	0
SV184				0	0	0	0	0	0	0	0	0
:				:	:	:	:	:	:	:	:	:
SV256				0	0	0	0	0	0	0	0	0

(Note) When using a motor for which SV025 is set to AAFF, the motor name displayed by selecting [Servo unit] on the drive monitor screen will be "LINmotor".

(2) Linear motor LM-FP Series (One unit and two motor system) (MDS-D2/DH2-V1)

Parameter			Motor	200/400V linear motor LM-FP Series					
				2A03M	2B06M	2D12M	2F18M	4B12M	4D24M
No.	Abbrev.	Details	MDS-D2-V1-	80	80	160	320	160	320
SV001	PC1	Motor side gear ratio		1	1	1	1	1	1
SV002	PC2	Machine side gear ratio		1	1	1	1	1	1
SV003	PGN1	Position loop gain 1		33	33	33	33	33	33
SV004	PGN2	Position loop gain 2		0	0	0	0	0	0
SV005	VGN1	Speed loop gain 1		100	100	100	100	100	100
SV006	VGN2	Speed loop gain 2		0	0	0	0	0	0
SV007	VIL	Speed loop delay compensation		0	0	0	0	0	0
SV008	VIA	Speed loop lead compensation		1364	1364	1364	1364	1364	1364
SV009	IQA	Current loop q axis lead compensation		10240	20480	20480	20480	20480	20480
SV010	IDA	Current loop d axis lead compensation		10240	20480	20480	20480	20480	20480
SV011	IQG	Current loop q axis gain		2048	4096	4096	6144	4096	4096
SV012	IDG	Current loop d axis gain		2048	4096	4096	6144	4096	4096
SV013	ILMT	Current limit value		800	800	800	800	800	800
SV014	ILMTsp	Current limit value in special control		800	800	800	800	800	800
SV015	FFC	Acceleration rate feed forward gain		0	0	0	0	0	0
SV016	LMC1	Lost motion compensation 1		0	0	0	0	0	0
SV017	SPEC1	Servo specification 1		6000	6000	6000	6000	6000	6000
SV018	PIT	Ball screw pitch/Magnetic pole pitch		48	48	48	48	48	48
SV019	RNG1	Sub side detector resolution		-	-	-	-	-	-
SV020	RNG2	Main side detector resolution		-	-	-	-	-	-
SV021	OLT	Overload detection time constant		60	60	60	60	60	60
SV022	OLL	Overload detection level		150	150	150	150	150	150
SV023	OD1	Excessive error detection width during servo ON		6	6	6	6	6	6
SV024	INP	In-position detection width		50	50	50	50	50	50
SV025	MTYP	Motor/Detector type		AAFF	AAB0	AAB1	AAB2	AAB3	AAB4
SV026	OD2	Excessive error detection width during servo OFF		6	6	6	6	6	6
SV027	SSF1	Servo function 1		4000	4000	4000	4000	4000	4000
SV028	MSFT	Magnetic pole shift amount		0	0	0	0	0	0
SV029	VCS	Speed at the change of speed loop gain		0	0	0	0	0	0
SV030	IVC	Voltage non-sensitive band compensation		0	0	0	0	0	0
SV031	OVS1	Overshooting compensation 1		0	0	0	0	0	0
SV032	TOF	Torque offset		0	0	0	0	0	0
SV033	SSF2	Servo function 2		0000	0000	0000	0000	0000	0000
SV034	SSF3	Servo function 3		0200	0200	0200	0200	0200	0200
SV035	SSF4	Servo function 4		0000	0000	0000	0000	0000	0000
SV036	PTYP	Power supply type/ Regenerative resistor type		0000	0000	0000	0000	0000	0000
SV037	JL	Load inertia scale		0	0	0	0	0	0
SV038	FHz1	Notch filter frequency 1		0	0	0	0	0	0
SV039	LMCD	Lost motion compensation timing		0	0	0	0	0	0
SV040	LMCT	Lost motion compensation non-sensitive band		0	0	0	0	0	0
SV041	LMC2	Lost motion compensation 2		0	0	0	0	0	0
SV042	OVS2	Overshooting compensation 2		0	0	0	0	0	0
SV043	OBS1	Disturbance observer filter frequency		0	0	0	0	0	0
SV044	OBS2	Disturbance observer gain		0	0	0	0	0	0
SV045	TRUB	Friction torque		0	0	0	0	0	0
SV046	FHz2	Notch filter frequency 2		0	0	0	0	0	0
SV047	EC	Inductive voltage compensation gain		100	100	100	100	100	100
SV048	EMGrt	Vertical axis drop prevention time		0	0	0	0	0	0
SV049	PGN1sp	Position loop gain 1 in spindle synchronous control		15	15	15	15	15	15
SV050	PGN2sp	Position loop gain 2 in spindle synchronous control		0	0	0	0	0	0
SV051	DFBT	Dual feedback control time constant		0	0	0	0	0	0
SV052	DFBN	Dual feedback control non-sensitive band		0	0	0	0	0	0
SV053	OD3	Excessive error detection width in special control		0	0	0	0	0	0
SV054	ORE	Overrun detection width in closed loop control		0	0	0	0	0	0
SV055	EMGx	Max. gate off delay time after emergency stop		0	0	0	0	0	0
SV056	EMGt	Deceleration time constant at emergency stop		0	0	0	0	0	0
SV057	SHGC	SHG control gain		0	0	0	0	0	0
SV058	SHGCsp	SHG control gain in spindle synchronous control		0	0	0	0	0	0
SV059	TCNV	Collision detection torque estimated gain		0	0	0	0	0	0
SV060	TLMT	Collision detection level		0	0	0	0	0	0
SV061	DA1NO	D/A output ch1 data No. for initial DC excitation level		0	0	0	0	0	0
SV062	DA2NO	D/A output ch2 data No. for final DC excitation level		0	0	0	0	0	0
SV063	DA1MPY	D/A output ch1 output scale for initial DC excitation time		0	0	0	0	0	0
SV064	DA2MPY	D/A output ch2 output scale		0	0	0	0	0	0
SV065	TLC	Machine end compensation gain		0	0	0	0	0	0

Parameter			Motor	200/400V linear motor LM-FP Series					
				2A03M	2B06M	2D12M	2F18M	4B12M	4D24M
No.	Abbrev.	Details	MDS-D2-V1-	80	80	160	320	160	320
		(System parameter area)							
SV073	FEEDout	Specified speed output speed		0	0	0	0	0	0
		(System parameter area)							
SV081	SPEC2	Servo specification 2		0200	0200	0200	0200	0200	0200
SV082	SSF5	Servo function 5		0000	0000	0000	0000	0000	0000
SV083	SSF6	Servo function 6		0000	0000	0000	0000	0000	0000
SV084	SSF7	Servo function 7		0000	0000	0000	0000	0000	0000
SV085	LMCk	Lost motion compensation 3 spring constant		0	0	0	0	0	0
SV086	LMCc	Lost motion compensation 3 viscous coefficient		0	0	0	0	0	0
SV087	FHz4	Notch filter frequency 4		0	0	0	0	0	0
SV088	FHz5	Notch filter frequency 5		0	0	0	0	0	0
SV089				0	0	0	0	0	0
SV090				0	0	0	0	0	0
SV091	LMC4G	Lost motion compensation 4 gain		0	0	0	0	0	0
SV092				0	0	0	0	0	0
SV093				0	0	0	0	0	0
SV094	MPV	Magnetic pole position error detection speed		1005	1005	1005	1005	1005	1005
SV095	ZUPD	Vertical axis pull up distance		0	0	0	0	0	0
SV096				0	0	0	0	0	0
SV097				0	0	0	0	0	0
SV098				0	0	0	0	0	0
SV099				0	0	0	0	0	0
SV100				0	0	0	0	0	0
SV101				0	0	0	0	0	0
:				:	:	:	:	:	:
SV160				0	0	0	0	0	0
SV161	POLE	Motor unique constants		2	0	0	0	0	0
SV162	IS	Motor unique constants		-6902	0	0	0	0	0
SV163	IP	Motor unique constants		-2611	0	0	0	0	0
SV164	NR	Motor unique constants		1200	0	0	0	0	0
SV165	JM	Motor unique constants		-4802	0	0	0	0	0
SV166	RDQ	Motor unique constants		-9403	0	0	0	0	0
SV167	LQ	Motor unique constants		-8795	0	0	0	0	0
SV168	LD	Motor unique constants		0	0	0	0	0	0
SV169	KE	Motor unique constants		-1451	0	0	0	0	0
SV170	KT	Motor unique constants		-4401	0	0	0	0	0
SV171	OLT3	Motor unique constants		1500	0	0	0	0	0
SV172				0	0	0	0	0	0
:				:	:	:	:	:	:
SV176				0	0	0	0	0	0
SV177	ATYP	Motor unique constants		400	0	0	0	0	0
SV178				0	0	0	0	0	0
SV179				0	0	0	0	0	0
SV180				0	0	0	0	0	0
SV181				0	0	0	0	0	0
SV182				0	0	0	0	0	0
SV183				0	0	0	0	0	0
SV184				0	0	0	0	0	0
:				:	:	:	:	:	:
SV256				0	0	0	0	0	0

(Note) When using a motor for which SV025 is set to AAFF, the motor name displayed by selecting [Servo unit] on the drive monitor screen will be "LINmotor".

(3) Linear motor LM-FP Series (MDS-DJ-V1)

Parameter			Motor	200V linear motor LM-FP Series			
				2A03M	2B06M	2D12M	4B12M
No.	Abbrev.	Details	MDS-DJ-V1-	40	40	80	80
SV001	PC1	Motor side gear ratio		1	1	1	1
SV002	PC2	Machine side gear ratio		1	1	1	1
SV003	PGN1	Position loop gain 1		33	33	33	33
SV004	PGN2	Position loop gain 2		0	0	0	0
SV005	VGN1	Speed loop gain 1		100	100	100	100
SV006	VGN2	Speed loop gain 2		0	0	0	0
SV007	VIL	Speed loop delay compensation		0	0	0	0
SV008	VIA	Speed loop lead compensation		1364	1364	1364	1364
SV009	IQA	Current loop q axis lead compensation		20480	20480	20480	20480
SV010	IDA	Current loop d axis lead compensation		20480	20480	20480	20480
SV011	IQG	Current loop q axis gain		4096	8192	6144	6144
SV012	IDG	Current loop d axis gain		4096	8192	6144	6144
SV013	ILMT	Current limit value		800	800	800	800
SV014	ILMTsp	Current limit value in special control		800	800	800	800
SV015	FFC	Acceleration rate feed forward gain		0	0	0	0
SV016	LMC1	Lost motion compensation 1		0	0	0	0
SV017	SPEC1	Servo specification 1		6000	6000	6000	6000
SV018	PIT	Ball screw pitch/Magnetic pole pitch		48	48	48	48
SV019	RNG1	Sub side detector resolution		-	-	-	-
SV020	RNG2	Main side detector resolution		-	-	-	-
SV021	OLT	Overload detection time constant		60	60	60	60
SV022	OLL	Overload detection level		150	150	150	150
SV023	OD1	Excessive error detection width during servo ON		6	6	6	6
SV024	INP	In-position detection width		50	50	50	50
SV025	MTYP	Motor/Detector type		AAFF	AAB0	AAB1	AAB3
SV026	OD2	Excessive error detection width during servo OFF		6	6	6	6
SV027	SSF1	Servo function 1		4000	4000	4000	4000
SV028	MSFT	Magnetic pole shift amount		0	0	0	0
SV029	VCS	Speed at the change of speed loop gain		0	0	0	0
SV030	IVC	Voltage non-sensitive band compensation		0	0	0	0
SV031	OVS1	Overshooting compensation 1		0	0	0	0
SV032	TOF	Torque offset		0	0	0	0
SV033	SSF2	Servo function 2		0000	0000	0000	0000
SV034	SSF3	Servo function 3		0000	0000	0000	0000
SV035	SSF4	Servo function 4		0000	0000	0000	0000
SV036	PTYP	Power supply type/ Regenerative resistor type		0000	0000	0000	0000
SV037	JL	Load inertia scale		0	0	0	0
SV038	FHz1	Notch filter frequency 1		0	0	0	0
SV039	LMCD	Lost motion compensation timing		0	0	0	0
SV040	LMCT	Lost motion compensation non-sensitive band		0	0	0	0
SV041	LMC2	Lost motion compensation 2		0	0	0	0
SV042	OVS2	Overshooting compensation 2		0	0	0	0
SV043	OBS1	Disturbance observer filter frequency		0	0	0	0
SV044	OBS2	Disturbance observer gain		0	0	0	0
SV045	TRUB	Friction torque		0	0	0	0
SV046	FHz2	Notch filter frequency 2		0	0	0	0
SV047	EC	Inductive voltage compensation gain		100	100	100	100
SV048	EMGrt	Vertical axis drop prevention time		0	0	0	0
SV049	PGN1sp	Position loop gain 1 in spindle synchronous control		15	15	15	15
SV050	PGN2sp	Position loop gain 2 in spindle synchronous control		0	0	0	0
SV051	DFBT	Dual feedback control time constant		0	0	0	0
SV052	DFBN	Dual feedback control non-sensitive band		0	0	0	0
SV053	OD3	Excessive error detection width in special control		0	0	0	0
SV054	ORE	Overrun detection width in closed loop control		0	0	0	0
SV055	EMGx	Max. gate off delay time after emergency stop		0	0	0	0
SV056	EMGt	Deceleration time constant at emergency stop		0	0	0	0
SV057	SHGC	SHG control gain		0	0	0	0
SV058	SHGCsp	SHG control gain in spindle synchronous control		0	0	0	0
SV059	TCNV	Collision detection torque estimated gain		0	0	0	0
SV060	TLMT	Collision detection level		0	0	0	0
SV061	DA1NO	D/A output ch1 data No. for initial DC excitation level		0	0	0	0
SV062	DA2NO	D/A output ch2 data No. for final DC excitation level		0	0	0	0
SV063	DA1MPY	D/A output ch1 output scale for initial DC excitation time		0	0	0	0
SV064	DA2MPY	D/A output ch2 output scale		0	0	0	0
SV065	TLC	Machine end compensation gain		0	0	0	0

Parameter			Motor	200V linear motor LM-FP Series			
				2A03M	2B06M	2D12M	4B12M
No.	Abbrev.	Details	MDS-DJ-V1-	40	40	80	80
		(System parameter area)					
SV073	FEEDout	Specified speed output speed		0	0	0	0
		(System parameter area)					
SV081	SPEC2	Servo specification 2		0000	0000	0000	0000
SV082	SSF5	Servo function 5		0000	0000	0000	0000
SV083	SSF6	Servo function 6		0000	0000	0000	0000
SV084	SSF7	Servo function 7		0000	0000	0000	0000
SV085	LMCk	Lost motion compensation 3 spring constant		0	0	0	0
SV086	LMCc	Lost motion compensation 3 viscous coefficient		0	0	0	0
SV087	FHz4	Notch filter frequency 4		0	0	0	0
SV088	FHz5	Notch filter frequency 5		0	0	0	0
SV089				0	0	0	0
SV090				0	0	0	0
SV091	LMC4G	Lost motion compensation 4 gain		0	0	0	0
SV092				0	0	0	0
SV093				0	0	0	0
SV094	MPV	Magnetic pole position error detection speed		1005	1005	1005	1005
SV095	ZUPD	Vertical axis pull up distance		0	0	0	0
SV096				0	0	0	0
SV097				0	0	0	0
SV098				0	0	0	0
SV099				0	0	0	0
SV100				0	0	0	0
SV101				0	0	0	0
:				:	:	:	:
SV160				0	0	0	0
SV161	POLE	Motor unique constants		2	0	0	0
SV162	IS	Motor unique constants		-6902	0	0	0
SV163	IP	Motor unique constants		-2611	0	0	0
SV164	NR	Motor unique constants		1200	0	0	0
SV165	JM	Motor unique constants		-4802	0	0	0
SV166	RDQ	Motor unique constants		-9403	0	0	0
SV167	LQ	Motor unique constants		-8795	0	0	0
SV168	LD	Motor unique constants		0	0	0	0
SV169	KE	Motor unique constants		-1451	0	0	0
SV170	KT	Motor unique constants		-4401	0	0	0
SV171	OLT3	Motor unique constants		1500	0	0	0
SV172				0	0	0	0
:				:	:	:	:
SV176				0	0	0	0
SV177	ATYP	Motor unique constants		400	0	0	0
SV178				0	0	0	0
SV179				0	0	0	0
SV180				0	0	0	0
SV181				0	0	0	0
SV182				0	0	0	0
SV183				0	0	0	0
SV184				0	0	0	0
:				:	:	:	:
SV256				0	0	0	0

(Note) When using a motor for which SV025 is set to AAFF, the motor name displayed by selecting [Servo unit] on the drive monitor screen will be "LINmotor".

(4) Linear motor LM-FP Series (One unit and two motor system) (MDS-DJ-V1)

Parameter			Motor	200V linear motor LM-FP Series	
				2A03M	2B06M
No.	Abbrev.	Details	MDS-DJ-V1-	80	80
SV001	PC1	Motor side gear ratio		1	1
SV002	PC2	Machine side gear ratio		1	1
SV003	PGN1	Position loop gain 1		33	33
SV004	PGN2	Position loop gain 2		0	0
SV005	VGN1	Speed loop gain 1		100	100
SV006	VGN2	Speed loop gain 2		0	0
SV007	VIL	Speed loop delay compensation		0	0
SV008	VIA	Speed loop lead compensation		1364	1364
SV009	IQA	Current loop q axis lead compensation		20480	20480
SV010	IDA	Current loop d axis lead compensation		20480	20480
SV011	IQG	Current loop q axis gain		4096	8192
SV012	IDG	Current loop d axis gain		4096	8192
SV013	ILMT	Current limit value		800	800
SV014	ILMTsp	Current limit value in special control		800	800
SV015	FFC	Acceleration rate feed forward gain		0	0
SV016	LMC1	Lost motion compensation 1		0	0
SV017	SPEC1	Servo specification 1		6000	6000
SV018	PIT	Ball screw pitch/Magnetic pole pitch		48	48
SV019	RNG1	Sub side detector resolution		-	-
SV020	RNG2	Main side detector resolution		-	-
SV021	OLT	Overload detection time constant		60	60
SV022	OLL	Overload detection level		150	150
SV023	OD1	Excessive error detection width during servo ON		6	6
SV024	INP	In-position detection width		50	50
SV025	MTYP	Motor/Detector type		AAFF	AAB0
SV026	OD2	Excessive error detection width during servo OFF		6	6
SV027	SSF1	Servo function 1		4000	4000
SV028	MSFT	Magnetic pole shift amount		0	0
SV029	VCS	Speed at the change of speed loop gain		0	0
SV030	IVC	Voltage non-sensitive band compensation		0	0
SV031	OVS1	Overshooting compensation 1		0	0
SV032	TOF	Torque offset		0	0
SV033	SSF2	Servo function 2		0000	0000
SV034	SSF3	Servo function 3		0200	0200
SV035	SSF4	Servo function 4		0000	0000
SV036	PTYP	Power supply type/ Regenerative resistor type		0000	0000
SV037	JL	Load inertia scale		0	0
SV038	FHz1	Notch filter frequency 1		0	0
SV039	LMCD	Lost motion compensation timing		0	0
SV040	LMCT	Lost motion compensation non-sensitive band		0	0
SV041	LMC2	Lost motion compensation 2		0	0
SV042	OVS2	Overshooting compensation 2		0	0
SV043	OBS1	Disturbance observer filter frequency		0	0
SV044	OBS2	Disturbance observer gain		0	0
SV045	TRUB	Friction torque		0	0
SV046	FHz2	Notch filter frequency 2		0	0
SV047	EC	Inductive voltage compensation gain		100	100
SV048	EMGrt	Vertical axis drop prevention time		0	0
SV049	PGN1sp	Position loop gain 1 in spindle synchronous control		15	15
SV050	PGN2sp	Position loop gain 2 in spindle synchronous control		0	0
SV051	DFBT	Dual feedback control time constant		0	0
SV052	DFBN	Dual feedback control non-sensitive band		0	0
SV053	OD3	Excessive error detection width in special control		0	0
SV054	ORE	Overrun detection width in closed loop control		0	0
SV055	EMGx	Max. gate off delay time after emergency stop		0	0
SV056	EMGt	Deceleration time constant at emergency stop		0	0
SV057	SHGC	SHG control gain		0	0
SV058	SHGCsp	SHG control gain in spindle synchronous control		0	0
SV059	TCNV	Collision detection torque estimated gain		0	0
SV060	TLMT	Collision detection level		0	0
SV061	DA1NO	D/A output ch1 data No. for initial DC excitation level		0	0
SV062	DA2NO	D/A output ch2 data No. for final DC excitation level		0	0
SV063	DA1MPY	D/A output ch1 output scale for initial DC excitation time		0	0
SV064	DA2MPY	D/A output ch2 output scale		0	0
SV065	TLC	Machine end compensation gain		0	0

Parameter			Motor	200V linear motor LM-FP Series	
				2A03M	2B06M
No.	Abbrev.	Details	MDS-DJ-V1-	80	80
		(System parameter area)			
SV073	FEEDout	Specified speed output speed		0	0
		(System parameter area)			
SV081	SPEC2	Servo specification 2		0000	0000
SV082	SSF5	Servo function 5		0000	0000
SV083	SSF6	Servo function 6		0000	0000
SV084	SSF7	Servo function 7		0000	0000
SV085	LMCk	Lost motion compensation 3 spring constant		0	0
SV086	LMCc	Lost motion compensation 3 viscous coefficient		0	0
SV087	FHz4	Notch filter frequency 4		0	0
SV088	FHz5	Notch filter frequency 5		0	0
SV089				0	0
SV090				0	0
SV091	LMC4G	Lost motion compensation 4 gain		0	0
SV092				0	0
SV093				0	0
SV094	MPV	Magnetic pole position error detection speed		1005	1005
SV095	ZUPD	Vertical axis pull up distance		0	0
SV096				0	0
SV097				0	0
SV098				0	0
SV099				0	0
SV100				0	0
SV101				0	0
:				:	:
SV160				0	0
SV161	POLE	Motor unique constants		2	0
SV162	IS	Motor unique constants		-6902	0
SV163	IP	Motor unique constants		-2611	0
SV164	NR	Motor unique constants		1200	0
SV165	JM	Motor unique constants		-4802	0
SV166	RDQ	Motor unique constants		-9403	0
SV167	LQ	Motor unique constants		-8795	0
SV168	LD	Motor unique constants		0	0
SV169	KE	Motor unique constants		-1451	0
SV170	KT	Motor unique constants		-4401	0
SV171	OLT3	Motor unique constants		1500	0
SV172				0	0
:				:	:
SV176				0	0
SV177	ATYP	Motor unique constants		400	0
SV178				0	0
SV179				0	0
SV180				0	0
SV181				0	0
SV182				0	0
SV183				0	0
SV184				0	0
:				:	:
SV256				0	0

(Note) When using a motor for which SV025 is set to AAFF, the motor name displayed by selecting [Servo unit] on the drive monitor screen will be "LINmotor".

8.2 Initial Setup for the Absolute Position Detection System

This section explains the initial setup procedures for the absolute position detection system.

⚠ CAUTION

1. Perform the initial setup after the operation is enabled for NC system.
2. The initial setup is required for each linear motor.
3. Perform the initial setup again after replacing the detector.
4. For a system with multiple linear motor axes, the initial setup (DC excitation function) must be performed for each axis. Set #2213(SV013) to 0 and #2228(SV028) to 1 for the linear motor axis for which the DC excitation function is not enabled. If the emergency stop is released in the state of #2228(SV028) is 0, magnetic pole position detection error (16) will occur.
5. The axis moves right and left by about the magnetic pole pitch at the initial setup (DC excitation function). Perform the initial setup after manually moving the axis to or near the machine's center so that no problem should occur even if the axis moves.
6. As for the vertical (inclined) axis, always perform the initial magnetic pole adjustment providing a counter balance (balancer), etc. to avoid the axis from dropping.
7. The initial setup method differs when using a relative position detector. Refer to "8.3 Initial Setup for the Relative Position Detection System".

8.2.1 Adjustment Procedure

For the linear motor system, the initial setup must be performed for each machine because the position relation between the motor coil and detector differs among machines. Be sure to set up according to the following procedures. The motor may not work properly unless the initial setup for the magnetic pole (DC excitation function) is performed correctly.
DC excitation function detects the position relation (magnetic pole shift amount) between the motor coil and detector. The magnetic pole shift amount can be seen at [AFLT gain] on the NC's servo diagnosis screen by moving the linear motor with DC excitation function. The motor will be driven according to the magnetic pole shift amount from next time the NC power is turned ON.
With the DC excitation function, once the servo parameter #2228(SV028) is set, resetting is not required unless the detector is replaced.

< DC excitation function >

(1) Turn ON the servo drive unit and NC. Confirm that there is no error such as Initial parameter error (37).
(2) Set the servo parameter #2213(SV013) to 100.
(3) Set the parameters related to the DC excitation function (#2261(SV061) to 10, #2262(SV062) to 10, and #2263(SV063) to 1000).
(4) Set the servo parameter #2234/bit4(SV034/bit4) to "1" to enable the DC excitation mode.
(5) Release the emergency stop.
(6) Confirm that the linear motor carries out a reciprocation operation between about ±40mm and 50mm once (start DC excitation).
(7) Confirm that the linear motor stops after the reciprocation operation.
(8) Switch to the [Servo diagn] menu on the NC maintenance screen, select [Servo unit] and monitor [AFLT gain].
(9) Turn ON the emergency stop (terminate DC excitation).
(10) Repeat (5) to (9) 5 times, and monitor the ALFT gain value (magnetic pole shift amount) each time.
If difference of the magnetic pole shift amounts is 1000 data or bigger, reset the related parameter settings (#2261(SV061)=+10, #2262(SV062)=+10) and perform (5) to (9) again.
(11) Calculate the average of the magnetic pole shift amounts, and set it to #2228(SV028).
(12) Return the servo parameter #2234/bit4(SV034/bit4) back to the original setting, "0".
(13) Turn the NC power ON again.

< Confirmation of detector installation polarity >

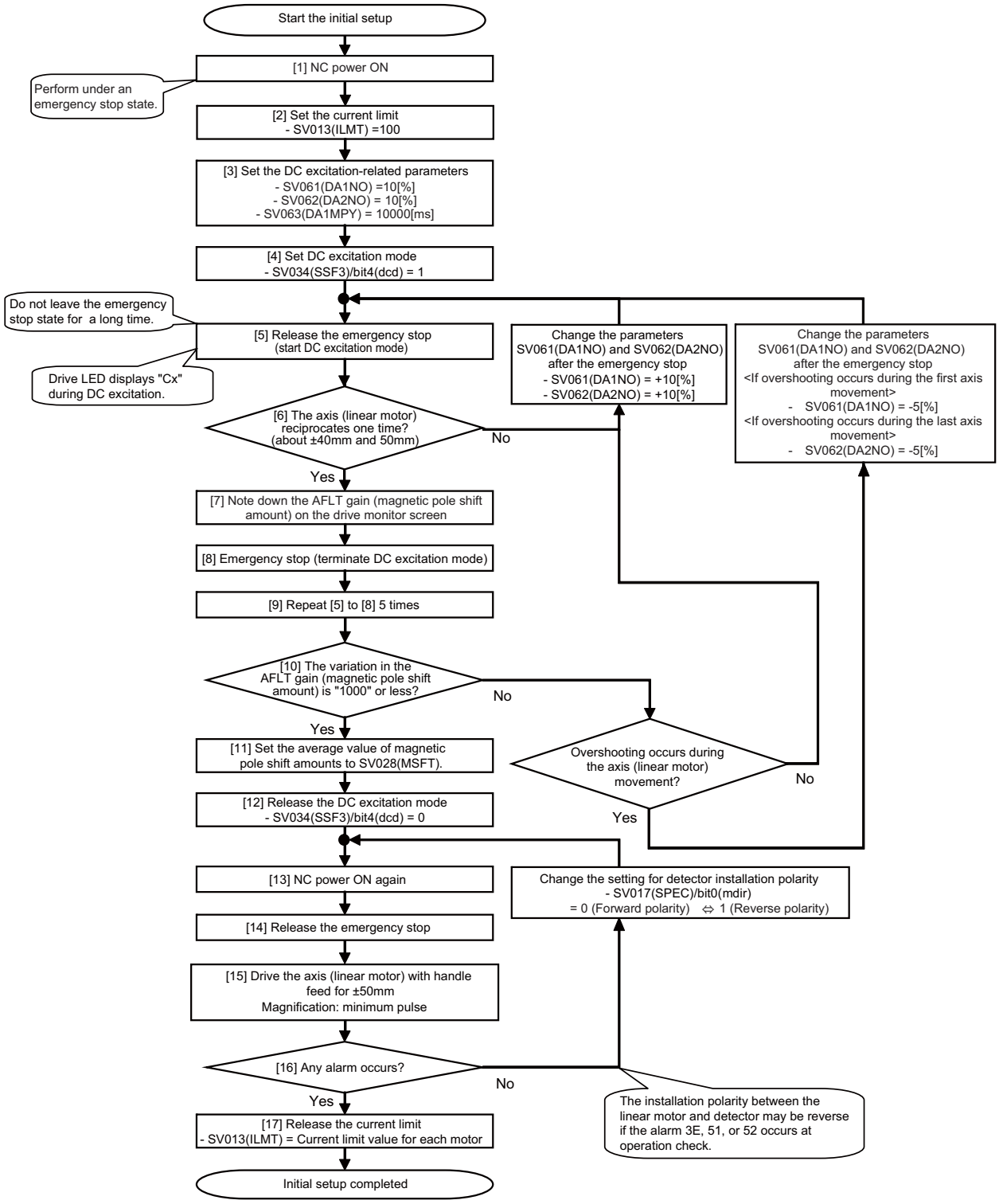
(14) Release the emergency stop.
(15) Drive the linear motor about ±50mm with handle feed (select the minimum pulse magnification).
(16) Switch to the [Servo diagn] menu on the NC maintenance screen, select [Servo unit] and check [Load current]. Also check if any alarm is occurring.
-> The detector installation polarity may be reverse if the current value reaches to the current limit or any alarm occurs. Set the servo parameter #2217/bit0(SV017/bit0) to "1" and perform (14) to (16) again after turning the NC power ON again.
(17) Turn ON the emergency stop.
(18) Return the servo parameter #2213(SV013) back to the original setting after confirming the initial setup.

⚠ CAUTION

1. Never operate the linear 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 detector cable.

Initial setup procedures for linear motor (Absolute position detector)

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



8.2.2 Related parameters

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

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

bit 0 : mdir Main side detector feedback (for linear motor)

Set the detector installation polarity in the linear motor control.

0: Forward polarity 1: Reverse polarity

【#2228(PR)】 SV028 MSFT Magnetic pole shift amount (for linear motor)

Set this parameter to adjust the motor magnetic pole position and detector's installation phase when using linear motors.
During the DC excitation of the initial setup (SV034/bit4=1), set the same value displayed in "AFLT gain" on the NC monitor screen.

Related parameters: SV034/bit4, SV061, SV062, SV063

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

【#2234】 SV034 SSF3 Servo function 3

bit 4 : dcd (linear motor)

0: Normal setting 1: DC excitation mode

Related parameters: SV061, SV062, SV063

【#2261】 SV061 DA1NO Initial DC excitation level

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

Related parameters: SV034/bit4,SV062, SV063

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

【#2262】 SV062 DA2NO Final DC excitation level

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

Related parameters: SV034/bit4,SV061, SV063

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

【#2263】 SV063 DA1MPY Initial DC excitation time

When the DC excitation is running (SV034/bit4=1):
Use this when the DC excitation is running (SV034/bit4=1) to adjust the initial setup (when measuring the magnetic pole shift amount) for linear motor.
Set the initial excitation time in DC excitation control.
Set 1000ms as standard.

Related parameters: SV034/bit4,SV061, SV062

---Setting range---
When the DC excitation is running (SV034/bit4=1): 0 to 10000 (ms)

8.3 Initial Setup for Relative Position Detection System

This section explains the initial setup procedures for relative position system.

> **⚠ CAUTION**
>
> 1. Perform the initial setup after the operation is enabled for NC system.
> 2. The initial setup is required for each linear motor.
> 3. Perform the initial setup again after replacing the detector.
> 4. A relative position detector is required to be used with a detector interface unit (such as MDS-B-HR).

8.3.1 Adjustment procedure

In the linear motor drive system with a relative position detector, create the initial magnetic pole by the method listed below after the power ON. The DC excitation function detects the magnetic pole shift amount on the Z-phase basis when using a relative position detector, so the linear 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
[1] Detection by the initial magnetic pole estimate function	At the initial servo ON	SV121(Kpp), SV122(Kvp), SV123(Kvi)	Relative position detector
[2] Detection by MDS-B-MD	During the initial communication	-	Relative position detector + MDS-B-HR + MDS-B-MD

The linear motor will be driven according to the magnetic pole shift amount set in the servo parameter #2228(SV028), which you determined through the DC excitation function, after turning the NC power ON next and the Z-phase has been passed. (The linear 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 servo parameter #2228(SV028) is set, resetting is not required unless the detector is replaced.

< Confirmation of the initial magnetic polar detection >

(1) Turn ON the servo drive unit and NC. Confirm that there is no error such as Initial parameter error (37).
(2) Set the servo parameter #2213(SV013) to 100.
(3) Release the emergency stop.
-> When MDS-B-MD is not used, the parameters related to the initial magnetic pole estimate function are required to be set.
(#2321(SV121) to 33, #2322(SV122) to Standard VGN1, and #2323(SV123) to 1364)
(Note) Standard VGN1 is set depending on the load inertia scale for #2322(SV122).
(Refer to "9.1.1 Speed loop gain".)
(4) The LED on the drive unit changes to "Cx" and the linear 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).

< Confirmation of detector installation polarity >

(6) Drive the linear motor until the Z-phase has been detected with handle feed (select the minimum pulse magnification).
   -> Switch to the [Servo diagn] menu on the NC maintenance screen, select [Servo unit] and confirm [Control output 2/bit0(ZCN) *Z-phase passed] is "1".

(7) Switch to the [Servo diagn] menu on the NC maintenance screen, select [Servo unit] and check [Load current]. Also check if any alarm is occurring.
   -> The detector installation polarity may be reverse if the current value reaches to the current limit or any alarm occurs. Set the servo parameter #2217/bit0(SV017/bit0) to "1" and perform (3) to (7) again after turning the NC power ON again.

(8) Turn ON the emergency stop.

< DC excitation function >

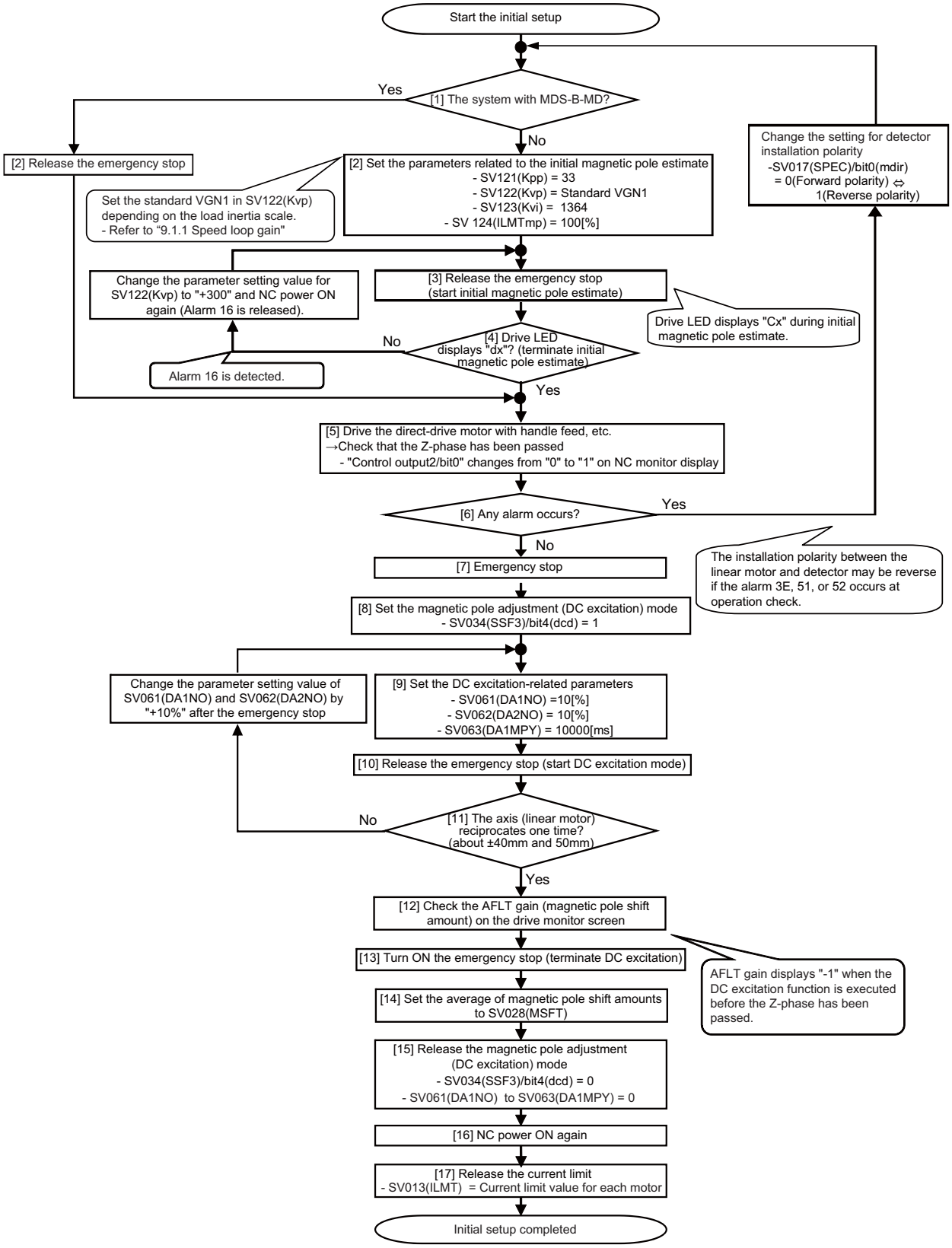
(9) Set the parameters related to the DC excitation (#2261(SV061) to 10, #2262(SV062) to 10, and #2263(SV063) to 1000).
(10) Set the servo parameter #2234/bit4(SV034/bit4) to "1" to enable the DC excitation mode.
(11) Release the emergency stop.
(12) Confirm that the linear motor carries out a reciprocation operation between about ±40mm and 50mm once (start DC excitation).
(13) Confirm that the linear motor stops after the reciprocation operation.
(14) Switch to the [Servo diagn] menu on the NC maintenance screen, select [Servo unit] and monitor [AFLT gain].
(15) Turn ON the emergency stop (terminate DC excitation).
(16) Repeat (11) to (15) 5 times, and monitor the ALFT gain value (magnetic pole shift amount) each time.
   If difference of the magnetic pole shift amounts is 1000 data or bigger, reset the related parameter settings (#2261(SV061)=+10, #2262(SV062)=+10) and perform (11) to (15) again.
(17) Calculate the average of the magnetic pole shift amounts, and set it to #2228(SV028).
(18) Return the servo parameter #2234/bit4(SV034/bit4) back to the original setting, "0".
(19) Turn the NC power ON again.

⚠ CAUTION

AFLT gain displays "-1" when the DC excitation function is executed before the Z-phase has been passed.

Initial setup procedures for linear motor (Relative position detector)

When using a relative position scale, perform the initial setup for the linear motor by following the steps in the flow diagram below.



8.3.2 Related parameters

For the initial setup when connecting a relative position scale and serial output interface unit by other manufacturer, the following parameters are required to be set in addition to those related to the DC excitation function. If the initial setup is performed before setting these parameters, an alarm for Initial parameter error (37) occurs.

【#2321】SV121 Kpp Magnetic pole detection position loop gain

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

The initial magnetic polar detection is performed for the linear motor which uses the relative position scale and serial output interface unit by other manufacturer as the motor side detector.

Related parameters : SV122,SV123,SV124

--- Setting range---
0 to 32767

【#2322】 SV122 Kvp Magnetic pole detection speed loop gain

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

The initial magnetic polar detection is performed for the linear motor which uses the relative position scale and serial output interface unit by other manufacturer as the motor side detector.

Related parameters : SV121,SV123,SV124

--- Setting range---
0 to 32767

【#2323】 SV123 Kvi Magnetic pole detection speed loop lead compensation

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

The initial magnetic polar detection is performed for the linear motor which uses the relative position scale and serial output interface unit by other manufacturer as the motor side detector.

Related parameters : SV121,SV122,SV124

--- Setting range---
0 to 32767

【#2324】SV124 ILMTmp Initial magnetic polar estimate/current limit value

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

The initial magnetic polar detection is performed for the linear motor which uses the relative position scale and serial output interface unit by other manufacturer as the motor side detector.
When set to "0", use SV014(ILMTsp) for the current limit at the initial magnetic polar estimate.

Related parameters : SV121,SV122,SV123

--- Setting range---
0 to 200
(Stall current %)

8.4 Protective functions list of units

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

8.4.1 Drive unit alarm

No.	Name	Details	Reset method	Stop method
16	Initial magnetic pole position detection error	- In the linear motor which uses the absolute position detector, the servo ON has been set before the magnetic pole shift amount (SV028) is set. - In the linear motor which uses the relative position detector, the magnetic pole position is not correctly detected during the initial magnetic pole position detection by the initial magnetic pole estimate function or MDS-B-MD.	PR	Dynamic 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 (SV028) is not reliable. - The detector installation polarity (SV17/bit0) may be reverse.	AR	Dynamic stop
46	Motor overheat / Thermal error	- An overheat is detected on the motor. - The thermistor signal receiving circuit of the linear 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 detector installation polarity (SV17/bit0) may be reverse.	NR	Deceleration stop
52	Excessive error 1	- A position tracking error during servo ON was excessive. - The detector installation polarity (SV17/bit0) 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.

Detector alarm (Servo drive unit)

Alarm number when the detector is connected to CN2 side		2B	2C	2D	2E	48	49	4A	4B
MDS-B-HR	Mitsubishi Electric	Memory error	-	Data error	-	Scale not connected	-	-	-
SR77 SR87	Magnescale	Laser diode error	System memory error	Encoder mismatch error	-	-	Over speed	Absolute position data error	Relative position data error
LC193M, LC493M LC195M, LC495M LC291M EIB192M, EIB392M	HEIDENHAIN	Initialization error	EEPROM error	Relative/ absolute position data mismatch	ROM/RAM error	CPU error	Over speed	Absolute position data error	Relative position data error
AT343, AT543 ST748, AT545	Mitutoyo	Initialization error	EEPROM error	Photoelectric type, static capacity type data mismatch	ROM/RAM error	CPU error	Photoelec-tric type overspeed	Static capacity type error	Photoelec-tric type error
SAM, SVAM, GAM, LAM Series	FAGOR	-	-	Absolute value detection error	H/W error	CPU error	-	-	-
RL40N Series	Renishaw	Initialization error	-	Absolute position data error	-	-	Over speed	-	-

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

8.4.2 Drive unit warning

No.	Name	Details	Reset method	Stop method
9B	Relative position detector/ magnetic pole shift warning	The difference between the initial magnetic pole position which is detected by the initial magnetic pole estimate function or MDS-B-MD and the magnetic pole position which is set for magnetic pole shift amount(SV028) is excessive in the linear motor with a relative position detector. It is controlled by the initial magnetic pole position while warning 9B is detected.	PR	-
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 detector.
(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 servo drive unit power ON again.
(Note 3) Linear motor does not stop when the warning occurs.
(Note 4) When an emergency stop is input, linear motor decelerates to a stop. (When SV048, SV055 or SV056 is set.)

8.4.3 Parameter numbers during initial parameter error

<Parameter error No.>

f 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 linear motor system, and correctly set the parameters according to the descriptions in the following table.

Error parameter No.	Details	Related parameters
2217	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.	SV017
2219	- In a semi-closed loop control system, the setting value of SV019 is different from that of SV020. Set them to the same value. - SV019 is set to a value outside the setting range.	SV019
2220	- The resolution of the motor side detector actually connected is not consistent with the setting value for SV020. -SV020 is set to a value outside the setting range.	SV020
2225	Incompatible motor type is selected. The machine side detector type or the motor side detector type is incorrectly set.	SV017, SV025
2228	The magnetic pole shift amount (SV028) is set for a general servo motor (not a built-in motor).	SV028
2234	The DC excitation mode (SV034/bit4) is set in the following conditions: - When the NC is powered ON - When a general servo motor (not a built-in motor) is used. - Before creating an initial magnetic pole(when a relative position detector is used)	SV034
2261	When the DC excitation mode (SV034/bit4) is set, the initial DC excitation level (SV061) is set to a value outside the setting range.	SV034, SV061
2262	When the DC excitation mode (SV034/bit4) is set, the final DC excitation level (SV062) is set to a value outside the setting range.	SV034, SV062
2263	When the DC excitation mode (SV034/bit4) is set, the initial DC excitation time (SV063) is set to a value outside the setting range.	SV034, SV063
2317	- The expansion sub side detector resolution (SV117) is set to "0" for a detector that requires the resolution expansion setting. If the upper 16 bits for the detector resolution are 0, this should be set to "-1". - The expansion sub side detector resolution (SV117) is set to a value other than "0" for a detector that does not support the resolution expansion setting.	SV019,SV025,SV117
2318	- The expansion main side detector resolution (SV118) is set to "0" for a detector that requires the resolution expansion setting. If the upper 16 bits for the detector resolution are 0, this should be set to "-1". - The expansion main side detector resolution (SV118) is set to a value other than "0" for a detector that does not support the resolution expansion setting.	SV020,SV025,SV118
2321	Magnetic pole detection position loop gain (SV121) is not set at initial setup when a relative position detector (except MDS-B-HR+MDS-B-MD system) is connected.	SV121
2322	Magnetic pole detection speed loop gain (SV122) is not set at initial setup when a relative position detector (except MDS-B-HR+MDS-B-MD system) is connected.	SV122
2323	Magnetic pole detection speed loop lead compensation (SV123) is not set at initial setup when a relative position detector (except MDS-B-HR+MDS-B-MD system) is connected.	SV123
2454	The parameter for enabling the absolute position control (#2049 type) is set before the initial setup is completed when a relative position detector is used.	#2049

9

Servo Adjustment

9.1 Gain Adjustment

9.1.1 Speed Loop Gain

(1) Setting the speed loop gain

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

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

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

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

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

< When machine resonance occurs at the standard VGN1 >

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

【#2205】 SV005 VGN1 Speed loop gain 1

Set the speed loop gain.
The higher the setting value is, the more accurate the control will be, however, vibration tends to occur.
If vibration occurs, adjust by lowering by 20 to 30%.
The value should be determined to the 70 to 80% of the value at which the vibration stops.

---Setting range---
1 to 30000

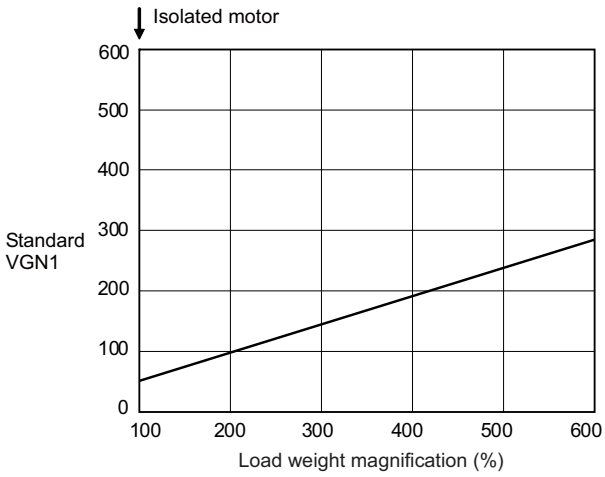
POINT

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

Standard VGN1 graph (Linear motor LM-F Series)

< MDS-D2/DH2 Series >

[LM-FP2A-03M]



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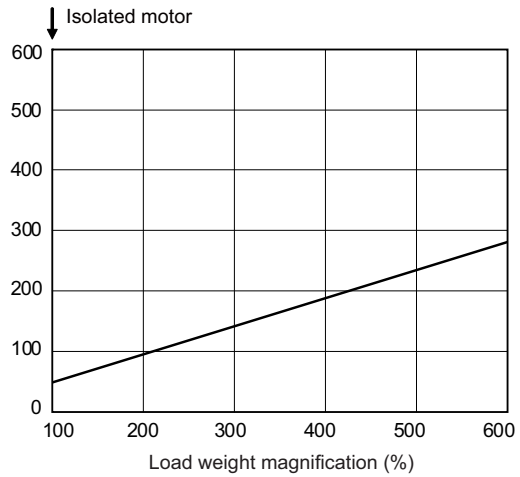

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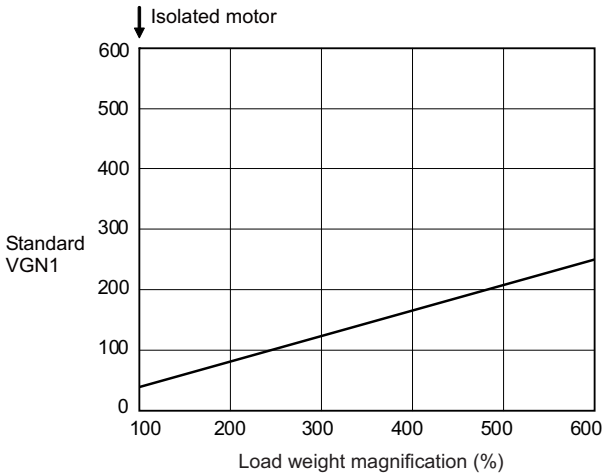

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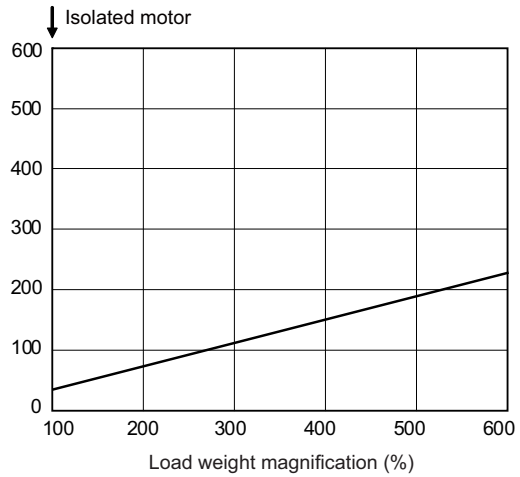

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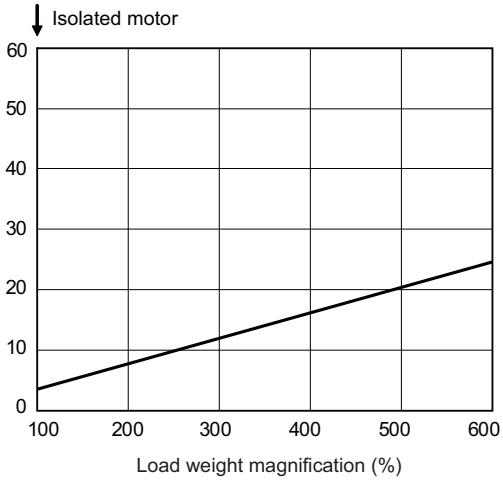

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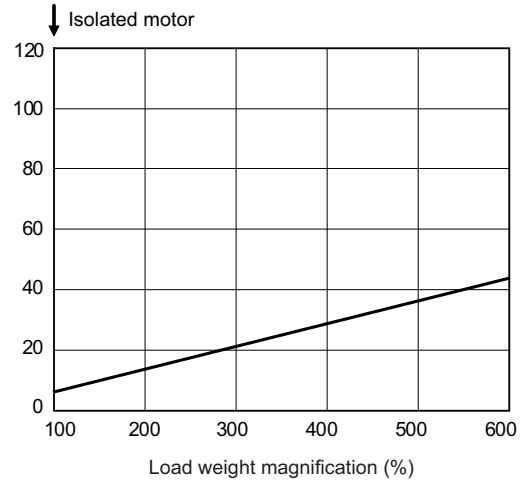

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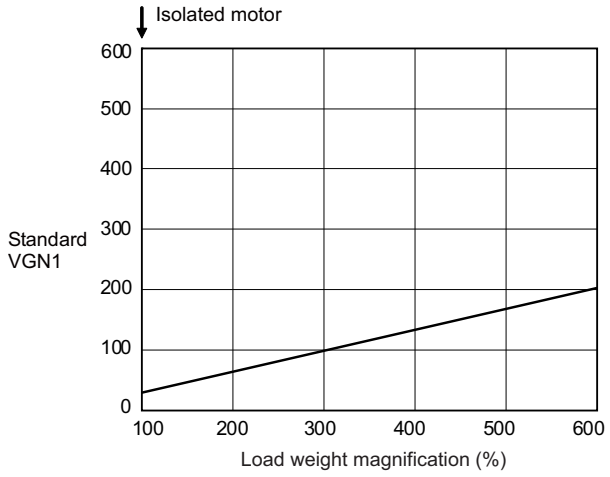

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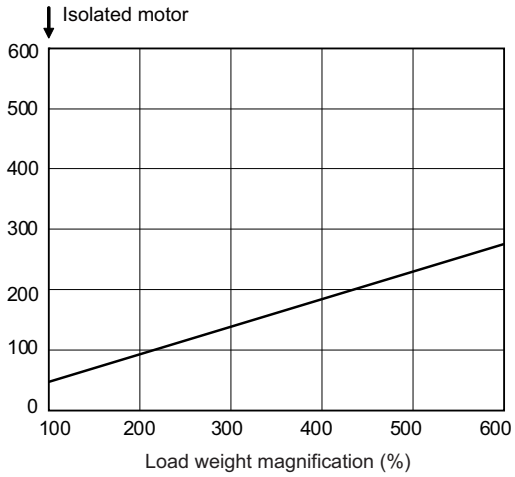

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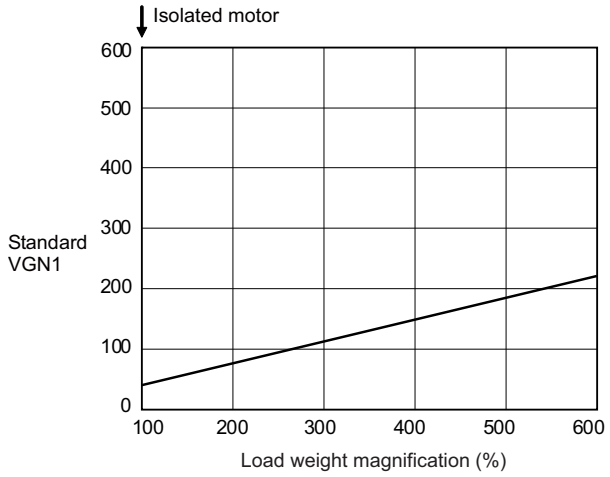
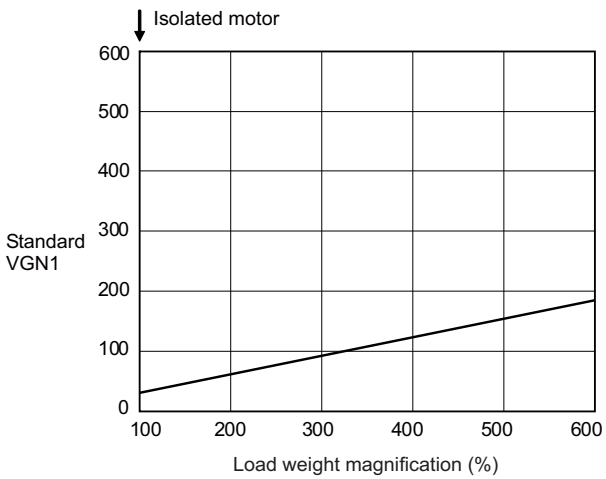


< MDS-DJ Series >

[LM-FP2A-03M]



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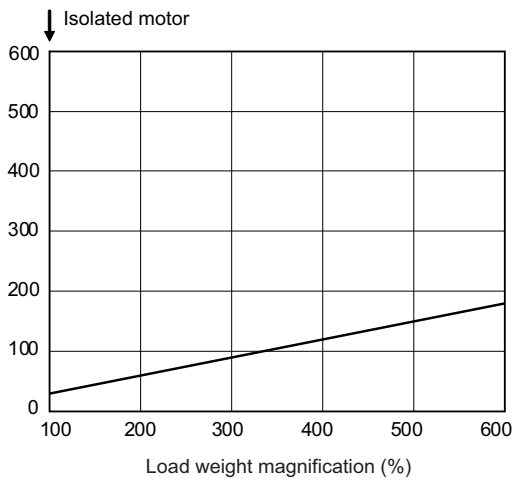

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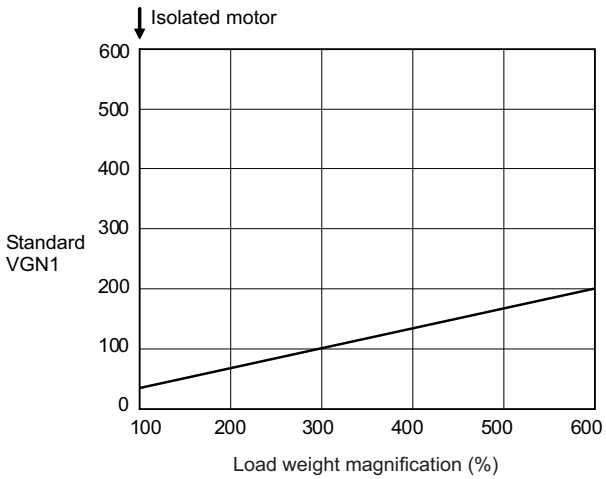

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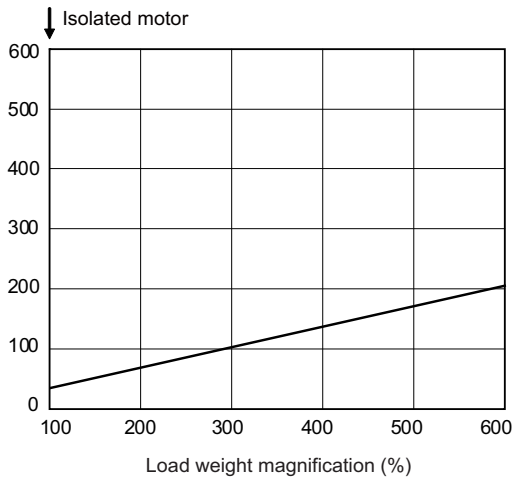

Revision History

Date of revision	Manual No.	Revision details
Jan. 2014	IB(NA)1501213-A	First edition created. MDS-D Series Linear Servo System Specifications Manual (IB-1500895(ENG)) and MDS-D Series Linear Servo System Instruction Manual (IB-1500900 (ENG)) were integrated.

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Notice

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

Duplication Prohibited

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MODEL	Linear Motor
MODEL CODE	100-395
Manual No.	IB-1501213

IB(NA)1501213(ENG)-A(1401)MEE
Made in JAPAN