FOR USER

Before getting started

- Read this manual thoroughly before using FANUC LINEAR MOTOR. It contains many important items.
- Do not try operation not described in this manual without permission. Otherwise, your motor may get into trouble. If it is unavoidable to operate your motor in a way not described in this manual, get FANUC’s permission in advance.
- For easy maintenance, consider the structure for installing the motor on the machine.
- No part of this manual may be reproduced in any form.
- All specifications and designs are subject to change without notice.
SAFETY PRECAUTIONS

This "Safety Precautions" section describes the precautions which must be observed to ensure safety when using FANUC linear motors. Users of any linear motor model are requested to read this manual carefully before using the linear motor. The users are also requested to read this manual carefully and understand each function of the motor for correct use. The users are basically forbidden to do any behavior or action not mentioned in this manual. They are invited to ask FANUC previously about what behavior or action is prohibited.
DEFINITION OF WARNING, CAUTION, AND NOTE

This manual includes safety precautions for protecting the user and preventing damage to the machine. Precautions are classified into Warning and Caution according to their bearing on safety. Also, supplementary information is described as a Note. Read the Warning, Caution, and Note thoroughly before attempting to use the machine.

⚠️ **WARNING**
Applied when there is a danger of the user being injured or when there is a damage of both the user being injured and the equipment being damaged if the approved procedure is not observed.

⚠️ **CAUTION**
Applied when there is a danger of the equipment being damaged, if the approved procedure is not observed.

**NOTE**
The Note is used to indicate supplementary information other than Warning and Caution.

* A "motor" described in this manual means all parts of the motor: coil slider, magnet plate, magnetic pole sensor, position detection circuit, and others.

- Read this manual carefully, and store it in a safe place.
WARNING

⚠️ WARNING
- Be safely dressed when handling a motor.
  Wear safety shoes or gloves when handling a motor as you may get hurt on any edge or protrusion on it or electric shocks.

- Any person having a medical apparatus must keep at least 30 cm away from any magnet plate.
  A magnet plate contains very strong magnets. If a person has a medical apparatus and does not keep a safe distance, the medical apparatus may malfunction. Any person having a medical apparatus such as a pacemaker or defibrillation equipment must not handle the motor if possible to prevent any accidents.

- Do not unpack any magnet plate from the packing box until starting work.
  A magnet plate contains very strong magnets. Do not unpack any magnet plate from the packing box until starting work to prevent any accidents.

- Do not remove the tin plates and corrugated cardboard for protection unless it is necessary.
  Corrugated cardboard and tin plates are attached to a magnet plate (using magnetic force) to protect the magnet plate and reduce magnetic leakage. Do not remove the tin plates and corrugated cardboard for protection also during work unless it is necessary.

- When moving a magnet plate, place it flat with the magnet side facing up and slide it.
  When moving a magnet plate on a table after unpacking it, always place it flat with the magnet side facing up and slide it. If the table is made of magnetic materials, standing the magnet plate on its narrow surface and moving it is highly dangerous. This is because if the magnet plate falls over, your hand or body may be caught between the magnet plate and table.

- When moving the motor, do not use any tapped hole on the motor.
  The tapped holes on the motor are dedicated to installing it on a machine. Do not use any tapped hole for other purposes such as moving the motor. If another part is installed on the motor or the motor is installed on a machine, in particular, never use the tapped holes. If it is absolute necessary to use a tapped hole for lifting the motor, lift only the motor from the side on which coating is not applied all over the surface (iron is partially exposed). Lifting the motor from the other side may damage the motor, resulting in a fall of the motor.
⚠️ WARNING

- When moving the motor, use a crane or another equipment.
  A motor is a heavy object. Use a crane or another equipment as required (for the weight of the motor, see this manual).
  When moving the motor, lift it using a fabric rope passed round the motor in balance or a dedicated handing jig. If it is absolute necessary to use a tapped hole for lifting the motor, lift only the motor from the side on which coating is not applied all over the surface (iron is partially exposed).

- Be careful of the magnetic attraction when installing the motor.
  A linear motor has the magnet attraction about 2.5 to 3 times as strong as the maximum force. Before work, consider the magnetic attraction, prepare devices, and take safety measures to prevent accidents.

- Do not touch a motor with a wet hand.
  A failure to observe this caution is very dangerous because you may get electric shocks.

- Before starting to connect a motor to electric wires, make sure they are isolated from an electric power source.
  A failure to observe this caution is very dangerous because you may get electric shocks.

- Do not bring any dangerous stuff near a motor.
  Motors are connected to a power line, and may get hot. If a flammable is placed near a motor, it may be ignited, catch fire, or explode.

- Be sure to ground a motor frame.
  To avoid electric shocks, be sure to connect the grounding terminal in the terminal box to the grounding terminal of the machine.

- Do not ground a motor power wire terminal or short-circuit it to another power wire terminal.
  A failure to observe this caution may cause electric shocks or a burned wiring.

- Connect power wires securely so that they will not get loose.
  A failure to observe this caution may cause a wire to be disconnected, resulting in a ground fault, short circuit, or electric shock.

- Do not supply the power to the motor while any terminal is exposed.
  A failure to observe this caution is very dangerous because you may get electric shocks if your body or any conductive stuff touches an exposed terminal.
**WARNING**

- **While the motor is running, do not get near or touch the motor driving section.**
  
  While the motor is running, getting near or touching the motor driving section may entangle cloths or fingers with the motor or cause a collision with a movable part. Before running the motor, check that no object will fly due to the running motor.

- **Before touching a motor, shut off the power to it.**
  
  Even if a motor is not rotating, there may be a voltage across the terminals of the motor. Especially before touching a power supply connection, take sufficient precautions. Otherwise you may get electric shocks.

- **Do not touch any terminal of a motor for a while (at least 5 minutes) after the power to the motor is shut off.**
  
  High voltage remains across power line terminals of a motor for a while after the power to the motor is shut off. So, do not touch any terminal or connect it to any other equipment. Otherwise, you may get electric shocks or the motor and/or equipment may get damaged.

- **To drive a motor, use a specified amplifier and parameters.**
  
  An incorrect combination of a motor, amplifier, and parameters may cause the motor to behave unexpectedly. This is dangerous, and the motor may get damaged.

- **While the motor is running, do not stand in the way of travel of the motor.**
  
  While the motor is running, standing in the way of travel of the motor may cause injury in the event of an accident.

- **When designing and assembling a machine tool, make it compliant with EN60204-1.**
  
  To ensure the safety of the machine tool and satisfy European standards, when designing and assembling a machine tool, make it compliant with EN60204-1. For details of the standards, refer to the standards.

- **Do not touch a motor when it is running or immediately after it stops.**
  
  A motor may get hot when it is running. Do not touch the motor before it gets cool enough. Otherwise, you may get burned.

- **Ensure that motors and related components are mounted securely.**
  
  If a motor or its component slips out of place or comes off when the motor is running, it is very dangerous.
CAUTION

⚠️ CAUTION

- Keep electronic devices and magnetic media away from any magnet plate.
  Bring an electronic device such as a personal computer, camera, or cellular phone or magnetic media such as a magnetic card or disk near a magnet plate may cause a failure or damage.

- FANUC motors are designed for use with machines. Do not use them for any other purpose.
  If a FANUC motor is used for an unintended purpose, it may cause an unexpected symptom or trouble. If you want to use a motor for an unintended purpose, previously consult with FANUC.

- Ensure that a base or frame on which a motor is mounted is strong enough.
  Motors are heavy. If a base or frame on which a motor is mounted is not strong enough, it is impossible to achieve the required precision.

- Be sure to connect motor cables correctly.
  An incorrect connection of a cable cause abnormal heat generation, equipment malfunction, or failure. Always use a cable with an appropriate current carrying capacity (or thickness).

- Ensure that motors are cooled if they are those that require forcible cooling.
  If a motor that requires forcible cooling is not cooled normally, it may cause a failure or trouble. For water cooling or air cooling, make sure that a flow rate is sufficient and the duct is not clogged. For both types, perform regular cleaning and inspection. When the cooling unit stops due to a failure or other reason, be sure to interrupt power for the motor.

- Use caution against leak current.
  The amount of leak current flowing through the linear motor may exceed the value specified in EN60335-1. Take appropriate measures against leak current by, for example, adopting a structure that prevents the operator from contacting conductive parts near the motor during energization.

- Be sure to make thermostat wiring.
  Be sure to make thermostat wiring for thermal protection. In addition, create a ladder or other program to enable thermal protection by the thermostat.
NOTE

- **Do not step or sit on a motor.**
  If you step or sit on a motor, it may get deformed or broken. Do not put a motor on another unless they are in packages.

- **When storing a motor, put it in a dry (non-condensing) place at room temperature (0 to 40 °C).**
  If a motor is stored in a humid or hot place, its components may get damaged or deteriorated. In addition, keep a motor horizontally.

- **Be careful not to lose the nameplate.**
  If you lose the nameplate, you may not sure of the model number of the motor or maintenance may become difficult. Stick the nameplate on a place where it is easy to read it for maintenance and hard to tear it off, such as on a surface near the motor or inside the cabinet of the machine.

- **Do not apply shocks to a motor or cause scratches to it.**
  If a motor is subjected to shocks or is scratched, its components may be adversely affected, resulting in normal operation being impaired. When handling linear motors, pay particular attention. Since they are molded of resin in whole, they cause chips and cracks easily.

- **Do not conduct dielectric strength or insulation test for a sensor.**
  Such a test can damage elements in the sensor.

- **When testing the winding or insulation resistance of a motor, satisfy the conditions stipulated in EN60034.**
  Testing a motor under a condition severer than those specified in EN60034 may damage the motor.

- **Do not disassemble the motor.**
  Disassembling the motor may cause a failure or malfunction. Coil sliders and magnet plates are molded products and cannot be used once disassembled.

- **Do not modify a motor.**
  Do not modify a motor unless directed by FANUC. Modifying a motor may cause a failure or trouble in it.

- **Use a motor under an appropriate environmental condition.**
  Using a motor in an adverse environment may cause a failure or trouble in it. Refer to this manual for details of the operating and environmental conditions for motors.
NOTE

- Do not apply a commercial power source voltage directly to a motor.
  Applying a commercial power source voltage directly to a motor may result in its windings being burned. Be sure to use a specified amplifier for supplying voltage to the motor.

- Before using a motor, measure its winding and insulation resistances, and make sure they are normal.
  Especially for a motor that has been stored for a prolonged period of time, conduct these checks. A motor may deteriorate depending on the condition under which it is stored or the time during which it is stored. For the winding resistances of motors, refer to their respective specification manuals. For insulation resistances, see the following table.

- To use a motor as long as possible, perform periodic maintenance and inspection for it, and check its winding and insulation resistances.
  Note that extremely severe inspections (such as dielectric strength tests) of a motor may damage its windings.

- Motor insulation resistance measurement
  Measure an insulation resistance between each winding and motor frame using an insulation resistance meter (500 VDC). Judge the measurements according to the following table.

<table>
<thead>
<tr>
<th>Insulation resistance</th>
<th>Judgment</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 MΩ or higher</td>
<td>Acceptable</td>
</tr>
<tr>
<td>10 to 100 MΩ</td>
<td>The winding has begun deteriorating. There is no problem with the performance at present. Be sure to perform periodic inspection.</td>
</tr>
<tr>
<td>1 to 10 MΩ</td>
<td>The winding has considerably deteriorated. Special care is in need. Be sure to perform periodic inspection.</td>
</tr>
<tr>
<td>Lower than 1 MΩ</td>
<td>Unacceptable. Replace the motor.</td>
</tr>
</tbody>
</table>
This manual covers information on the following models:

FANUC LINEAR MOTOR LİS series

- Model LİS 300A1/4
- Model LİS 600A1/4
- Model LİS 900A1/4
- Model LİS 1500B1/4
- Models LİS 3000B2/2 and LİS 3000B2/4
- Models LİS 4500B2/2 and L4500B2/2HV
- Models LİS 6000B2/2, LİS 6000B2/4, and LİS 6000B2/2HV
- Models LİS 7500B2/2 and LİS 7500B2/2HV
- Models LİS 9000B2/2 and LİS 9000B2/4
- Model LİS 3300C1/2
- Models LİS 9000C2/2 and LİS 9000C2/2HV
- Models LİS 11000C2/2 and LİS 11000C2/2HV
- Models LİS 15000C2/2, LİS 15000C2/3, and LİS 15000C2/3HV
- Models LİS 10000C3/2 and LİS 10000C3/2HV
- Models LİS 17000C3/2 and LİS 17000C3/2HV

**CAUTION**
Handling or installing the motor incorrectly may not only prevent normal operation but also adversely affect the life of the motor. Before designing or installing axes, always read Part III, "HANDLING, DESIGN, AND ASSEMBLY."

**NOTE**
1. The third angle projection method is used for many drawings in this manual.
2. For details of amplifiers, refer to the latest version of "FANUC SERVO AMPLIFIER αi series DESCRIPTIONS" (B-65282EN).
ORGANIZATION OF THIS MANUAL

This manual is mainly divided into the following five chapters:

I. SPECIFICATIONS
   Contains information about the specifications of linear motors such as force versus speed diagrams, external dimensions, and cooling conditions.

II. CONFIGURATIONS AND SELECTION
   Contains system configurations of linear motors and information required for selecting a motor, and explains how to select a motor.

III. HANDLING, DESIGN, AND ASSEMBLY
   Explains how to handle a linear motor, how to design a machine, and how to install a linear motor. Always read this chapter before designing an axis containing a linear motor or installing a linear motor.

IV. START-UP
   Contains information about servo adjustment of a linear motor. Always read this chapter before running a linear motor.

V. MAINTENANCE
   Contains information about maintenance of a linear motor. Periodically maintain the linear motor according to the instructions described in this chapter.

APPENDIX
   Contains additional information that is not described in other chapters.
WARNING
Mishandling a magnet plate may be highly dangerous, resulting in a fatal accident. Read and thoroughly understand the cautions on the next page and Part III, "HANDLING, DESIGN, AND ASSEMBLY," before handling the magnet plate and strictly observe the cautions when handling it. Do not handle the magnet plate unless you have been trained in handling linear motors. A "motor" described in this manual means all parts of the linear motor: Coil slider, magnet plate, magnetic pole sensor, cooling plate, and others.

After you have received a FANUC Linear Motor, check it as follows:

- Is the linear motor exactly what you ordered? Check the motor model, magnet plate, and sensor.
- Is it free from any damage? Damage may have occurred during shipment.
- Are all accessories supplied with the linear motor?
  All models of coil sliders are supplied with a nameplate and laminate sheet. Terminal models of coil sliders are supplied with a crimp terminal, rubber dripproof terminal cover, and thermostat connector.

All FANUC Linear Motors are strictly inspected and carefully packed before shipment. They need no special incoming inspection. Just check the specifications (for wiring, current, voltage, and other data) of the motor as required. When measuring resistance and insulation data, reference Part V, "MAINTENANCE." Be extremely careful in measuring the dimensions of the magnet plate as incoming inspection because the plate has very strong magnetism.

- Do not apply unnecessary external force or shock to the motor. Otherwise, the motor may be damaged and become incapable of operating normally.
- Do not machine the motor without permission. If the motor requires machining, machine only the portion specified or approved by FANUC.
- Keep the motor from contact with and away from water and oil, chemicals which may damage motors, conductive materials, and other materials harmful to motors.
- Store the motor in indoor locations where are free from rainwater, condensation, and excessive dust. Avoid warming or cooling the motor externally when unnecessary and placing it in special environments.
HANDLING A MAGNET PLATE (CAUTIONS)

⚠️ WARNING

1. Mishandling a magnet plate may be highly dangerous, resulting in a fatal accident. Read and thoroughly understand these cautions and Part III, "HANDLING, DESIGN, AND ASSEMBLY," before handling the magnet plate and strictly observe the cautions when handling it. Do not handle the magnet plate unless you have been trained in handling linear motors.

2. A magnet plate uses many very strong magnets. It may cause a malfunction of a medical apparatus such as a pacemaker or AICD. For this reason, any person having a medical apparatus must keep away from the magnet plate. Also arrange the environment to keep any person having a medical apparatus away from the magnet plate. Keep at least 30 cm away from the magnet plate when it is absolutely necessary.

When a magnet plate is shipped from FANUC, it is packed so that the magnets will not seriously affect outside. Do not remove the tin plates and cushioning corrugated cardboard attached to the magnet plate until the magnet plate is installed on a machine.

Keep any magnetic material (including a tool) away from the magnet plate. If magnetic materials such as iron are brought near the magnet plate, the magnetic materials may be pulled to the magnet plate with a force of about 5 tons, resulting in serious injury. In any case, always keep any magnetic material away from the magnet plate and also be extremely careful of magnetic materials around the work area.
The following items may be affected by magnetic fields, resulting in damage or malfunction. When handling the magnet plate, do not carry any item listed below (or another item which is not listed) with you and keep the items away from the magnet fields unless it is necessary. FANUC accepts no liability for any damage such as corruption or failure of an item due to magnetic fields.

- Watches, cellular phones, magnetic cards, and other portable items
- Magnetic tapes, floppy disks, MO disks, and other magnetic media
- Cameras, personal computers, and other electronic devices

When moving the magnet plate on a surface of a magnetic material such as the mounting surface of the machine or a table, always place it flat with the magnet side facing up and iron side facing down and slide it. If the magnet plate is moved with standing it on its narrow surface, the magnet plate may be attracted to the magnetic material and your hand may be caught between the magnet plate and magnetic material, resulting in injury. The force of magnetic attraction can be 5 tons at the maximum. If your hand is caught under the magnet plate, it is difficult even to pull out the hand. Be extremely careful in moving the magnet plate.

Moving the magnet plate with standing it on its narrow surface is strictly prohibited.
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<td>2.1</td>
<td>CHECKING INSULATION RESISTANCE</td>
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<td>MAGNET PLATE SURFACE PROTECTION</td>
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</tr>
</tbody>
</table>
I. SPECIFICATIONS
1 OVERVIEW

Parts supplied by FANUC

The following shows a typical system configuration of the FANUC Linear Motor LİS series.

FANUC supplies the following parts according to the system configuration of your machine:

- CNC system (CNC, PMC, amplifier, and others)
- Coil slider
- Magnet plate
- Cooling plate for the LİS 300A1/4, LİS 600A1/4, and LİS 900A1/4
  (Other models have a coil slider containing a cooling tube.)
- Magnetic pole sensor
- Position detection circuit
- Signal cables (such as a cable between the position detection circuit and amplifier)

NOTE

Some parts may be unnecessary depending on the system configuration of the machine. For details, see Part II,"CONFIGURATIONS AND SELECTION."
FANUC does not supply parts listed below. Use parts manufactured by third parties as required.

- Linear encoder
- Movable cable and others
- Linear guide
- Cable carrier
- Axis cover
- Scraper
- Cooling devices (cooler, fan, and others)
- Shock absorber
- External brake
- Other than the above that are not in the list of FANUC-supplied parts

**NOTE**

1. Select a linear encoder which meets the FANUC specifications. For details, see Part II, "CONFIGURATIONS AND SELECTION."

2. FANUC does not currently supply any system consisting of a linear motor, linear guide, linear encoder, and other parts you can use as a machine immediately after you purchase it. As described above, you must purchase required parts and configure a system. When you use a motor consisting of parts supplied by FANUC under the specified conditions, FANUC guarantees the performance of the motor. For a part which is not supplied by FANUC, its performance is guaranteed by the relevant manufacturer. For details of a part which is not supplied by FANUC, contact the relevant parts manufacturer or dealer.
2 SPECIFICATIONS
2.1 TERMS USED IN THE SPECIFICATION LIST AND SPEED DIAGRAMS

- Cooling method

There are the following methods for cooling a coil slider: No cooling, air cooling, and water cooling.

- Maximum speed

Maximum speed of the motor. You can run the motor at up to this speed.

- Upper speed for the maximum force

Upper limit of the speed at which the maximum force can be maintained. If the speed exceeds this limit, the maximum force is reduced.

- Continuous force

Force the motor can continuously output. How the coil slider temperature rises depends on the material of the machine on which it is mounted. When no cooling or air cooling is used, in particular, the material affects the coil slider temperature. The specification list contains the size of an aluminum heat sink on which each coil slider is mounted.

<table>
<thead>
<tr>
<th>Model</th>
<th>Size of the heat sink (mm)</th>
<th>Surface area of the coil slider \times 2 \times thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIŚ 300A1</td>
<td>(73 \times 71) \times 2 \times 20</td>
<td></td>
</tr>
<tr>
<td>LIŚ 600A1</td>
<td>(133 \times 71) \times 2 \times 20</td>
<td></td>
</tr>
<tr>
<td>LIŚ 900A1</td>
<td>(193 \times 71) \times 2 \times 20</td>
<td></td>
</tr>
<tr>
<td>LIŚ 1500B1</td>
<td>(297 \times 130) \times 2 \times 50</td>
<td></td>
</tr>
<tr>
<td>LIŚ 3000B2</td>
<td>(297 \times 200) \times 2 \times 50</td>
<td></td>
</tr>
<tr>
<td>LIŚ 4500B2</td>
<td>(417 \times 200) \times 2 \times 50</td>
<td></td>
</tr>
<tr>
<td>LIŚ 6000B2</td>
<td>(537 \times 200) \times 2 \times 50</td>
<td></td>
</tr>
<tr>
<td>LIŚ 7500B2</td>
<td>(657 \times 200) \times 2 \times 50</td>
<td></td>
</tr>
<tr>
<td>LIŚ 9000B2</td>
<td>(777 \times 200) \times 2 \times 50</td>
<td></td>
</tr>
<tr>
<td>LIŚ 3300C1</td>
<td>(417 \times 150) \times 2 \times 50</td>
<td></td>
</tr>
<tr>
<td>LIŚ 9000C2</td>
<td>(537 \times 260) \times 2 \times 50</td>
<td></td>
</tr>
<tr>
<td>LIŚ 11000C2</td>
<td>(657 \times 260) \times 2 \times 50</td>
<td></td>
</tr>
<tr>
<td>LIŚ 15000C2</td>
<td>(897 \times 260) \times 2 \times 50</td>
<td></td>
</tr>
<tr>
<td>LIŚ 10000C3</td>
<td>(417 \times 355) \times 2 \times 50</td>
<td></td>
</tr>
<tr>
<td>LIŚ 17000C3</td>
<td>(657 \times 355) \times 2 \times 50</td>
<td></td>
</tr>
</tbody>
</table>

- Maximum force

Maximum force the motor can generate when driven using the standard amplifier. The maximum force can be used only in a short time such as during acceleration or deceleration.

- Continuous current

Effective current per phase when the motor outputs the continuous force. The peak value can be obtained by multiplying this value by $\sqrt{2}$. 

- 6 -
- **Maximum current**
  Effective current per phase when the motor outputs the maximum force. The peak value can be obtained by multiplying this value by \( \sqrt{2} \).

- **Continuous output/maximum output**
  Value obtained by converting the force (N) during motor operation to the output (kW). For selection of a power supply module (PSM), see Part II, "CONFIGURATIONS AND SELECTION."

- **Maximum amplifier current**
  Maximum peak current of the standard amplifier. The effective value can be obtained by dividing this value by \( \sqrt{2} \).

- **Force constant**
  Force obtained when 1 Ams flows for one phase. The following expression can be satisfied: [force constant] \( \times \) [continuous current] \( \leq \) [continuous force]. This expression may not be satisfied due to saturated magnetic force, however.

- **Back electromotive force constant**
  Electromotive force per phase generated with the motor running at a speed of 1 m/s that is indicated by the effective value. The voltage between motor terminals can be obtained by multiplying this value by \( \sqrt{3} \).

- **Armature resistance**
  Resistance per phase of the coil slider at an ambient temperature of 25°C. The resistance between terminals is double this value.

- **Thermal time constant**
  Thermal time constant for the coil slider

- **Cooling conditions**
  Conditions for obtaining the rated output when forced cooling is used
  - IC code:
    Code indicating the cooling method that conforms to EN60034-6
  - Coolant:
    Primary coolant for directly cooling the coil slider
  - Flow rate:
    Required flow rate of the primary coolant
  - Recommended pressure:
    Recommended pressure for the primary coolant
  - Maximum pressure:
    Maximum pressure for the primary coolant
  - Required cooling capacity:
    Amount of heat absorbed that is required for obtaining the rated output

- **Magnetic attraction**
  Force of the magnetic attraction between the coil slider and magnet plate

- **Mass of the coil slider**
  Mass per coil slider

- **Type of applicable magnet plate**
  Type of magnet plate that is applicable
## 2.2 SPECIFICATION LIST

### Model List

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Unit</th>
<th>L/S 300A1/4</th>
<th>L/S 600A1/4</th>
<th>L/S 900A1/4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling method (*2)</td>
<td>-</td>
<td></td>
<td>No cooling</td>
<td>Air cooling</td>
<td>Water cooling</td>
</tr>
<tr>
<td>Maximum speed</td>
<td>-</td>
<td>m/s</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Upper speed for the maximum force</td>
<td>-</td>
<td>m/s</td>
<td>2.3</td>
<td>2.3</td>
<td>2.3</td>
</tr>
<tr>
<td>Continuous force</td>
<td>Fc</td>
<td>N</td>
<td>50</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>Maximum force</td>
<td>Fp</td>
<td>N</td>
<td>300</td>
<td>600</td>
<td>900</td>
</tr>
<tr>
<td>Continuous output</td>
<td>Pm</td>
<td>kW</td>
<td>0.2</td>
<td>0.24</td>
<td>0.4</td>
</tr>
<tr>
<td>Maximum output</td>
<td>Pc</td>
<td>N</td>
<td>50</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>Continuous current</td>
<td>Ic</td>
<td>Arms</td>
<td>1.2</td>
<td>1.5</td>
<td>2.4</td>
</tr>
<tr>
<td>Maximum current</td>
<td>Ip</td>
<td>Arms</td>
<td>7.3</td>
<td>14.6</td>
<td>21.9</td>
</tr>
<tr>
<td>Maximum amplifier current</td>
<td>Ap</td>
<td></td>
<td>20</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Back electromotive force constant</td>
<td>Ke</td>
<td>Vrms/(m/s)</td>
<td>13.7</td>
<td>13.7</td>
<td>13.7</td>
</tr>
<tr>
<td>Armature resistance</td>
<td>Ra</td>
<td>Ω</td>
<td>3.0</td>
<td>1.5</td>
<td>1.0</td>
</tr>
<tr>
<td>Thermal time constant</td>
<td>Tt</td>
<td>min.</td>
<td>30</td>
<td>15</td>
<td>0.5</td>
</tr>
<tr>
<td>Cooling conditions (*3)</td>
<td></td>
<td></td>
<td>9A7A7</td>
<td>9W7A7</td>
<td>9W7A7</td>
</tr>
<tr>
<td>IC code (*4)</td>
<td>-</td>
<td></td>
<td>0A8</td>
<td>9A7A7</td>
<td>9W7A7</td>
</tr>
<tr>
<td>Coolant (*5)</td>
<td>-</td>
<td></td>
<td>Air</td>
<td>Water</td>
<td>Air</td>
</tr>
<tr>
<td>Flow rate</td>
<td>-</td>
<td>L/min</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Recommended pressure</td>
<td>-</td>
<td>MPa</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Maximum pressure</td>
<td>-</td>
<td>MPa</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>Required cooling capacity</td>
<td>-</td>
<td>W</td>
<td>100</td>
<td>200</td>
<td>300</td>
</tr>
<tr>
<td>Magnetic attraction (*6)</td>
<td>Fa</td>
<td>N</td>
<td>750</td>
<td>1500</td>
<td>2250</td>
</tr>
<tr>
<td>Weight of the coil slider (*7)</td>
<td>W</td>
<td>kg</td>
<td>0.8</td>
<td>1.5</td>
<td>2.2</td>
</tr>
<tr>
<td>Type of applicable magnet plate (*8)</td>
<td>-</td>
<td></td>
<td>A1</td>
<td>A1</td>
<td>A1</td>
</tr>
</tbody>
</table>

*1 Standard values at an ambient temperature of 25°C and a power supply voltage of 200 V. The values may vary depending on the ambient temperature, digital servo software, parameters, power supply voltage, amplifier specifications, and others.

*2 To use "air cooling" or "water cooling," a forced cooling system with a cooling plate (option) is required. For details, see Subsection 2.4.5, "Cooling Plate."

*3 When "no cooling" or "air cooling" is used, the thermal loss differs depending on the materials of parts around the coil slider and machine configuration. According to the thermal loss, the rating may vary.

*4 Conforms to EN60034-6. IC code "0A8" for "no cooling" is cooling for a movable coil slider. For cooling for a movable magnet plate, the IC code is "0A0".

*5 Primary coolant for forced cooling (coolant for directly cooling the coil slider). "Air" means ordinary industrial compressed air. "Water" means ion exchanged water (including 5% rust inhibitor).

*6 Maximum magnetic attraction between the coil slider and the magnet plate. The value varies depending on the size of the gap.

*7 When "air cooling" or "water cooling" is used, the weight of the cooling plate is added. For details, see the subsection "Cooling Plate" below. When an incremental linear encoder is used, the weight of the magnetic pole sensor is added. For details, see the subsection "Magnetic Pole Sensor" below.

*8 The type of applicable magnet plate differs depending on the motor model. For details, see the subsection "Magnet Plate" below.
<table>
<thead>
<tr>
<th>Model</th>
<th>Unit</th>
<th>Symbol</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LiS 1500B/1/4</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No cooling</td>
<td>Air cooling</td>
<td>Water cooling</td>
<td>Cooling method (*2)</td>
</tr>
<tr>
<td>4</td>
<td>2 (4)</td>
<td>4 m/s</td>
<td>Maximum speed</td>
</tr>
<tr>
<td>2</td>
<td>1 (2)</td>
<td>2.2 m/s</td>
<td>Upper speed for the maximum force</td>
</tr>
<tr>
<td>300</td>
<td>600</td>
<td>1200</td>
<td>N Fc Continuous force</td>
</tr>
<tr>
<td>1500</td>
<td>3000</td>
<td></td>
<td>N Fp Maximum force</td>
</tr>
<tr>
<td>1.2</td>
<td>1.4</td>
<td>2.4 kWe</td>
<td>Continuous output</td>
</tr>
<tr>
<td>3.2</td>
<td>3.2 (6.8)</td>
<td>6.8 kW</td>
<td>Maximum output</td>
</tr>
<tr>
<td>5.1</td>
<td>6.1</td>
<td>10.2</td>
<td>Arms Ic Continuous current</td>
</tr>
<tr>
<td>28</td>
<td>28</td>
<td>57</td>
<td>Arms Ip Maximum current</td>
</tr>
<tr>
<td>40</td>
<td>40</td>
<td>80</td>
<td>Ap Maximum amplifier current</td>
</tr>
<tr>
<td>58.7</td>
<td>129.4</td>
<td>58.7</td>
<td>N/Arms Kf Force constant</td>
</tr>
<tr>
<td>19.6</td>
<td>43.1</td>
<td>19.6</td>
<td>Vrms/(m/s) Ke Back electromotive force constant</td>
</tr>
<tr>
<td>1.3</td>
<td>2.22</td>
<td>0.555</td>
<td>Ω Ra Armature resistance</td>
</tr>
<tr>
<td>60 30 1 60 30 1 60 30 1</td>
<td></td>
<td>min. Ti Thermal time constant</td>
<td></td>
</tr>
<tr>
<td>0A8 9A7A7 9W7A7 0A8 9A7A7 9W7A7 0A8 9A7A7 9W7A7</td>
<td></td>
<td>IC code (*4)</td>
<td></td>
</tr>
<tr>
<td>- Air Water - Air Water - Air Water</td>
<td>-</td>
<td>-</td>
<td>Coolant (*5)</td>
</tr>
<tr>
<td>- - 7.5 - - 7.5 - - 7.5 L/min -</td>
<td></td>
<td>Flow rate</td>
<td></td>
</tr>
<tr>
<td>- - 0.35 - - 0.35 - - 0.35 MPa -</td>
<td></td>
<td>Recommended pressure</td>
<td></td>
</tr>
<tr>
<td>- - 0.63 - - 0.63 - - 0.63 MPa -</td>
<td></td>
<td>Maximum pressure</td>
<td></td>
</tr>
<tr>
<td>- - 450 - - 900 - - 900 W -</td>
<td></td>
<td>Required cooling capacity</td>
<td></td>
</tr>
<tr>
<td>4500</td>
<td>9000</td>
<td>9000</td>
<td>N Fa Magnetic attraction (*6)</td>
</tr>
<tr>
<td>8</td>
<td>12</td>
<td>12</td>
<td>kg W Weight of the coil slider (*7)</td>
</tr>
<tr>
<td>B1 B2 B2</td>
<td></td>
<td>-</td>
<td>Type of applicable magnet plate (*8)</td>
</tr>
</tbody>
</table>

---

*1 Standard values at an ambient temperature of 25°C and a power supply voltage of 200 V
*2 When "no cooling" is used, the cooling tube in the coil slider is not used. To use "air cooling" or "water cooling," a forced cooling system using the internal cooling tube is required.
*3 When "no cooling" or "air cooling" is used, the thermal loss differs depending on the materials of parts around the coil slider and machine configuration. According to the thermal loss, the rating may vary.
*4 Conforms to EN60034-6. IC code "0A8" for "no cooling" is cooling for a movable coil slider. For cooling for a movable magnet plate, the IC code is "0A0".
*5 Primary coolant for forced cooling (coolant for directly cooling the coil slider)
*6 Maximum magnetic attraction between the coil slider and the magnet plate
*7 When an incremental linear encoder is used, the weight of the magnetic pole sensor is added. For details, see the subsection "Magnetic Pole Sensor" below.
*8 The type of applicable magnet plate differs depending on the motor model. For details, see the subsection "Magnet Plate" below.
*9 Can be driven by 400 V input (FANUC HV amplifier). The values in parentheses in the table indicate data when the motor is driven with 400 V. Drive parameters dedicated to 400 V are required.
<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Unit</th>
<th>Lf 4500B2/2</th>
<th>Lf 6000B2/2</th>
<th>Lf 6000B2/4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling method (*2)</td>
<td>-</td>
<td>-</td>
<td>No cooling</td>
<td>No cooling</td>
<td>No cooling</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Air cooling</td>
<td>Air cooling</td>
<td>Air cooling</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Water cooling</td>
<td>Water cooling</td>
<td>Water cooling</td>
</tr>
<tr>
<td>Maximum speed</td>
<td>-</td>
<td>m/s</td>
<td>2 (4)</td>
<td>2 (4)</td>
<td>4</td>
</tr>
<tr>
<td>Upper speed for the maximum force</td>
<td>-</td>
<td>m/s</td>
<td>1 (2)</td>
<td>1 (2)</td>
<td>2.2</td>
</tr>
<tr>
<td>Continuous force</td>
<td>Fc</td>
<td>N</td>
<td>900</td>
<td>1080</td>
<td>1800</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1200</td>
<td>1440</td>
<td>2400</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1200</td>
<td>1440</td>
<td>2400</td>
</tr>
<tr>
<td>Maximum force</td>
<td>Fp</td>
<td>kW</td>
<td>1.8</td>
<td>2.2</td>
<td>2.4</td>
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<td></td>
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<td></td>
<td>(3.6)</td>
<td>(4.3)</td>
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<td>(7.2)</td>
<td>(5.8)</td>
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<td></td>
<td></td>
<td></td>
<td>(4.8)</td>
<td>(9.6)</td>
<td>4.8</td>
</tr>
<tr>
<td>Maximum output</td>
<td>Pm</td>
<td>kW</td>
<td>4.8 (9.6)</td>
<td>6.4 (12.8)</td>
<td>13.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>20.4</td>
<td>24.5</td>
<td>40.9</td>
</tr>
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<td>Continuous current</td>
<td>Ic</td>
<td>Arms</td>
<td>7</td>
<td>8.3</td>
<td>9.3</td>
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<td></td>
<td>13.9</td>
<td>11.1</td>
<td>18.5</td>
</tr>
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<td>Max current</td>
<td>Ip</td>
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<td>Max current</td>
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<tr>
<td>Force constant</td>
<td>Kf</td>
<td>N/Ams</td>
<td>129.4</td>
<td>129.4</td>
<td>58.7</td>
</tr>
<tr>
<td>Back electromotive force constant</td>
<td>Ke</td>
<td>Vrms/(m/s)</td>
<td>43.1</td>
<td>43.1</td>
<td>19.6</td>
</tr>
<tr>
<td>Armature resistance</td>
<td>Ra</td>
<td>Ω</td>
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<td>1.09</td>
<td>0.273</td>
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<tr>
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<td>Tt</td>
<td>min.</td>
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<td>30</td>
<td>1</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>60</td>
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<td>1</td>
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<td>-</td>
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<td>-</td>
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</tr>
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<td>W</td>
<td>-</td>
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</tr>
<tr>
<td>Magnetic attraction *6</td>
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<td>18000</td>
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<td>kg</td>
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*1 Standard values at an ambient temperature of 25°C and a power supply voltage of 200 V. The values may vary depending on the ambient temperature, digital servo software, parameters, power supply voltage, amplifier specifications, and others.

*2 When "no cooling" is used, the cooling tube in the coil slider is not used. To use "air cooling" or "water cooling," a forced cooling system using the internal cooling tube is required.

*3 When "no cooling" or "air cooling" is used, the thermal loss differs depending on the materials of parts around the coil slider and machine configuration. According to the thermal loss, the rating may vary.

*4 Conforms to EN60034-6. IC code "0A8" for "no cooling" is cooling for a movable coil slider. For cooling for a movable magnet plate, the IC code is "0A0".

*5 Primary coolant for forced cooling (coolant for directly cooling the coil slider). "Air" means ordinary industrial compressed air. "Water" means ion exchanged water (including 5% rust inhibitor).

*6 Maximum magnetic attraction between the coil slider and the magnet plate. The value varies depending on the size of the gap.

*7 When an incremental linear encoder is used, the weight of the magnetic pole sensor is added. For details, see the subsection "Magnetic Pole Sensor" below.

*8 The type of applicable magnet plate differs depending on the motor model. For details, see the subsection "Magnet Plate" below.

*9 Can be driven by 400 V input (FANUC HV amplifier). The values in parentheses in the table indicate data when the motor is driven with 400 V. Drive parameters dedicated to 400 V are required.
## Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>LÍS 7500B2/2</th>
<th>LÍS 9000B2/2</th>
<th>LÍS 9000B2/4</th>
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</tr>
<tr>
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<td>4</td>
</tr>
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<td>1 (2)</td>
<td>2</td>
<td>-</td>
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<td>No cooling</td>
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<td>(7.2)</td>
<td>(7.2)</td>
<td>(13.5)</td>
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<td>9A7A7</td>
<td>9W7A7</td>
<td>9A7A7</td>
</tr>
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<td>-</td>
<td>-</td>
<td>-</td>
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<td>24.5</td>
<td>34</td>
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</table>

### Notes:

1. Standard values at an ambient temperature of 25°C and a power supply voltage of 200 V. The values may vary depending on the ambient temperature, digital servo software, parameters, power supply voltage, amplifier specifications, and others.
2. When "no cooling" is used, the cooling tube in the coil slider is not used. To use "air cooling" or "water cooling," a forced cooling system using the internal cooling tube is required.
3. When "no cooling" or "air cooling" is used, the thermal loss differs depending on the materials of parts around the coil slider and machine configuration. According to the thermal loss, the rating may vary.
4. Conforms to EN60034-6. IC code "0A8" for "no cooling" is cooling for a movable coil slider. For cooling for a movable magnet plate, the IC code is "0A0".
5. Primary coolant for forced cooling (coolant for directly cooling the coil slider) "Air" means ordinary industrial compressed air. "Water" means ion exchanged water (including 5% rust inhibitor).
6. Maximum magnetic attraction between the coil slider and the magnet plate. The value varies depending on the size of the gap.
7. When an incremental linear encoder is used, the weight of the magnetic pole sensor is added. Details, see the subsection "Magnetic Pole Sensor" below.
8. The type of applicable magnet plate differs depending on the motor model. Details, see the subsection "Magnet Plate" below.
9. Can be driven by 400 V input (FANUC HV amplifier). The values in parentheses in the table indicate data when the motor is driven with 400 V. Drive parameters dedicated to 400 V are required.
<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Unit</th>
<th>LİS 3300C1/2</th>
<th>LİS 9000C2/2</th>
<th>LİS 11000C2/2</th>
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</thead>
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<tr>
<td>Cooling method (*2)</td>
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<td>-</td>
<td>No cooling</td>
<td>Air cooling</td>
<td>Water cooling</td>
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<td>-</td>
<td>m/s</td>
<td>2 (4)</td>
<td>2(4)</td>
<td>2(4)</td>
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<tr>
<td>Upper speed for the maximum force</td>
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<td>m/s</td>
<td>1.2 (3)</td>
<td>1(2)</td>
<td>1(2)</td>
</tr>
<tr>
<td>Continuous force</td>
<td>Fc</td>
<td>N</td>
<td>660</td>
<td>792</td>
<td>1320</td>
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<td>Maximum force</td>
<td>Fp</td>
<td>N</td>
<td>3300</td>
<td>9000</td>
<td>11000</td>
</tr>
<tr>
<td>Continuous output</td>
<td>Pc</td>
<td>kW</td>
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<td>1.6</td>
<td>2.6</td>
</tr>
<tr>
<td>Maximum output</td>
<td>Pm</td>
<td>kW</td>
<td>3.5 (7.0)</td>
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<td>11.7 (23.4)</td>
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<td>Maximum current</td>
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<td>Arms</td>
<td>6.9</td>
<td>8.3</td>
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<td>Maximum current</td>
<td>Ip</td>
<td>Arms</td>
<td>42</td>
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<td>Force constant</td>
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<td>135.8</td>
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<td>9W7A7</td>
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<td>9A7A7</td>
<td>9W7A7</td>
</tr>
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<td>-</td>
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<td>C2</td>
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</table>

*1 *Standard values at an ambient temperature of 25°C and a power supply voltage of 200 V
The values may vary depending on the ambient temperature, digital servo software, parameters, power supply voltage, amplifier specifications, and others.

*2 When "no cooling" is used, the cooling tube in the coil slider is not used. To use "air cooling" or "water cooling," a forced cooling system using the internal cooling tube is required.

*3 When "no cooling" or "air cooling" is used, the thermal loss differs depending on the materials of parts around the coil slider and machine configuration. According to the thermal loss, the rating may vary.

*4 Conforms to EN60034-6. IC code "0A8" for "no cooling" is cooling for a movable coil slider. For cooling for a movable magnet plate, the IC code is "0A0".

*5 Primary coolant for forced cooling (coolant for directly cooling the coil slider). "Air" means ordinary industrial compressed air. "Water" means ion exchanged water (including 5% rust inhibitor).

*6 Maximum magnetic attraction between the coil slider and the magnet plate
The value varies depending on the size of the gap.

*7 An incremental linear encoder is used, the weight of the magnetic pole sensor is added. For details, see the subsection "Magnetic Pole Sensor" below.

*8 The type of applicable magnet plate differs depending on the motor model. For details, see the subsection "Magnet Plate" below.

*9 Can be driven by 400 V input (FANUC HV amplifier). The values in parentheses in the table indicate data when the motor is driven with 400 V. Drive parameters dedicated to 400 V are required.
<table>
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<tr>
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<th>LİS 15000C2/3</th>
<th>LİS 10000C3/2</th>
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<th>Symbol</th>
<th>Item</th>
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<td>Water cooling</td>
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</tr>
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<td>3600</td>
<td>7000</td>
<td>2000</td>
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<td>10000</td>
<td>N</td>
<td>Fc</td>
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<td>(9.6)</td>
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<td>23.8</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>-</td>
<td>-</td>
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<td>Ke</td>
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<td>Water</td>
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<td>9W7A7</td>
<td>0A8</td>
<td>9A7A7</td>
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<td>kg</td>
<td>W</td>
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<td>C2</td>
<td>C3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Type of applicable magnet plate (*8)</td>
</tr>
</tbody>
</table>

*1 Standard values at an ambient temperature of 25°C and a power supply voltage of 200 V. The values may vary depending on the ambient temperature, digital servo software parameters, power supply voltage, amplifier specifications, and others.

*2 When "no cooling" is used, the cooling tube in the coil slider is not used. To use "air cooling" or "water cooling," a forced cooling system using the internal cooling tube is required.

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*9 Can be driven by 400 V input (FANUC HV amplifier). The values in parentheses in the table indicate data when the motor is driven with 400 V. Drive parameters dedicated to 400 V are required.
<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Unit</th>
<th>LîS 17000C3/2</th>
<th>LîS 4500B2/2HV</th>
<th>LîS 6000B2/2HV</th>
</tr>
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<tbody>
<tr>
<td>Cooling method (*2)</td>
<td>-</td>
<td>-</td>
<td>No cooling</td>
<td>Air cooling</td>
<td>Water cooling</td>
</tr>
<tr>
<td>Maximum speed</td>
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<td>m/s</td>
<td>2 (4)</td>
<td>(2)</td>
<td>(2)</td>
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<td>(1)</td>
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<td>40000</td>
<td>6800</td>
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<td>N</td>
<td>17000</td>
<td>45000</td>
<td>60000</td>
</tr>
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<td>Continuous output</td>
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<td>kW</td>
<td>6.8 (13.6)</td>
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<td>13.6 (27.2)</td>
</tr>
<tr>
<td>Maximum output</td>
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<td>kW</td>
<td>16.1 (36.2)</td>
<td>(4.5)</td>
<td>6.4</td>
</tr>
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<td>Ic</td>
<td>Arms</td>
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<td>33.9</td>
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<tr>
<td>Maximum current</td>
<td>Ip</td>
<td>Arms</td>
<td>184</td>
<td>25.5</td>
<td>33.9</td>
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<td>Maximum amplifier current</td>
<td>Ap</td>
<td>-</td>
<td>360</td>
<td>40</td>
<td>80</td>
</tr>
<tr>
<td>Force constant</td>
<td>Kf</td>
<td>N/Ams</td>
<td>120.3</td>
<td>227.7</td>
<td>227.7</td>
</tr>
<tr>
<td>Back electromotive force constant</td>
<td>Ke</td>
<td>Vrms/(m/s)</td>
<td>40.1</td>
<td>75.9</td>
<td>75.9</td>
</tr>
<tr>
<td>Armature resistance</td>
<td>Ra</td>
<td>Ω</td>
<td>0.36</td>
<td>4</td>
<td>3.05</td>
</tr>
<tr>
<td>Thermal time constant</td>
<td>T1</td>
<td>min.</td>
<td>60 30 1</td>
<td>60 30 1</td>
<td>60 30 1</td>
</tr>
<tr>
<td>IC code (*4)</td>
<td>-</td>
<td>-</td>
<td>0A8 9A7A7 9W7A7</td>
<td>0A8 9A7A7 9W7A7</td>
<td>0A8 9A7A7 9W7A7</td>
</tr>
<tr>
<td>Coolant (*5)</td>
<td>-</td>
<td>-</td>
<td>Air Water</td>
<td>Air Water</td>
<td>Air Water</td>
</tr>
<tr>
<td>Flow rate</td>
<td>-</td>
<td>L/min</td>
<td>7.5</td>
<td>7.5</td>
<td>7.5</td>
</tr>
<tr>
<td>Recommended pressure</td>
<td>-</td>
<td>MPa</td>
<td>0.48</td>
<td>0.35</td>
<td>0.42</td>
</tr>
<tr>
<td>Maximum pressure</td>
<td>-</td>
<td>MPa</td>
<td>0.63</td>
<td>0.63</td>
<td>0.63</td>
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<td>Required cooling capacity</td>
<td>-</td>
<td>W</td>
<td>4000</td>
<td>1300</td>
<td>17000</td>
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<td>Magnetic attraction (*6)</td>
<td>Fa</td>
<td>N</td>
<td>51000</td>
<td>13500</td>
<td>18000</td>
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<tr>
<td>Weight of the coil slider (*7)</td>
<td>W</td>
<td>Kg</td>
<td>49</td>
<td>15.5</td>
<td>20</td>
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<tr>
<td>Type of applicable magnet plate (*8)</td>
<td>-</td>
<td>-</td>
<td>C3</td>
<td>B2</td>
<td>B2</td>
</tr>
</tbody>
</table>

*1 Standard values at an ambient temperature of 25°C and a power supply voltage of 200 V

*2 When "no cooling" is used, the cooling tube in the coil slider is not used. To use "air cooling" or "water cooling," a forced cooling system using the internal cooling tube is required.

*3 When "no cooling" or "air cooling" is used, the thermal loss differs depending on the materials of parts around the coil slider and machine configuration. According to the thermal loss, the rating may vary.

*4 Conforms to EN60034-4. IC code "0A0" for "no cooling" is cooling for a movable coil slider. For cooling for a movable magnet plate, the IC code is "0A0".

*5 Primary coolant for forced cooling (coolant for directly cooling the coil slider)

*6 Maximum magnetic attraction between the coil slider and the magnet plate

*7 When "air cooling" or "water cooling" is used, the weight of the cooling plate is added. For details, see the subsection "Cooling Plate" below. When an incremental linear encoder is used, the weight of the magnetic pole sensor is added. For details, see the subsection "Magnetic Pole Sensor" below.

*8 The type of applicable magnet plate differs depending on the motor model. For details, see the subsection "Magnet Plate" below.

*9 Can be driven by 400 V input (FANUC HV amplifier). The values in parentheses in the table indicate data when the motor is driven with 400 V. Drive parameters dedicated to 400 V are required.
### LÍS 7500B2/2HV  LÍS 9000C2/2HV  LÍS 11000C2/2HV

<table>
<thead>
<tr>
<th>Model</th>
<th>Unit</th>
<th>Symbol</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>No cooling</td>
<td></td>
<td>-</td>
<td>Cooling method (*2)</td>
</tr>
<tr>
<td>(2)</td>
<td>m/s</td>
<td>-</td>
<td>Maximum speed</td>
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<td>(1)</td>
<td>m/s</td>
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<td>Upper speed for the</td>
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<tr>
<td></td>
<td></td>
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<td>maximum force</td>
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<tr>
<td>1500</td>
<td></td>
<td>N</td>
<td>Continuous force</td>
</tr>
<tr>
<td>7500</td>
<td></td>
<td>N</td>
<td>Maximum force</td>
</tr>
<tr>
<td>(3.0)</td>
<td>kW</td>
<td>Pc</td>
<td>Continuous output</td>
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<tr>
<td>(8)</td>
<td>kW</td>
<td>Pm</td>
<td>Maximum output</td>
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<td>6.6</td>
<td>Arms</td>
<td>lc</td>
<td>Continuous current</td>
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<td>42.4</td>
<td>Arms</td>
<td>lp</td>
<td>Maximum current</td>
</tr>
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<td>80</td>
<td>Ap</td>
<td>-</td>
<td>Maximum amplifier current</td>
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<tr>
<td>227.7</td>
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<td>N/Arms</td>
<td>Force constant</td>
</tr>
<tr>
<td>75.9</td>
<td>Vrms</td>
<td>Ke</td>
<td>Back electromotive force</td>
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<td>2.4</td>
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<th>60</th>
<th>30</th>
<th>1</th>
<th>60</th>
<th>30</th>
<th>1</th>
<th>min. Ti</th>
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<tr>
<td>0A8</td>
<td>9A7A7</td>
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<td>0A8</td>
<td>9A7A7</td>
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<td>-</td>
<td>-</td>
<td>7.5</td>
<td>-</td>
<td>-</td>
<td>7.5</td>
<td>L/min</td>
<td>Flow rate</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>0.42</td>
<td>-</td>
<td>-</td>
<td>0.5</td>
<td>-</td>
<td>-</td>
<td>0.54</td>
<td>MPa</td>
<td>Recommended pressure</td>
</tr>
<tr>
<td>-</td>
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<tr>
<td>-</td>
<td>-</td>
<td>1700</td>
<td>-</td>
<td>-</td>
<td>2600</td>
<td>-</td>
<td>-</td>
<td>3400</td>
<td>W</td>
<td>Required cooling capacity</td>
</tr>
<tr>
<td>22500</td>
<td>27000</td>
<td>-</td>
<td>33000</td>
<td>N</td>
<td>Fa</td>
<td>Magnetic attraction (*6)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>24.5</td>
<td>27</td>
<td>33.5</td>
<td>kg</td>
<td>W</td>
<td>Weight of the coil slider (*7)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B2</td>
<td>C2</td>
<td>C2</td>
<td>-</td>
<td>-</td>
<td>Type of applicable magnet plate (*8)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

*1 Standard values at an ambient temperature of 25°C. The values may vary depending on the ambient temperature, digital servo software, parameters, power supply voltage, amplifier specifications, and others.

*2 When "no cooling" is used, the cooling tube in the coil slider is not used. To use "air cooling" or "water cooling," a forced cooling system using the internal cooling tube is required.

*3 When "no cooling" or "air cooling" is used, the thermal loss differs depending on the materials of parts around the coil slider and machine configuration. According to the thermal loss, the rating may vary.

*4 Conforms to EN60034-6. IC code "0A8" for "no cooling" is cooling for a movable coil slider. For cooling for a movable magnet plate, the IC code is "0A0".

*5 Primary coolant for forced cooling (coolant for directly cooling the coil slider) "Air" means ordinary industrial compressed air. "Water" means ion exchanged water (including 5% rust inhibitor).

*6 Maximum magnetic attraction between the coil slider and the magnet plate. The value varies depending on the size of the gap.

*7 When an incremental linear encoder is used, the weight of the magnetic pole sensor is added. For details, see the subsection "Magnetic Pole Sensor" below.

*8 The type of applicable magnet plate differs depending on the motor model. For details, see the subsection "Magnet Plate" below.

*9 Can be driven by 400 V input (FANUC HV amplifier). The values in parentheses in the table indicate data when the motor is driven with 400 V. Drive parameters dedicated to 400 V are required.
## 2. SPECIFICATIONS

### SPECIFICATIONS

<table>
<thead>
<tr>
<th>Model</th>
<th>LİŞ 15000C2/3HV</th>
<th>LİŞ 10000C3/2HV</th>
<th>LİŞ 17000C3/2HV</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Item</strong></td>
<td>Symbol</td>
<td>Unit</td>
<td><strong>No cooling</strong></td>
</tr>
<tr>
<td>Cooling method (*2)</td>
<td>-</td>
<td>-</td>
<td>No cooling</td>
</tr>
<tr>
<td>Maximum speed</td>
<td>- m/s</td>
<td>(3)</td>
<td>(2)</td>
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<tr>
<td>Upper speed for the maximum force</td>
<td>- m/s</td>
<td>(1.2)</td>
<td>(0.8)</td>
</tr>
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<td>Continuous force</td>
<td>Fc N</td>
<td>3000</td>
<td>3600</td>
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<td>Maximum force</td>
<td>Fp N</td>
<td>15500</td>
<td>10000</td>
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<td>Continuous output</td>
<td>Pc kW</td>
<td>(9.0)</td>
<td>(10.8)</td>
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<tr>
<td>Maximum output</td>
<td>Ip Arms</td>
<td>(23.8)</td>
<td>(10.7)</td>
</tr>
<tr>
<td>Continuous current</td>
<td>Ic Arms</td>
<td>16.9</td>
<td>20.3</td>
</tr>
<tr>
<td>Maximum current</td>
<td>Ip Arms</td>
<td>127</td>
<td>57</td>
</tr>
<tr>
<td>Maximum amplifier current</td>
<td>- Ap</td>
<td>(180)</td>
<td>80</td>
</tr>
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<td>Force constant</td>
<td>Kf N/A</td>
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<td>263.1</td>
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<td>Back electromotive force constant</td>
<td>Ke Vrms/(m/s)</td>
<td>59.2</td>
<td>87.7</td>
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<td>30</td>
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<td>Cooling conditions (*3)</td>
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<td>-</td>
<td>-</td>
<td>Air</td>
</tr>
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<td>- L/min</td>
<td>-</td>
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</tr>
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<td>Recommended pressure</td>
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<td>Maximum pressure</td>
<td>- MPa</td>
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<td>0.63</td>
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<td>Required cooling capacity</td>
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<td>-</td>
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<td>Fa N</td>
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<td>30000</td>
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<td>Weight of the coil slider (*7)</td>
<td>W kg</td>
<td>48</td>
<td>31</td>
</tr>
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<td>Type of applicable magnet plate (*8)</td>
<td>-</td>
<td>-</td>
<td>C2</td>
</tr>
</tbody>
</table>

---

*1 Standard values at an ambient temperature of 25°C

The values may vary depending on the ambient temperature, digital servo software, parameters, power supply voltage, amplifier specifications, and others.

*2 When "no cooling" is used, the cooling tube in the coil slider is not used. To use "air cooling" or "water cooling," a forced cooling system using the internal cooling tube is required.

*3 When "no cooling" or "air cooling" is used, the thermal loss differs depending on the materials of parts around the coil slider and machine configuration. According to the thermal loss, the rating may vary.

*4 Conforms to EN60034-6. IC code "0A8" for "no cooling" is cooling for a movable coil slider. For cooling for a movable magnet plate, the IC code is "0A0".

*5 Primary coolant for forced cooling (coolant for directly cooling the coil slider).

*6 Maximum magnetic attraction between the coil slider and the magnet plate.

*7 When an incremental linear encoder is used, the weight of the magnetic pole sensor is added. For details, see the subsection "Magnetic Pole Sensor" below.

*8 The type of applicable magnet plate differs depending on the motor model. For details, see the subsection "Magnet Plate" below.

*9 Can be driven by 400 V input (FANUC HV amplifier). The values in parentheses in the table indicate data when the motor is driven with 400 V. Drive parameters dedicated to 400 V are required.
2.3 FORCE-VERSUS-SPEED DIAGRAMS AND OUTPUT-VERSUS-SPEED DIAGRAMS

**LïS 300A1/4 (A06B-0441-B200#0000)**

- **Force-Versus-Speed Diagram**
  - Maximum force
  - Water cooling
  - Air cooling
  - No cooling
- **Output-Versus-Speed Diagram**
  - Maximum output
  - Water cooling
  - Air cooling
  - No cooling

**LïS 600A1/4 (A06B-0442-B200#0000)**

- **Force-Versus-Speed Diagram**
  - Maximum force
  - Water cooling
  - Air cooling
  - No cooling
- **Output-Versus-Speed Diagram**
  - Maximum output
  - Water cooling
  - Air cooling
  - No cooling

**LïS 900A1/4 (A06B-0443-B200#0000)**

- **Force-Versus-Speed Diagram**
  - Maximum force
  - Water cooling
  - Air cooling
  - No cooling
- **Output-Versus-Speed Diagram**
  - Maximum output
  - Water cooling
  - Air cooling
  - No cooling

**NOTE**

1. Data obtained when the motor is driven with 200 V is indicated unless the voltage is indicated.
2. The maximum output indicates the rated maximum output and is not data for PSM selection. For PSM selection, see Part II, "CONFIGURATIONS AND SELECTION."
**Lis 1500B1/4 (A06B-0444-B210#0000)**

![Graph of Lis 1500B1/4 showing force vs. speed and output vs. speed with cooling options.]

**Lis 3000B2/2 (A06B-0445-B110#0000)**

![Graph of Lis 3000B2/2 showing force vs. speed and output vs. speed with cooling options.]

**Lis 3000B2/4 (A06B-0445-B210#0000)**

![Graph of Lis 3000B2/4 showing force vs. speed and output vs. speed with cooling options.]

**Lis 3000B2/2 (A06B-0445-B110#0000 driven with 400 V)**

![Graph of Lis 3000B2/2 driven with 400 V showing force vs. speed and output vs. speed with cooling options.]

**NOTE**

1. Data obtained when the motor is driven with 200 V is indicated unless the voltage is indicated.
2. The maximum output indicates the rated maximum output and is not data for PSM selection. For PSM selection, see Part II, "CONFIGURATIONS AND SELECTION."
LiS 4500B2/2HV (A06B-0446-B010#0000 driven with 400 V)
LiS 4500B2/2 (A06B-0446-B110#0000)

![Graph showing force vs. speed for LiS 4500B2/2HV and LiS 4500B2/2.]

LiS 4500B2/2 (A06B-0446-B110#0000 driven with 400 V)

![Graph showing force vs. speed for LiS 4500B2/2.]

LiS 6000B2/2HV (A06B-0447-B010#0000 driven with 400 V)
LiS 6000B2/2 (A06B-0447-B110#0000)

![Graph showing force vs. speed for LiS 6000B2/2HV and LiS 6000B2/2.]

NOTE
1. Data obtained when the motor is driven with 200 V is indicated unless the voltage is indicated.
2. The maximum output indicates the rated maximum output and is not data for PSM selection. For PSM selection, see Part II, "CONFIGURATIONS AND SELECTION."
LiŚ 6000B2/4 (A06B-0447-B210#0000)
LiŚ 6000B2/2 (A06B-0447-B110#0000 driven with 400 V)

LiŚ 7500B2/2HV (A06B-0448-B010#0000 driven with 400 V)
LiŚ 7500B2/2 (A06B-0448-B110#0000)

LiŚ 7500B2/2 (A06B-0448-B110#0000 driven with 400 V)

NOTE
1 Data obtained when the motor is driven with 200 V is indicated unless the voltage is indicated.
2 The maximum output indicates the rated maximum output and is not data for PSM selection. For PSM selection, see Part II, "CONFIGURATIONS AND SELECTION."
**NOTE**

1. Data obtained when the motor is driven with 200 V is indicated unless the voltage is indicated.
2. The maximum output indicates the rated maximum output and is not data for PSM selection. For PSM selection, see Part II, "CONFIGURATIONS AND SELECTION."
**LíS 3300C1/2 (A06B-0451-B110#0000 driven with 400 V)**

![Graph showing force vs. speed for LíS 3300C1/2](image)

**LíS 9000C2/2HV (A06B-0454-B010#0000 driven with 400 V)**

![Graph showing force vs. speed for LíS 9000C2/2HV](image)

**LíS 9000C2/2 (A06B-0454-B110#0000)**

![Graph showing force vs. speed for LíS 9000C2/2](image)

**NOTE**

1. Data obtained when the motor is driven with 200 V is indicated unless the voltage is indicated.
2. The maximum output indicates the rated maximum output and is not data for PSM selection. For PSM selection, see Part II, "CONFIGURATIONS AND SELECTION."
**LiS 9000C2/2 (A06B-0454-B110#0000 driven with 400 V)**

- **Maximum force**
  - Water cooling
  - Air cooling
  - No cooling

- **Output (kW)**
  - Water cooling
  - Air cooling
  - No cooling

**LiS 11000C2/2HV (A06B-0455-B010#0000 driven with 400 V)**

- **Maximum force**
  - Water cooling
  - Air cooling
  - No cooling

- **Output (kW)**
  - Water cooling
  - Air cooling
  - No cooling

**LiS 11000C2/2 (A06B-0455-B110#0000)**

- **Maximum force**
  - Water cooling
  - Air cooling
  - No cooling

- **Output (kW)**
  - Water cooling
  - Air cooling
  - No cooling

**NOTE**

1. Data obtained when the motor is driven with 200 V is indicated unless the voltage is indicated.
2. The maximum output indicates the rated maximum output and is not data for PSM selection. For PSM selection, see "POWER SUPPLY MODULE (PSM) SELECTION."
LiS 11000C2/2 (A06B-0455-B110#0000 driven with 400 V)

LiS 15000C2/3HV (A06B-0456-B010#0000 driven with 400 V)
LiS 15000C2/3 (A06B-0456-B210#0000)

NOTE
1 Data obtained when the motor is driven with 200 V is indicated unless the voltage is indicated.
2 The maximum output indicates the rated maximum output and is not data for PSM selection. For PSM selection, see "POWER SUPPLY MODULE (PSM) SELECTION."
**LîS 15000C2/2 (A06B-0456-B110#0000 driven with 400 V)**

![Graph showing force and speed for LîS 15000C2/2](image)

**LîS 10000C3/2HV (A06B-0457-B010#0000 driven with 400 V)**

![Graph showing force and speed for LîS 10000C3/2HV](image)

**LîS 10000C3/2 (A06B-0457-B110#0000)**

![Graph showing force and speed for LîS 10000C3/2](image)

**NOTE**

1. Data obtained when the motor is driven with 200 V is indicated unless the voltage is indicated.

2. The maximum output indicates the rated maximum output and is not data for PSM selection. For PSM selection, see Part II, "CONFIGURATIONS AND SELECTION."
Lis 17000C3/2HV (A06B-0459-B010#0000 driven with 400 V)
Lis 17000C3/2 (A06B-0459-B110#0000)

![Graphs showing force and output vs. speed for Lis 17000C3/2HV and Lis 17000C3/2 with different cooling methods.]

**NOTE**
1. Data obtained when the motor is driven with 200 V is indicated unless the voltage is indicated.
2. The maximum output indicates the rated maximum output and is not data for PSM selection. For PSM selection, see Part II, "CONFIGURATIONS AND SELECTION."
2.4 EXTERNAL DIMENSIONS

2.4.1 Coil Slider

LiS 300A1/4 (A06B-0441-B200#0000)

<table>
<thead>
<tr>
<th>Line type</th>
<th>Sheath color</th>
<th>Conductor cross section (mm²)</th>
<th>Average outside diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power line (U phase)</td>
<td>Red</td>
<td>2.0</td>
<td>2.6</td>
</tr>
<tr>
<td>Power line (V phase)</td>
<td>White</td>
<td>2.0</td>
<td>2.6</td>
</tr>
<tr>
<td>Power line (W phase)</td>
<td>Black</td>
<td>2.0</td>
<td>2.6</td>
</tr>
<tr>
<td>Power line (ground)</td>
<td>Green / Yellow</td>
<td>2.0</td>
<td>2.6</td>
</tr>
<tr>
<td>Thermostat line 1</td>
<td>Black</td>
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</tr>
<tr>
<td>Thermostat line 2</td>
<td>Black</td>
<td>0.35</td>
<td>1.28</td>
</tr>
</tbody>
</table>

* The power and thermostat lines are about 350 mm long.
* No crimp terminal is supplied with any power or thermostat line.
* The thermostat lines are nonpolarized.

NOTE
1. To bring a corner of the coil slider into intimate contact with a peripheral part, recess the corner of the part by 0.2 to 0.3.
2. This drawing contains no magnetic pole sensor. To use an incremental linear encoder, a magnetic pole sensor is required. For the outline drawings of magnetic pole sensors, see the subsection “Magnetic Pole Sensor” below.
3. Always read and understand Part III, “HANDLING, DESIGN, AND ASSEMBLY,” before handling or installing the motor.
### LiS 600A1/4 (A06B-0442-B200#0000)

#### POWER LINE, THERMOSTAT LINE

<table>
<thead>
<tr>
<th>Line type</th>
<th>Sheath color</th>
<th>Conductor cross section (mm²)</th>
<th>Average outside diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power line (U phase)</td>
<td>Red</td>
<td>2.0</td>
<td>2.6</td>
</tr>
<tr>
<td>Power line (V phase)</td>
<td>White</td>
<td>2.0</td>
<td>2.6</td>
</tr>
<tr>
<td>Power line (W phase)</td>
<td>Black</td>
<td>2.0</td>
<td>2.6</td>
</tr>
<tr>
<td>Power line (ground)</td>
<td>Green / Yellow</td>
<td>2.0</td>
<td>2.6</td>
</tr>
<tr>
<td>Thermostat line 1</td>
<td>Black</td>
<td>0.35</td>
<td>1.28</td>
</tr>
<tr>
<td>Thermostat line 2</td>
<td>Black</td>
<td>0.35</td>
<td>1.28</td>
</tr>
</tbody>
</table>

* The power and thermostat lines are about 350 mm long.
* No crimp terminal is supplied with any power or thermostat line.
* The thermostat lines are nonpolarized.

### NOTE
1. To bring a corner of the coil slider into intimate contact with a peripheral part, recess the corner of the part by 0.2 to 0.3.
2. This drawing contains no magnetic pole sensor. To use an incremental linear encoder, a magnetic pole sensor is required. For the outline drawings of magnetic pole sensors, see the subsection "Magnetic Pole Sensor" below.
3. Always read and understand Part III, “HANDLING, DESIGN, AND ASSEMBLY,” before handling or installing the motor.
**LiS 900A1/4 (A06B-0443-B200#0000)**

**POWER LINE, THERMOSTAT LINE**

**DETAILS OF TAPPED HOLE**

<table>
<thead>
<tr>
<th>Line type</th>
<th>Sheath color</th>
<th>Conductor cross section (mm²)</th>
<th>Average outside diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power line (U phase)</td>
<td>Red</td>
<td>2.0</td>
<td>2.6</td>
</tr>
<tr>
<td>Power line (V phase)</td>
<td>White</td>
<td>2.0</td>
<td>2.6</td>
</tr>
<tr>
<td>Power line (W phase)</td>
<td>Black</td>
<td>2.0</td>
<td>2.6</td>
</tr>
<tr>
<td>Power line (ground)</td>
<td>Green / Yellow</td>
<td>2.0</td>
<td>2.6</td>
</tr>
<tr>
<td>Thermostat line 1</td>
<td>Black</td>
<td>0.35</td>
<td>1.28</td>
</tr>
<tr>
<td>Thermostat line 2</td>
<td>Black</td>
<td>0.35</td>
<td>1.28</td>
</tr>
</tbody>
</table>

* The power and thermostat lines are about 350 mm long.
* No crimp terminal is supplied with any power or thermostat line.
* The thermostat lines are nonpolarized.

**NOTE**

1. To bring a corner of the coil slider into intimate contact with a peripheral part, recess the corner of the part by 0.2 to 0.3.
2. This drawing contains no magnetic pole sensor. To use an incremental linear encoder, a magnetic pole sensor is required. For the outline drawings of magnetic pole sensors, see the subsection “Magnetic Pole Sensor” below.
3. Always read and understand Part III, “HANDLING, DESIGN, AND ASSEMBLY,” before handling or installing the motor.
LiS 1500B1/4 (A06B-0444-B210#0000)

Cooling tube: Deoxidized copper phosphorus seamless tube.
Outside diameter: 8 mm, Wall thickness: 0.8 mm

NOTE
1 To bring a corner of the coil slider into intimate contact with a peripheral part, recess the corner of the part by 0.2 to 0.3.
2 This drawing contains no magnetic pole sensor. To use an incremental linear encoder, a magnetic pole sensor is required. For the outline drawings of magnetic pole sensors, see the subsection “Magnetic Pole Sensor” below.
3 Always read and understand Part III, “HANDLING, DESIGN, AND ASSEMBLY,” before handling or installing the motor.
**NOTE**

1. To bring a corner of the coil slider into intimate contact with a peripheral part, recess the corner of the part by 0.2 to 0.3.

2. This slider contains a terminal for connecting power lines and a connector for connecting a thermostat. For details, see Part III, “HANDLING, DESIGN, AND ASSEMBLY.”

3. This drawing contains a magnetic pole sensor. When an absolute linear encoder is used, the magnetic pole sensor is not required.

4. Always read and understand Part III, “HANDLING, DESIGN, AND ASSEMBLY,” before handling or installing the motor.
**NOTE**

1. To bring a corner of the coil slider into intimate contact with a peripheral part, recess the corner of the part by 0.2 to 0.3.

2. This slider contains a terminal for connecting power lines and a connector for connecting a thermostat. For details, see Part III, "HANDLING, DESIGN, AND ASSEMBLY."

3. This drawing contains a magnetic pole sensor. When an absolute linear encoder is used, the magnetic pole sensor is not required.

4. Always read and understand Part III, "HANDLING, DESIGN, AND ASSEMBLY," before handling or installing the motor.
**NOTE**

1. To bring a corner of the coil slider into intimate contact with a peripheral part, recess the corner of the part by 0.2 to 0.3.

2. This slider contains a terminal for connecting power lines and a connector for connecting a thermostat. For details, see Part III, “HANDLING, DESIGN, AND ASSEMBLY.”

3. This drawing contains a magnetic pole sensor. When an absolute linear encoder is used, the magnetic pole sensor is not required.

4. Always read and understand Part III, “HANDLING, DESIGN, AND ASSEMBLY,” before handling or installing the motor.
**NOTE**

1. To bring a corner of the coil slider into intimate contact with a peripheral part, recess the corner of the part by 0.2 to 0.3.

2. This slider contains a terminal for connecting power lines and a connector for connecting a thermostat. For details, see Part III, "HANDLING, DESIGN, AND ASSEMBLY."

3. This drawing contains a magnetic pole sensor. When an absolute linear encoder is used, the magnetic pole sensor is not required.

4. Always read and understand Part III, "HANDLING, DESIGN, AND ASSEMBLY," before handling or installing the motor.
**NOTE**

1. To bring a corner of the coil slider into intimate contact with a peripheral part, recess the corner of the part by 0.2 to 0.3.

2. This slider contains a terminal for connecting power lines and a connector for connecting a thermostat. For details, see Part III, “HANDLING, DESIGN, AND ASSEMBLY.”

3. This drawing contains a magnetic pole sensor. When an absolute linear encoder is used, the magnetic pole sensor is not required.

4. Always read and understand Part III, “HANDLING, DESIGN, AND ASSEMBLY,” before handling or installing the motor.

**LiS 9000B2/2 (A06B-0449-B110#0000)  
LiS 9000B2/4 (A06B-0449-B210#0000)**
NOTE
1 To bring a corner of the coil slider into intimate contact with a peripheral part, recess the corner of the part by 0.2 to 0.3.
2 This slider contains a terminal for connecting power lines and a connector for connecting a thermostat. For details, see Part III, “HANDLING, DESIGN, AND ASSEMBLY.”
3 This drawing contains no magnetic pole sensor. To use an incremental linear encoder, a magnetic pole sensor is required. For the outline drawings of magnetic pole sensors, see the subsection “Magnetic Pole Sensor” below.
4 Always read and understand Part III, “HANDLING, DESIGN, AND ASSEMBLY,” before handling or installing the motor.
**Lis 9000C2/2HV (A06B-0454-B010#0000)**

**Lis 9000C2/2 (A06B-0454-B110#0000)**

**NOTE**

1. To bring a corner of the coil slider into intimate contact with a peripheral part, recess the corner of the part by 0.2 to 0.3.
2. This slider contains a terminal for connecting power lines and a connector for connecting a thermostat. For details, see Part III, “HANDLING, DESIGN, AND ASSEMBLY.”
3. This drawing contains a magnetic pole sensor. When an absolute linear encoder is used, the magnetic pole sensor is not required.
4. Always read and understand Part III, “HANDLING, DESIGN, AND ASSEMBLY,” before handling or installing the motor.
NOTE

1. To bring a corner of the coil slider into intimate contact with a peripheral part, recess the corner of the part by 0.2 to 0.3.

2. This slider contains a terminal for connecting power lines and a connector for connecting a thermostat. For details, see Part III, “HANDLING, DESIGN, AND ASSEMBLY.”

3. This drawing contains a magnetic pole sensor. When an absolute linear encoder is used, the magnetic pole sensor is not required.

4. Always read and understand Part III, “HANDLING, DESIGN, AND ASSEMBLY,” before handling or installing the motor.
**NOTE**

1. To bring a corner of the coil slider into intimate contact with a peripheral part, recess the corner of the part by 0.2 to 0.3.

2. This slider contains a terminal for connecting power lines and a connector for connecting a thermostat. For details, see Part III, “HANDLING, DESIGN, AND ASSEMBLY.”

3. This drawing contains a magnetic pole sensor. When an absolute linear encoder is used, the magnetic pole sensor is not required.

4. Always read and understand Part III, “HANDLING, DESIGN, AND ASSEMBLY,” before handling or installing the motor.
**NOTE**

1. To bring a corner of the coil slider into intimate contact with a peripheral part, recess the corner of the part by 0.2 to 0.3.

2. This slider contains a terminal for connecting power lines and a connector for connecting a thermostat. For details, see Part III, “HANDLING, DESIGN, AND ASSEMBLY.”

3. This drawing contains a magnetic pole sensor. When an absolute linear encoder is used, the magnetic pole sensor is not required.

4. Always read and understand Part III, “HANDLING, DESIGN, AND ASSEMBLY,” before handling or installing the motor.
Li’S 10000C3/2HV (A06B-0457-B010#0000)
Li’S 10000C3/2 (A06B-0457-B110#0000)

**NOTE**

1. To bring a corner of the coil slider into intimate contact with a peripheral part, recess the corner of the part by 0.2 to 0.3.
2. This slider contains a terminal for connecting power lines and a connector for connecting a thermostat. For details, see Part III, “HANDLING, DESIGN, AND ASSEMBLY.”
3. This drawing contains a magnetic pole sensor. When an absolute linear encoder is used, the magnetic pole sensor is not required.
4. Always read and understand Part III, “HANDLING, DESIGN, AND ASSEMBLY,” before handling or installing the motor.
2. SPECIFICATIONS

**LIS 17000C2/2HV (A06B-0459-B010#0000)**

- **COIL SLIDER**
- **MAGNET**
- **PLATE**
- **MAGNETIC POLE SENSOR**
- **COOLING TUBE**
- **REGULAR HEXAGON OUTSIDE SHAPE, WIDTHS ACROSS FLATS 17 mm**
- **M8X1.25**

**NOTE**

1. To bring a corner of the coil slider into intimate contact with a peripheral part, recess the corner of the part by 0.2 to 0.3.

2. This slider contains a terminal for connecting power lines and a connector for connecting a thermostat. For details, see Part III, “HANDLING, DESIGN, AND ASSEMBLY.”

3. This drawing contains a magnetic pole sensor. When an absolute linear encoder is used, the magnetic pole sensor is not required.

4. Always read and understand Part III, “HANDLING, DESIGN, AND ASSEMBLY,” before handling or installing the motor.
**NOTE**

1. To bring a corner of the coil slider into intimate contact with a peripheral part, recess the corner of the part by 0.2 to 0.3.
2. This slider contains a terminal for connecting power lines and a connector for connecting a thermostat. For details, see Part III, “HANDLING, DESIGN, AND ASSEMBLY.”
3. This drawing contains a magnetic pole sensor. When an absolute linear encoder is used, the magnetic pole sensor is not required.
4. Always read and understand Part III, “HANDLING, DESIGN, AND ASSEMBLY,” before handling or installing the motor.
Thermostat connector (LîS 1500B1/4~ <standard accessory>)

NOTE
1 This connector is supplied with the coil slider. It is not supplied with LîS 300A1/4, LîS 600A1/4, and LîS 900A1/4.
2 The reference dimension, 55, is enclosed in parentheses. The actual dimension may differ from the reference dimension by about 1 to 2 mm.
3 If the thermostat cable is bent at a distance of up to 55 mm from the connector, the connector may not deliver dripproof performance.
4 To ensure appropriate waterproof performance, use an appropriate cable. For details of applicable cables, see Part III, "HANDLING, DESIGN, AND ASSEMBLY."
2.4.2 Magnet Plate (Standard Type)

**WARNING**
Mishandling a magnet plate may be highly dangerous, resulting in a fatal accident. Read and thoroughly understand Part III, "HANDLING, DESIGN, AND ASSEMBLY," before handling the magnet plate and strictly observe the cautions when handling it.

For LiS 300A1/4, LiS 600A1/4, LiS 900A1/4 (Magnet plate A1)

A06B-0440-B111#0000 (Length 30mm)
A06B-0440-B113#0000 (Length 120mm)

**NOTE**
1. These magnet plates are dedicated to the LiS 300A1/4, LiS 600A1/4, and LiS 900A1/4. They cannot be used for other models. Use the above two types of magnet plates in combination according to the required axis length (track length).
2. A white marking is made on the surface (black resin side) at the N-pole end of each magnet plate above. (Marked with a circle in the above drawing.)
2. SPECIFICATIONS

For LİS 1500B1 (Magnet plate B1)

- A06B-0440-B212#0000 (Length 60mm)
- A06B-0440-B214#0000 (Length 240mm)
- A06B-0440-B215#0000 (Length 420mm)
- A06B-0440-B217#0000 (Length 600mm)
- A06B-0440-B218#0000 (Length 960mm)

**NOTE**

These magnet plates are dedicated to the LİS 1500B1/4. They cannot be used for other models. Use the above five types of magnet plates in combination according to the required axis length (track length).
(Magnet plate B2)

A06B-0440-B222#0000 (Length 60mm)
A06B-0440-B224#0000 (Length 240mm)
A06B-0440-B225#0000 (Length 420mm)
A06B-0440-B227#0000 (Length 600mm)
A06B-0440-B228#0000 (Length 960mm)

<table>
<thead>
<tr>
<th>Length: L(mm)</th>
<th>Length: L1(mm)</th>
<th>Number of through holes: A (places)</th>
<th>Mass (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>239</td>
<td>180</td>
<td>9</td>
<td>4.5</td>
</tr>
<tr>
<td>419</td>
<td>360</td>
<td>15</td>
<td>8</td>
</tr>
<tr>
<td>599</td>
<td>540</td>
<td>21</td>
<td>11.5</td>
</tr>
<tr>
<td>959</td>
<td>900</td>
<td>33</td>
<td>18</td>
</tr>
</tbody>
</table>

**NOTE**

These magnet plates are dedicated to the
For LīS 3300C1 (Magnet plate C1)

A06B-0440-B312#0000 (Length 60mm)
A06B-0440-B314#0000 (Length 240mm)
A06B-0440-B315#0000 (Length 420mm)
A06B-0440-B317#0000 (Length 600mm)
A06B-0440-B318#0000 (Length 960mm)

<table>
<thead>
<tr>
<th>Length: L(mm)</th>
<th>Length: L1(mm)</th>
<th>Number of through holes: A (places)</th>
<th>Mass (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B314</td>
<td>239</td>
<td>180</td>
<td>6</td>
</tr>
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<td></td>
<td>2.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B315</td>
<td>419</td>
<td>360</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>4.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B317</td>
<td>599</td>
<td>540</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>6.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B318</td>
<td>959</td>
<td>900</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTE
These magnet plates are dedicated to the LīS 3300C1/2. They cannot be used for other models. Use the above five types of magnet plates in combination according to the required axis length (track length).
For LiS 9000C2, LiS 11000C2, and LiS 15000C2 (Magnet plate C2)

A06B-0440-B324#0000 (Length 240mm)
A06B-0440-B325#0000 (Length 420mm)
A06B-0440-B327#0000 (Length 600mm)
A06B-0440-B328#0000 (Length 960mm)

<table>
<thead>
<tr>
<th></th>
<th>Length: L(mm)</th>
<th>Length: L1(mm)</th>
<th>Number of through holes: A (places)</th>
<th>Mass (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B324</td>
<td>239</td>
<td>180</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>B325</td>
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<td>360</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>B327</td>
<td>599</td>
<td>540</td>
<td>21</td>
<td>15</td>
</tr>
<tr>
<td>B328</td>
<td>959</td>
<td>900</td>
<td>33</td>
<td>23</td>
</tr>
</tbody>
</table>

NOTE
These magnet plates are dedicated to the LiS 9000C2/2HV, LiS 9000C2/2,
LiS 11000C2/2HV, LiS 11000C2/2,
LiS 15000C2/2, and LiS 15000C2/3,
LiS 15000C2/3HV. They cannot be used for other models. Use the above four types of magnet plates in combination according to the required axis length (track length).
For \( \text{LiS 10000C3 and LiS 17000C3 (Magnet plate C3)} \)

A06B-0440-B333#0000 (Length 120mm)
A06B-0440-B334#0000 (Length 240mm)
A06B-0440-B335#0000 (Length 420mm)
A06B-0440-B337#0000 (Length 600mm)

**NOTE**

These magnet plates are dedicated to the 
\( \text{LiS 10000C3/2HV, LiS 10000C3/2,}
\text{ LiS 17000C3/2HV, and LiS 17000C3/2. They}
\text{ cannot be used for other models. Use the above}
\text{ four types of magnet plates in combination}
\text{ according to the required axis length (track length).} \)
2.4.3 Magnet Plate (with Protection Cover)

<table>
<thead>
<tr>
<th>Magnet plate type</th>
<th>Magnet plate specification No. (with protection cover)</th>
<th>Magnet plate specification No. (*1) (without protection cover)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>A06B-0440-B21x#0001</td>
<td>A06B-0440-B21x#0002</td>
</tr>
<tr>
<td>B2</td>
<td>A06B-0440-B22x#0001</td>
<td>A06B-0440-B22x#0002</td>
</tr>
<tr>
<td>C1</td>
<td>A06B-0440-B31x#0001</td>
<td>A06B-0440-B31x#0002</td>
</tr>
<tr>
<td>C2</td>
<td>A06B-0440-B32x#0001</td>
<td>A06B-0440-B32x#0002</td>
</tr>
<tr>
<td>C3</td>
<td>A06B-0440-B33x#0001</td>
<td>A06B-0440-B33x#0002</td>
</tr>
</tbody>
</table>

(*1) Since this magnet plate is used in conjunction with the magnet plate protection sheet (optional), the magnet plate cannot be ordered alone.

For the FANUC Linear Motor LİS series, the magnet plate with a protection cover and the magnet plate protection sheet (optional) can be ordered to protect the magnet plate.

⚠️ WARNING
Mishandling a magnet plate may be highly dangerous, resulting in a fatal accident. Read and thoroughly understand Part III, "HANDLING, DESIGN, AND ASSEMBLY," before handling the magnet plate and strictly observe the cautions when handling it.
For Lis 1500B1 (Magnet plate B1)

A06B-0440-B212#000x (Length 60mm)

**MARKING "N" (ONLY ON THIS SIDE)**

2 M3×0.5, DEPTH: 7

**DATUM PLANE**

2: 8.5-DIA THROUGH HOLE COUNTERBORE, DEPTH: 9

**WITH COVER ATTACHED**

HEXAGONAL-HEAD BOLT WITH WASHER

STAINLESS COVER

NOTE) The screws (M3 x 0.5) must be tightened with a torque of 0.6 Nm.

**STAINLESS COVER**

**MARKING "N" (ONLY ON THIS SIDE)**

2 M3×0.5, DEPTH: 7

**DATUM PLANE**

2: 8.5-DIA THROUGH HOLE COUNTERBORE, DEPTH: 9

MASS : 0.6Kg
A06B-0440-B214#000x (Length 240mm)  
A06B-0440-B215#000x (Length 420mm)  
A06B-0440-B217#000x (Length 600mm)  
A06B-0440-B218#000x (Length 960mm)

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
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<tbody>
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<td>B214</td>
<td>239</td>
<td>180</td>
<td>-</td>
<td>210</td>
<td>6</td>
<td>4</td>
<td>2.5</td>
</tr>
<tr>
<td>B215</td>
<td>419</td>
<td>360</td>
<td>-</td>
<td>390</td>
<td>10</td>
<td>4</td>
<td>4.5</td>
</tr>
<tr>
<td>B217</td>
<td>599</td>
<td>540</td>
<td>270</td>
<td>570</td>
<td>14</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>B218</td>
<td>959</td>
<td>900</td>
<td>450</td>
<td>930</td>
<td>22</td>
<td>6</td>
<td>10</td>
</tr>
</tbody>
</table>

NOTE
These magnet plates are dedicated to the LiS 1500B1/4. They cannot be used for other models. Use the above five types of magnet plates in combination according to the required axis length (track length).

A06B-0440-B222#000x (Length 60mm)

NOTE) The screws (M3 x 0.5) must be tightened with a torque of 0.6 Nm.
A06B-0440-B224#000x (Length 240mm)
A06B-0440-B225#000x (Length 420mm)
A06B-0440-B227#000x (Length 600mm)
A06B-0440-B228#000x (Length 960mm)

<table>
<thead>
<tr>
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<th></th>
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<td>239</td>
<td>180</td>
<td>-</td>
<td>210</td>
<td>9</td>
<td>4</td>
<td>4.5</td>
</tr>
<tr>
<td>B225</td>
<td>419</td>
<td>360</td>
<td>-</td>
<td>390</td>
<td>15</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>B227</td>
<td>599</td>
<td>540</td>
<td>270</td>
<td>570</td>
<td>21</td>
<td>6</td>
<td>11.5</td>
</tr>
<tr>
<td>B228</td>
<td>959</td>
<td>900</td>
<td>450</td>
<td>930</td>
<td>33</td>
<td>6</td>
<td>18</td>
</tr>
</tbody>
</table>

NOTE
For LIS 3300C1 (Magnet plate C1) A06B-0440-B312#000x (Length 60mm)

MARKING "N" (ONLY ON THIS SIDE)

2 - 8.5-DIA THROUGH 14-DIA COUNTERBORE, DEPTH: 9

DATUM PLANE

2-M3×0.5, DEPTH: 7

MASS : 0.75Kg

NOTE) The screws (M3 x 0.5) must be tightened with a torque of 0.6 Nm.

STAINLESS COVER

HEXAGONAL-HEAD BOLT WITH WASHER

WITH COVER ATTACHED
A06B-0440-B314#000x (Length 240mm)
A06B-0440-B315#000x (Length 420mm)
A06B-0440-B317#000x (Length 600mm)
A06B-0440-B318#000x (Length 960mm)

<table>
<thead>
<tr>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td>B314</td>
<td>239</td>
<td>180</td>
<td>-</td>
<td>210</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>B315</td>
<td>419</td>
<td>360</td>
<td>-</td>
<td>390</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>B317</td>
<td>599</td>
<td>540</td>
<td>270</td>
<td>570</td>
<td>14</td>
<td>7.5</td>
</tr>
<tr>
<td>B318</td>
<td>959</td>
<td>900</td>
<td>450</td>
<td>930</td>
<td>22</td>
<td>12</td>
</tr>
</tbody>
</table>

NOTE: These magnet plates are dedicated to the LıS 3300C1/2. They cannot be used for other models. Use the above five types of magnet plates in combination according to the required axis length (track length).
For **LiS 9000C2**, **LiS 11000C2**, and **LiS 15000C2** (Magnet plate C2)

A06B-0440-B324#000x (Length 240mm)
A06B-0440-B325#000x (Length 420mm)
A06B-0440-B327#000x (Length 600mm)
A06B-0440-B328#000x (Length 960mm)

**NOTE**

These magnet plates are dedicated to the
**LiS 9000C2/2HV**, **LiS 9000C2/2**,  
**LiS 11000C2/2HV**, **LiS 11000C2/2**,  
**LiS 15000C2/2**, and **LiS 15000C2/3**, 
**LiS 15000C2/3HV**. They cannot be used for other models. Use the above four types of magnet plates in combination according to the required axis length (track length).
For LiS 10000C3 and LiS 17000C3 (Magnet plate C3)

A06B-0440-B333#000x (Length 120mm)

MARKING "N" (ONLY ON THIS SIDE)

2-M3×0.5, DEPTH: 7

MASS : 4.3Kg

NOTE: The screws (M3 x 0.5) must be tightened with a torque of 0.6 Nm.
### SPECIFICATIONS

**A06B-0440-B334#000x (Length 240mm)**
**A06B-0440-B335#000x (Length 420mm)**
**A06B-0440-B337#000x (Length 600mm)**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>B334</td>
<td>239</td>
<td>180</td>
<td>-</td>
<td>210</td>
<td>12</td>
<td>8.5</td>
</tr>
<tr>
<td>B335</td>
<td>419</td>
<td>360</td>
<td>-</td>
<td>390</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>B337</td>
<td>599</td>
<td>540</td>
<td>270</td>
<td>570</td>
<td>28</td>
<td>21.5</td>
</tr>
</tbody>
</table>

**NOTE**

These magnet plates are dedicated to the
LïS 10000C3/2HV, LïS 10000C3/2,
LïS 17000C3/2HV, and LïS 17000C3/2. They cannot be used for other models. Use the above four types of magnet plates in combination according to the required axis length (track length).
2.4.4 Magnet Plate Protection Sheet (Optional)

You can order one of three types of magnet plate protection sheets with different lengths according to the type of a magnet plate. You can freely cut and tailor the plain sheet provided by us to the desired size for attaching it to the machine.

<table>
<thead>
<tr>
<th>Magnet plate type</th>
<th>Specification number</th>
<th>Width (mm)</th>
<th>Length (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>A06B-0440-K710#x200</td>
<td>98</td>
<td>2000</td>
</tr>
<tr>
<td></td>
<td>A06B-0440-K710#x250</td>
<td>98</td>
<td>2500</td>
</tr>
<tr>
<td></td>
<td>A06B-0440-K710#x300</td>
<td>98</td>
<td>3000</td>
</tr>
<tr>
<td>B2</td>
<td>A06B-0440-K720#x200</td>
<td>178</td>
<td>2000</td>
</tr>
<tr>
<td></td>
<td>A06B-0440-K720#x250</td>
<td>178</td>
<td>2500</td>
</tr>
<tr>
<td></td>
<td>A06B-0440-K720#x300</td>
<td>178</td>
<td>3000</td>
</tr>
<tr>
<td>C1</td>
<td>A06B-0440-K730#x200</td>
<td>123</td>
<td>2000</td>
</tr>
<tr>
<td></td>
<td>A06B-0440-K730#x250</td>
<td>123</td>
<td>2500</td>
</tr>
<tr>
<td></td>
<td>A06B-0440-K730#x300</td>
<td>123</td>
<td>3000</td>
</tr>
<tr>
<td>C2</td>
<td>A06B-0440-K740#x200</td>
<td>228</td>
<td>2000</td>
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<tr>
<td></td>
<td>A06B-0440-K740#x250</td>
<td>228</td>
<td>2500</td>
</tr>
<tr>
<td></td>
<td>A06B-0440-K740#x300</td>
<td>228</td>
<td>3000</td>
</tr>
<tr>
<td>C3</td>
<td>A06B-0440-K750#x200</td>
<td>331</td>
<td>2000</td>
</tr>
<tr>
<td></td>
<td>A06B-0440-K750#x250</td>
<td>331</td>
<td>2500</td>
</tr>
<tr>
<td></td>
<td>A06B-0440-K750#x300</td>
<td>331</td>
<td>3000</td>
</tr>
</tbody>
</table>

The character x in the specification number indicates the number of sheets.
0: One sheet
A: Ten sheets

(Example)
A06B-0440-K710#0200:
One sheet with a width of 98 mm and a length of 2000 mm
A06B-0440-K710#A200:
Ten sheets with a width of 98 mm and a length of 2000 mm
2.4.5 Cooling Plate

For LİS 300A1/4 (A06B-0423-K001)

Material:
Plate: Aluminum
Tube: Deoxidized copper phosphorus seamless tube. Outside diameter: 6.35 mm (1/4 inches) Wall thickness: 0.6 mm
Mass: 0.15 kg

NOTE
This cooling plate is dedicated to the LİS 300A1/4. It cannot be used for other models. For installation of a cooling plate, see Part III, "HANDLING, DESIGN, AND ASSEMBLY."

For LİS 600A1/4 (A06B-0423-K002)

Material:
Plate: Aluminum
Tube: Deoxidized copper phosphorus seamless tube. Outside diameter: 6.35 mm (1/4 inches) Wall thickness: 0.6 mm
Mass: 0.2 kg

NOTE
This cooling plate is dedicated to the LİS 600A1/4. It cannot be used for other models. For installation of a cooling plate, see Part III, "HANDLING, DESIGN, AND ASSEMBLY."
For LiS 900A1/4 (A06B-0423-K003)

Material:
Plate: Aluminum
Tube: Deoxidized copper phosphorus seamless tube. Outside diameter: 6.35 mm (1/4 inches) Wall thickness: 0.6 mm
Mass: 0.25 kg

NOTE
This cooling plate is dedicated to the LiS 900A1/4. It cannot be used for other models. For installation of a cooling plate, see Part III, "HANDLING, DESIGN, AND ASSEMBLY."

Spacer (common to the A06B-0423-K001, A06B-0423-K002, and A06B-0423-K003)
A cooling plate is supplied with two spacers of this type. To use a magnetic pole sensor (that is, to use an incremental linear encoder) for the LiS 300A1/4, LiS 600A1/4, or LiS 900A1/4, mount these spacers on the magnetic pole sensor. They are not used when an absolute linear encoder is used. For details, see Part III, "HANDLING, DESIGN, AND ASSEMBLY."

Material: Alminium
2.4.6 Magnetic Pole Sensor

NOTE
To use an incremental linear encoder, a magnetic pole sensor is required. A position detection circuit described in the following subsection is also required. When an absolute linear encoder is used, neither is required.


Mass: 0.15 kg (body only, not including the cable)

NOTE
A cable 4 m long is directly connected. If the cable is too long, form loops in the cable or cut it.
For LiS 1500B1/4 to LiS 17000C3/2 (A860-0331-T001)

Mass: 0.12 kg (body only, not including the cable)

NOTE
To connect this sensor and position detection circuit, prepare cable K4. For details of cable K4, see Section 2.5, "CABLES."
2.4.7 Position Detection Circuit

Position detection circuit   one-output type (A860-0333-T201)
Position detection circuit   two-output type (A860-0333-T202)
Position detection circuit   one-output type (A860-0333-T301)  
   for Distance corded linear encoder
Position detection circuit   two-output type (A860-0333-T302)  
   for Distance corded linear encoder

**NOTE**
To use an incremental linear encoder, a position detection circuit is required. A magnetic pole sensor described in the previous subsection is also required. When an absolute linear encoder is used, neither is required.

Mass: 0.7 kg (body only, not including the cable)

**NOTE**
1. Use the one-output type (A860-0333-T201 or T301) in a typical configuration. Use the two-output type (A860-0333-T202 or -T302) only when signals must branch off from one linear encoder.
2. To connect the position detection circuit to a magnetic pole sensor, prepare cable K4. The magnetic pole sensor dedicated to the LİS 300A1/4, LİS 600A1/4, and LİS 900A1/4 is supplied with a cable.
3. For the cable between the linear encoder and position detection circuit, contact the relevant linear encoder manufacturer.
4. To connect the position detection circuit to a servo amplifier, prepare cable K2.
5. For details of each cable, see Section 2.5, "CABLES."
2.5 CABLES

2.5.1 Overview of Connection

When using an incremental linear encoder, connect the cables for the linear motor as follows. When using an absolute linear encoder, directly connect the signal cables for the linear encoder to the servo amplifier since the magnetic pole sensor and position detection circuit are not used.

---

<table>
<thead>
<tr>
<th>Cable number</th>
<th>Connection</th>
<th>Ordering information and remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>K1</td>
<td>Between the CNC and servo amplifier</td>
<td>For details, refer to the related CNC connection manual.</td>
</tr>
<tr>
<td>K2</td>
<td>Between the position detection circuit and servo amplifier</td>
<td>Only a cable with the standard length (7 m) can be ordered. Other cables must be prepared by yourself. Ordering information: A06B-6061-K802 Length: 7 m</td>
</tr>
<tr>
<td>K3</td>
<td>Between the motor and servo amplifier (power line)</td>
<td>For details, see Part III, &quot;HANDLING, DESIGN, AND ASSEMBLY.&quot;</td>
</tr>
<tr>
<td>K4</td>
<td>Between the magnetic pole sensor and position detection circuit</td>
<td>For the LiS 300A1/4 to LiS 900A1/4, a cable with a length of 4 m comes with the magnetic pole sensor. For the LiS 1500B1/4 or later, only a cable with the standard length (7 m) can be ordered. Other cables must be prepared by yourself. Ordering information: A06B-6061-K801 Length: 7 m</td>
</tr>
<tr>
<td>K5</td>
<td>Between the linear encoder and position detection circuit</td>
<td>Contact the relevant linear encoder manufacturer or dealer.</td>
</tr>
<tr>
<td>K6</td>
<td>Thermostat line wire</td>
<td>For details, see Part III, &quot;HANDLING, DESIGN, AND ASSEMBLY.&quot;</td>
</tr>
</tbody>
</table>

**NOTE**

FANUC does not recommend use of relayed signal lines. Relay signal lines on your own responsibility if required. If it is absolutely necessary to relay signal lines, use connectors and connect a shield.
2.5.2 Cable K2 (for Position Detection Circuit A860-0333-T201 or -T301)

<table>
<thead>
<tr>
<th>Used wires</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0V, 5V</td>
<td>Nominal cross section: 0.5mm², at least three wires each</td>
</tr>
<tr>
<td>SD1, *SD1, REQ, *REQ</td>
<td>Nominal cross section: 0.18mm², twisted pair</td>
</tr>
</tbody>
</table>
2.5.3 Cable K2 (for Position Detection Circuit A860-0333-T202 or -T302)

**Used wires**

<table>
<thead>
<tr>
<th>Used wires</th>
<th>Nominal cross section: 0.5mm², at least three wires each</th>
</tr>
</thead>
<tbody>
<tr>
<td>0V, 5V</td>
<td></td>
</tr>
<tr>
<td>SD1, *SD1, SD2, *SD2, REQ, *REQ</td>
<td>Nominal cross section: 0.18mm², twisted pair</td>
</tr>
</tbody>
</table>

**NOTE**

SD2 and *SD2 are output to another driver with the same logic signals as for SD1 and *SD1. In ordinary cases, SD1 and *SD1 are connected to an axis having an odd number of a DSP different from that for SD2 and *SD2.
2.5.4 Cable K2-2 (for Absolute Linear Encoder)

2.5.5 Cable K4
2.5.6 Cable K5

**NOTE**
Use the cable supplied with the linear encoder or specified by the linear encoder manufacturer. Specify dia (mm) at the end of the connector specification according to the diameter of the cable to be used. The dia value is between 6 to 9, however.

2.5.7 Cable K6

LiS 1500B1/4 and up

**NOTE**
The above connector is for the LiS 1500B1/4 to LiS 17000C3/2. Prepare the cable. For the LiS 300A1/4 to LiS 900A1/4, the thermostat line wire juts out the coil slider. Connect the lead wire to the PMC.
2.5.8 **Cable Length Design**

Design the cable length so that the voltage drop by cables K2 and K4 and that by cables K2 and K5 are 0.2 V or less.

**NOTE**

When designing the cable length, note that the sum of the current consumption of the position detection circuit, magnetic pole sensor, and linear encoder in a linear motor flows through cable K2.

**Sample calculations**

When HEIDENHAIN LS486 is used and the length of cable K2 is determined to be 10 m by design:

- Linear encoder LS486 (Maximum current consumption: 0.15 A)
- Position detection circuit A860-0333-T201
  (Maximum current consumption: 0.25 A)
- Magnetic pole sensor A860-0331-T001
  (Maximum current consumption: 0.05 A)
- Conductor resistance of a copper wire with a nominal cross section of 0.5 mm² at 20°C: \(38.7 \times 10^{-3} \, \Omega / m\)

<1> Voltage drop by cable K2: \(V_d \) (V)

When three copper wires having a nominal cross section of 0.5 mm² are connected, the voltage drop is:

\[
V_d = (0.25+0.05+0.15) \times \{(38.7 \times 10^{-3}) \times (10 \times 2)\} = 0.116 \, \text{V}
\]

according to \(V = I \times R\).

* \((10 \times 2)\) in the expression means both ways between 5 and 0 V.

<2> Maximum length of cable K4: \(L_1 \) (m)

To suppress the voltage drop to 0.2 V or less, the cable length must be designed so that the voltage drop by cable K4 is 0.084 V or less.

When two copper wires having a nominal cross section of 0.5 mm² are connected, the maximum cable length is:

\[
L_1 = [(0.2-0.116) +0.05] \div (38.7 \times 10^{-3} \div 2) \div 2 \approx 43.4 \, \text{m}
\]

according to conductor length (m) = resistance (\(\Omega\)) \div conductor resistance (\(\Omega / m\)).

<3> Maximum length of cable K5: \(L_2 \) (m)

\[
L_2 = [((0.2-0.116) \div 0.15] \div 38.7 \times 10^{-3} \div 2 \approx 7.2 \, \text{m}
\]

**NOTE**

The standard LS486 cable uses two copper wires having a nominal cross section of 0.25 mm² for connecting each of 5 and 0 V. At this time, the conductor resistance of the wires is \(38.7 \times 10^{-3} \, \Omega / m\).
2.6 APPLICABLE AMPLIFIERS

The FANUC Linear Motor L{iS} series is driven using the FANUC servo amplifier α{i} and β{i} series.

⚠️ CAUTION
Combining these motors with any amplifier other than listed below may damage the motor or amplifier.

NOTE
1 For details of amplifiers, refer to the relevant amplifier descriptions.
2 For selection of a power supply module (PSM), see Section 2.2, "SPECIFICATION LIST," and Section 2.3, "SELECTING A POWER SUPPLY MODULE (PSM)," in Part II, "CONFIGURATIONS AND SELECTION."
3 The applicable amplifiers listed below are representative examples. You can also use an amplifier which is not listed when the maximum current and rated current of the amplifier satisfy the conditions. In any case, the motor output may be limited because the used amplifier cannot exceed its limit, however. Note that when an amplifier which is not listed below is used, the drive parameters must also be changed.

For L{iS} 300A/4

<table>
<thead>
<tr>
<th>Type of amplifier</th>
<th>Name</th>
<th>Specification</th>
<th>Connectable axis</th>
</tr>
</thead>
<tbody>
<tr>
<td>α{i} series</td>
<td>α{i}SV20</td>
<td>A06B-6114-H103</td>
<td>L and M axes</td>
</tr>
<tr>
<td></td>
<td>α{i}SV20/20</td>
<td>A06B-6114-H205</td>
<td>L and M axes</td>
</tr>
<tr>
<td></td>
<td>α{i}SV20/40</td>
<td>A06B-6114-H206</td>
<td>L axis</td>
</tr>
<tr>
<td></td>
<td>α{i}SV20/20/20</td>
<td>A06B-6114-H303</td>
<td>L, M, and N axes</td>
</tr>
<tr>
<td></td>
<td>α{i}SV20/20/40</td>
<td>A06B-6114-H304</td>
<td>L and M axes</td>
</tr>
<tr>
<td>β{i} series</td>
<td>β{i}SV20</td>
<td>A06B-6130-H002</td>
<td></td>
</tr>
</tbody>
</table>
| Servo amplifier module (CNC: for the Series 30i)
|                  | α{i}SV20        | A06B-6117-H103   |                  |
|                  | α{i}SV20/20     | A06B-6117-H205   | L and M axes     |
|                  | α{i}SV20/40     | A06B-6117-H206   | L axis           |
|                  | α{i}SV20/20/20  | A06B-6117-H303   | L, M, and N axes |
|                  | α{i}SV20/20/40  | A06B-6117-H304   | L and M axes     |
| Servo amplifier module (CNC: for the Series 30i)
|                  | α{i}SV20L       | A06B-6117-H153   |                  |
|                  | α{i}SV20/20L    | A06B-6117-H255   | L and M axes     |
|                  | α{i}SV20/40L    | A06B-6117-H256   | L axis           |
## Specifications

For LiS 600A1/4, LiS 900A1/4, LiS 1500B1/4, and LiS 3000B2/2

<table>
<thead>
<tr>
<th>Type of amplifier</th>
<th>Name</th>
<th>Specification</th>
<th>Connectable axis</th>
</tr>
</thead>
<tbody>
<tr>
<td>α series</td>
<td>αSV40</td>
<td>A06B-6114-H104</td>
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</tr>
<tr>
<td>servo amplifier module</td>
<td>αSV20/40</td>
<td>A06B-6114-H206</td>
<td>M axis</td>
</tr>
<tr>
<td></td>
<td>αSV40/40</td>
<td>A06B-6114-H207</td>
<td>L and M axes</td>
</tr>
<tr>
<td></td>
<td>αSV40/80</td>
<td>A06B-6114-H208</td>
<td>L axis</td>
</tr>
<tr>
<td></td>
<td>αSV20/20/40</td>
<td>A06B-6114-H304</td>
<td>N axis</td>
</tr>
<tr>
<td>β series</td>
<td>βSV40</td>
<td>A06B-6117-H104</td>
<td></td>
</tr>
<tr>
<td>servo amplifier module</td>
<td>βSV40/80</td>
<td>A06B-6117-H206</td>
<td>M axis</td>
</tr>
<tr>
<td></td>
<td>βSV40/40</td>
<td>A06B-6117-H207</td>
<td>L and M axes</td>
</tr>
<tr>
<td></td>
<td>βSV40/80</td>
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</tr>
<tr>
<td></td>
<td>βSV20/20/40</td>
<td>A06B-6117-H304</td>
<td>N axis</td>
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</tbody>
</table>

For LiS 3000B2/4, LiS 4500B2/2, LiS 6000B2/2, and LiS 3300C1/2

<table>
<thead>
<tr>
<th>Type of amplifier</th>
<th>Name</th>
<th>Specification</th>
<th>Connectable axis</th>
</tr>
</thead>
<tbody>
<tr>
<td>α series</td>
<td>αSV80</td>
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<tr>
<td>servo amplifier module</td>
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<td>A06B-6114-H208</td>
<td>M axis</td>
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<tr>
<td></td>
<td>αSV80/80</td>
<td>A06B-6114-H209</td>
<td>L and M axes</td>
</tr>
<tr>
<td></td>
<td>αSV80/160</td>
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<td>L axis</td>
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<td>βSV80/80</td>
<td>A06B-6117-H206</td>
<td>M axis</td>
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<td></td>
<td>βSV80/80</td>
<td>A06B-6117-H209</td>
<td>L and M axes</td>
</tr>
<tr>
<td></td>
<td>βSV80/160</td>
<td>A06B-6117-H210</td>
<td>L axis</td>
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<td>βSV80L</td>
<td>A06B-6117-H155</td>
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<td>βSV80/80L</td>
<td>A06B-6117-H258</td>
<td>M axis</td>
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<td>βSV80/80L</td>
<td>A06B-6117-H259</td>
<td>L and M axes</td>
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<tr>
<td></td>
<td>βSV80</td>
<td>A06B-6130-H004</td>
<td></td>
</tr>
</tbody>
</table>
### Specifications

#### For LIS 6000B2/4, LIS 7500B2/2, LIS 9000B2/2, LIS 9000C2/2, LIS 11000C2/2, and LIS 10000C3/2

<table>
<thead>
<tr>
<th>Type of amplifier</th>
<th>Name</th>
<th>Specification</th>
<th>Connectable axis</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$ series servo amplifier module</td>
<td>$\alpha$SV160</td>
<td>A06B-6114-H106</td>
<td></td>
</tr>
<tr>
<td>$\alpha$ series servo amplifier module</td>
<td>$\alpha$SV80/160</td>
<td>A06B-6114-H210</td>
<td>M axis</td>
</tr>
<tr>
<td>$\alpha$ series servo amplifier module</td>
<td>$\alpha$SV160/160</td>
<td>A06B-6114-H211</td>
<td>L and M axes</td>
</tr>
<tr>
<td>$\alpha$ series servo amplifier module (CNC: for the Series 30i) No support for HRV4</td>
<td>$\alpha$SV160</td>
<td>A06B-6117-H106</td>
<td></td>
</tr>
<tr>
<td>$\alpha$ series servo amplifier module (CNC: for the Series 30i) Support for HRV4</td>
<td>$\alpha$SV160L</td>
<td>A06B-6117-H156</td>
<td></td>
</tr>
</tbody>
</table>

#### For LIS 9000B2/4, LIS 15000C2/2, LIS 15000C2/3, and LIS 17000C3/2

<table>
<thead>
<tr>
<th>Type of amplifier</th>
<th>Name</th>
<th>Specification</th>
<th>Connectable axis</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$ series servo amplifier module</td>
<td>$\alpha$SV360L</td>
<td>A06B-6114-H109</td>
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</tr>
<tr>
<td>$\alpha$ series servo amplifier module (CNC: for the Series 30i) Support for HRV4</td>
<td>$\alpha$SV360L</td>
<td>A06B-6117-H109</td>
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</tr>
</tbody>
</table>

#### For LIS 1500B1/4, LIS 3000B2/2, and LIS 4500B2/2HV (400V input)

<table>
<thead>
<tr>
<th>Type of amplifier</th>
<th>Name</th>
<th>Specification</th>
<th>Connectable axis</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$ series servo amplifier module</td>
<td>$\alpha$SV40HV</td>
<td>A06B-6124-H104</td>
<td></td>
</tr>
<tr>
<td>$\alpha$ series servo amplifier module</td>
<td>$\alpha$SV20/40HV</td>
<td>A06B-6124-H206</td>
<td>M axis</td>
</tr>
<tr>
<td>$\alpha$ series servo amplifier module</td>
<td>$\alpha$SV40/40HV</td>
<td>A06B-6124-H207</td>
<td>L and M axes</td>
</tr>
<tr>
<td>$\alpha$ series servo amplifier module</td>
<td>$\alpha$SV40/80HV</td>
<td>A06B-6124-H208</td>
<td>L axis</td>
</tr>
<tr>
<td>$\alpha$ series servo amplifier module (CNC: for the Series 30i) No support for HRV4</td>
<td>$\alpha$SV20/20/40HV</td>
<td>A06B-6124-H304</td>
<td>N axis</td>
</tr>
<tr>
<td>$\alpha$ series servo amplifier module (CNC: for the Series 30i) Support for HRV4</td>
<td>$\alpha$SV40HV</td>
<td>A06B-6127-H104</td>
<td></td>
</tr>
<tr>
<td>$\alpha$ series servo amplifier module</td>
<td>$\alpha$SV20/40HV</td>
<td>A06B-6127-H206</td>
<td>M axis</td>
</tr>
<tr>
<td>$\alpha$ series servo amplifier module</td>
<td>$\alpha$SV40/40HV</td>
<td>A06B-6127-H207</td>
<td>L and M axes</td>
</tr>
<tr>
<td>$\alpha$ series servo amplifier module</td>
<td>$\alpha$SV40/80HV</td>
<td>A06B-6127-H208</td>
<td>L axis</td>
</tr>
<tr>
<td>$\alpha$ series servo amplifier module</td>
<td>$\alpha$SV20/20/40HV</td>
<td>A06B-6127-H304</td>
<td>N axis</td>
</tr>
<tr>
<td>$\alpha$ series servo amplifier module (CNC: for the Series 30i) Support for HRV4</td>
<td>$\alpha$SV40HVL</td>
<td>A06B-6127-H154</td>
<td></td>
</tr>
<tr>
<td>$\alpha$ series servo amplifier module</td>
<td>$\alpha$SV20/40HVL</td>
<td>A06B-6127-H256</td>
<td>M axis</td>
</tr>
<tr>
<td>$\alpha$ series servo amplifier module</td>
<td>$\alpha$SV40/40HVL</td>
<td>A06B-6127-H257</td>
<td>L and M axes</td>
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</table>
(400V input)

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<thead>
<tr>
<th>Type of amplifier</th>
<th>Name</th>
<th>Specification</th>
<th>Connectable axis</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \alpha )i series servo amplifier module</td>
<td>( \alpha )iSV80HV</td>
<td>A06B-6124-H105</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( \alpha )iSV40/80HV</td>
<td>A06B-6124-H208</td>
<td>M axis</td>
</tr>
<tr>
<td></td>
<td>( \alpha )iSV80/80HV</td>
<td>A06B-6124-H209</td>
<td>L and M axes</td>
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</tbody>
</table>

(400V input)

<table>
<thead>
<tr>
<th>Type of amplifier</th>
<th>Name</th>
<th>Specification</th>
<th>Connectable axis</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \alpha )i series servo amplifier module (CNC: for the Series 30i)</td>
<td>( \alpha )iSV80HV</td>
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<td></td>
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<tr>
<td></td>
<td>( \alpha )iSV40/80HV</td>
<td>A06B-6127-H208</td>
<td>M axis</td>
</tr>
<tr>
<td></td>
<td>( \alpha )iSV80/80HV</td>
<td>A06B-6127-H209</td>
<td>L and M axes</td>
</tr>
<tr>
<td></td>
<td>( \alpha )iSV80HVL</td>
<td>A06B-6127-H155</td>
<td></td>
</tr>
</tbody>
</table>

For **LîS 15000C2/2**, **LîS 15000C2/3HV**, and **LîS 17000C3/2**
(400V input)

<table>
<thead>
<tr>
<th>Type of amplifier</th>
<th>Name</th>
<th>Specification</th>
<th>Connectable axis</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \alpha )i series servo amplifier module</td>
<td>( \alpha )iSV360HV</td>
<td>A06B-6124-H109</td>
<td></td>
</tr>
</tbody>
</table>
II. CONFIGURATIONS AND SELECTION
1

SYSTEM CONFIGURATION
1.1 LINEAR ENCODER SELECTION

For the FANUC Linear Motor LİS series, motors are controlled using feedback signals from a linear encoder. There are two types of linear encoders: an incremental linear encoder and absolute linear encoder, each of which has the following characteristics.

- Incremental linear encoder
  - Applicable to 3-m or longer axes.
  - Encoder zero point (Z phase) establishment operation is required.
  - The magnetic pole sensor and position detection circuit are required.
  - High resolution is achieved because the scale signal is internally multiplied.
  - The distance coded linear encoder can be selected.
  - The resolution can be made higher.

- Absolute linear encoder
  - For 3-m or shorter axes
  - Encoder zero point (Z phase) establishment operation is not required.
  - Wiring can be saved because it is directly connected to the servo amplifier.
  - The model supporting the FANUC serial interface is selected.
  - The resolution is relatively low.

The resolution of a linear encoder must be approximately ten to twenty times better than the target precision.
1.2 INCREMENTAL LINEAR ENCODER SYSTEM

This section explains a system in which an incremental linear encoder is used.

1.2.1 Example of Configuration

For a system in which an incremental linear encoder is used, the following devices are required to configure a motor, in addition to a coil slider and magnet plate.

**Magnetic pole sensor**

The magnetic pole sensor is a sensor to simply determine the position of the motor for each magnetic pole before the zero point is checked at start (the reference mark signal is detected).

**Position detection circuit**

The position detection circuit converts signals output from the magnetic pole sensor and linear encoder to FANUC serial interface signals and outputs the converted signals to the servo amplifier or CNC. This circuit internally multiplies a signal output from the linear encoder by 2048 and outputs the multiplied signal. For examples, when the signal pitch is 20 µm, the resolution is about 0.01 µm.

**NOTE**

For the specifications of the magnetic pole sensor and position detection circuit, see Part I, "SPECIFICATIONS."

An example of a typical system configuration is shown below:

![System Configuration Diagram](image)

This system requires detection of the zero point whenever the power to the NC is turned on or off.

**NOTE**

For how to install the linear encoder, see Part III, "HANDLING, DESIGN, AND ASSEMBLY."
### 1.2.2 Applicable Linear Encoder

An incremental linear encoder to be used for the FANUC Linear Motor LiS series must satisfy the following specifications:

- The output from the linear encoder is an analog signal at 1 Vp-p.
- A reference mark signal (Z-phase signal or another signal) is output from one device or the linear encoder is distance coded.

If reference mark signals are output from two or more devices, an alarm may occur when the same signal is detected for the second time.

The following table lists typical incremental linear encoders that can currently be combined with the FANUC Linear Motor LiS series.

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Manufacturer specification</th>
<th>Signal pitch (µm)</th>
<th>Resolution (µm)</th>
<th>Maximum speed (m/min)</th>
<th>Effective stroke (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEIDENHAIN</td>
<td>LS486</td>
<td>20</td>
<td>0.01</td>
<td>120</td>
<td>70 - 2040</td>
</tr>
<tr>
<td></td>
<td>LS186</td>
<td>20</td>
<td>0.01</td>
<td>120</td>
<td>240 - 3040</td>
</tr>
<tr>
<td></td>
<td>LB382</td>
<td>40</td>
<td>0.02</td>
<td>120</td>
<td>440 - 30040</td>
</tr>
<tr>
<td></td>
<td>LF183</td>
<td>4</td>
<td>0.002</td>
<td>48</td>
<td>140 - 3040</td>
</tr>
<tr>
<td></td>
<td>LF481</td>
<td>4</td>
<td>0.002</td>
<td>48</td>
<td>50 - 1220</td>
</tr>
<tr>
<td></td>
<td>LT181</td>
<td>20</td>
<td>0.01</td>
<td>120</td>
<td>35 or 60</td>
</tr>
<tr>
<td></td>
<td>LIP481R</td>
<td>2</td>
<td>0.001</td>
<td>24</td>
<td>10 – 420</td>
</tr>
<tr>
<td></td>
<td>LIF181</td>
<td>4</td>
<td>0.002</td>
<td>48</td>
<td>70 - 3040</td>
</tr>
<tr>
<td></td>
<td>LIDA181</td>
<td>40</td>
<td>0.02</td>
<td>480</td>
<td>220 - 2040</td>
</tr>
<tr>
<td></td>
<td>LIDA185</td>
<td>40</td>
<td>0.02</td>
<td>480</td>
<td>140 - 30040</td>
</tr>
<tr>
<td></td>
<td>LIDA187</td>
<td>40</td>
<td>0.02</td>
<td>480</td>
<td>240 - 6040</td>
</tr>
<tr>
<td></td>
<td>LIDA189</td>
<td>40</td>
<td>0.02</td>
<td>480</td>
<td>70 - 2000</td>
</tr>
<tr>
<td></td>
<td>PP281R</td>
<td>4</td>
<td>0.002</td>
<td>48</td>
<td>68 x 68</td>
</tr>
<tr>
<td>Mitutoyo</td>
<td>AT211 (*)</td>
<td>20</td>
<td>0.01</td>
<td>120</td>
<td>100 - 1500</td>
</tr>
<tr>
<td></td>
<td>AT402</td>
<td>20</td>
<td>0.01</td>
<td>120</td>
<td>100 - 2000</td>
</tr>
<tr>
<td>RENISHAW</td>
<td>RGH22</td>
<td>20</td>
<td>0.01</td>
<td>120</td>
<td>&lt; 50000</td>
</tr>
<tr>
<td></td>
<td>RGH41</td>
<td>40</td>
<td>0.02</td>
<td>120</td>
<td>&lt; 50000</td>
</tr>
<tr>
<td>Sony Precision</td>
<td>SH12</td>
<td>20</td>
<td>0.01</td>
<td>120</td>
<td>70 - 1240</td>
</tr>
<tr>
<td>Technology</td>
<td>SH52</td>
<td>20</td>
<td>0.01</td>
<td>120</td>
<td>120 - 2270</td>
</tr>
<tr>
<td></td>
<td>SL710 +PL101</td>
<td>880</td>
<td>0.39</td>
<td>384</td>
<td>50 - 30000</td>
</tr>
<tr>
<td>SUMTAK</td>
<td>FMV</td>
<td>8</td>
<td>0.005</td>
<td>48</td>
<td>100 - 2200</td>
</tr>
<tr>
<td></td>
<td>FTV</td>
<td>20</td>
<td>0.01</td>
<td>120</td>
<td>100 - 2200</td>
</tr>
<tr>
<td></td>
<td>FTV</td>
<td>20</td>
<td>0.01</td>
<td>120</td>
<td>75 - 1200</td>
</tr>
<tr>
<td>Optodyne</td>
<td>LDS</td>
<td>40.513167</td>
<td>0.02</td>
<td>240</td>
<td>1016 - 50800</td>
</tr>
</tbody>
</table>

*(*) Specify the analog output special type.

### NOTE
1. Optodyne LDS is Laser Doppler encoder.
2. The "resolution" in the above table indicates the value internally multiplied by the position detection circuit. The last digit is rounded off.
3. An incremental linear encoder must output only one reference mark signal. Before ordering a linear encoder, designate this requirement to the relevant linear encoder manufacturer.
4. Linear encoder manufacturers are responsible for the specifications, performance, guarantee, and other items of their linear encoders. For details, contact the relevant manufacturer.
1.3 ABSOLUTE LINEAR ENCODER SYSTEM

This section explains a system in which an absolute linear encoder is used.

1.3.1 Example of Configuration

When an absolute linear encoder is used, the absolute position is always determined. For this reason, magnetic pole sensor and position detection circuit are not required, which are required for an incremental linear encoder system. Consequently, the system configuration can be made simple. Currently available absolute linear encoders can handle a stroke of up to 3 m, however.

An example of a typical system configuration is shown below:

1.3.2 Applicable Linear Encoder

An absolute linear encoder to be used for the FANUC Linear Motor LI\textit{S} series must conform to the FANUC serial interface. If not, the absolute linear encoder cannot be used.

The following table lists absolute linear encoders that can currently be combined with the FANUC Linear Motor LI\textit{S} series.

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Manufacturer specification</th>
<th>Signal pitch ((\mu)m)</th>
<th>Maximum speed (m/min)</th>
<th>Effective stroke (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEIDENHAIN</td>
<td>LC192F</td>
<td>0.05(0.01)*</td>
<td>120</td>
<td>140 - 3040</td>
</tr>
<tr>
<td></td>
<td>LC491F</td>
<td>0.05(0.01)*</td>
<td>120</td>
<td>70 - 2040</td>
</tr>
<tr>
<td>Mitutoyo</td>
<td>AT353</td>
<td>0.05</td>
<td>120</td>
<td>100 - 3000</td>
</tr>
<tr>
<td></td>
<td>AT553</td>
<td>0.05</td>
<td>120</td>
<td>100 - 1500</td>
</tr>
<tr>
<td>Futaba Corp.</td>
<td>FMH</td>
<td>0.05</td>
<td>120</td>
<td>100-2200</td>
</tr>
</tbody>
</table>

(*) Two models of specifications of 0.05 \(\mu\)m and 0.01 \(\mu\)m are distributed.

NOTE
1 Linear encoder manufacturers are responsible for the specifications, performance, guarantee, and other items of their linear encoders. For details, contact the relevant manufacturer.
2 When HRV4 is applied, the linear encoder must support 2 Mbps communication. For support conditions, contact the relevant manufacturer.
1.4 MOTOR ARRANGEMENT AND DRIVING METHODS

1.4.1 When the Coil Slider Is Used as the Movable Part and When the Magnet Plate Is Used as the Movable Part

When installing a linear motor on a machine, you can select using the coil slider as the movable part and the magnet plate as the stationary part or using the magnet plate as the movable part and the coil slider as the stationary part. Select either way that is optimum for the configuration of the machine using linear motors.

When the coil slider is used as the movable part and the magnet plate is used as the stationary part

- Advantages
  A long-stroke system can easily be configured. As many magnet plates as required for the length (effective stroke + length of the coil slider +α) can be arranged to secure the required stroke.

- Disadvantages
  The cables and cooling tube must also be movable. Carefully select these parts, in particular, for a machine requiring high-speed operation. When the stroke exceeds 3 m, no absolute linear encoder can be selected currently.

When the magnet plate is used as the movable part and the coil slider is used as the stationary part

- Advantages
  The cables and cooling tube can be fixed. So, it is not necessary to consider movability of these parts. Only the magnet plate is the movable part and is lighter than the coil slider. So, it is easy to implement operation at a higher speed and acceleration. Consequently, this method is optimum for a short-stroke machine which oscillates in short cycles.

- Disadvantages
  This method is not suitable for a long-stroke machine because an axis space of a length of at least double the effective stroke is always required.
1.4.2 Parallel Arrangement, Serial Arrangement, and Symmetrical Arrangement

One feature of linear motors is that multiple motors (coil sliders) can be installed along one axis. For example, when the force obtained by one motor is insufficient, two motors can be arranged along the same axis to ensure the double force. This subsection introduces several typical types of linear motor arrangements.

**NOTE**
Explanation in this subsection assumes that the coil slider is used as the movable part. When the magnet plate is used as the movable part, each arrangement based on the same concept is available. There are rules for the orientation and position of a motor, however. For details of installation, see Part III, "HANDLING, DESIGN, AND ASSEMBLY."

### Parallel arrangement

Two or more linear motors are arranged in parallel. As many magnet plate tracks as the number of coil sliders are required. The length per track is the same as that when one linear motor is used. The following figure shows an example of arranging two motors in parallel:

![Parallel arrangement diagram](image)

### Serial arrangement

Two or more linear motors are arranged in serial. Only one magnet plate track is required regardless of the number of coil sliders. It is very difficult to arrange by using a ball screw and a rotation motor. The length of the magnet plate track depends on the number of coil sliders installed, however. The following figure shows an example of arranging two linear motors in serial:

![Serial arrangement diagram](image)
Combination of parallel and serial arrangements

Three or more linear motors can be arranged using the method of combining parallel and serial arrangements. The following figure shows an example of arranging four linear motors using this method:

![Diagram of linear motor arrangement](image)

### Symmetrical arrangement

The FANUC Linear Motor LİS series has the magnet attraction about three times as strong as the maximum force. The magnetic attraction always acts between the coil slider and magnet plate. For example, for the LİS 6000B2/4, a force of about 1.8 tons always acts. The magnetic attraction cannot be ignored for machine design which aims at lightness and rigidity in many cases. The symmetrical arrangement cancels out the magnetic attraction. There are two typical symmetrical arrangement methods.

![Symmetrical arrangement diagram](image)

The side view of a motor arrangement is shown above. This is an example of arranging magnet plates back to back.

![Side view of motor arrangement](image)

This is an example of arranging coil sliders back to back. With either method, the magnetic attraction can be canceled out. Either symmetrical arrangement can be combined with the parallel arrangement and serial arrangement introduced above.
NOTE
Although magnetic attraction is canceled by symmetrical arrangement, the machine may be deformed by magnetic attraction exerted on each motor if the strength of the mounting portion is insufficient. The design of the structural strength of the motor mounting portion must be made with great care.

1.4.3 Driving Two Motors

If you want to drive two motors along one axis, select one of the following control methods according to the connection rigidity between motors.

NOTE
This subsection gives typical examples when an incremental linear encoder is used. When an absolute linear encoder is used, the magnetic pole sensor and position detection circuit in each figure are not required. The rules may not always apply to the actual machine configuration. For details, contact FANUC.

When the connection rigidity between motors is high
In ordinary cases, torque tandem control is exercised. For linear motors, velocity tandem control or simple synchronous control can also be exercised by using common feedback signals in one DSP. In this case, only one linear encoder is required. The following is a block diagram for torque tandem control. The same configuration is used for velocity tandem control and simple synchronous control.

When the two-output type of position detection circuit is used in an incremental linear encoder system, control as shown below is also available:
When the connection rigidity between motors is low

The motors are driven with simple synchronous control based on separate position control for each axis or complete synchronous control. In this case, two linear encoders are required. The following is a block diagram for simple synchronous control:

When the connection rigidity between motors is medium

If the motors cannot be driven successfully with the method introduced on the previous page, they may be driven with velocity tandem control using two linear encoders. The following is a block diagram for velocity tandem control:

1.4.4 Driving Three or More Motors

Use three or more motors with combining control methods introduced in the previous subsection. The following shows an example of a configuration for driving four motors with torque tandem control and simple synchronous control in combination. In this example, the two-output type of position detection circuit is used for using signals from one linear encoder for all motors.
1.4.5 Driving Multiple Motors with a Large-Capacity Amplifier

With the methods introduced above, one motor is combined with one amplifier. Combining one motor with one amplifier is the best method from control and motor protection viewpoints because current is controlled individually. For a machine having many axes, however, the number of axes available for the CNC may be insufficient because as many hardware axes as the number of amplifiers are required. To resolve this problem, a method for connecting multiple motors in parallel and driving them with a large-capacity amplifier is available. The following figure is a typical example of this method. Two motors can be seen as one motor from the amplifier. Therefore, the number of linear encoders is one and the number of required axes is also one.

NOTE
To drive multiple motors with one amplifier, special installation and parameter settings different from those used in ordinary cases are required. For details, see Part III, "HANDLING, DESIGN, AND ASSEMBLY," and contact FANUC.
2 SELECTION METHODS
2.1 COIL SLIDER SELECTION

A coil slider should be selected according to the following items.

NOTE
For information related to the motor specifications, also see Part I, "SPECIFICATIONS."

2.1.1 Load Force

The load force means the whole load on a motor. That is, the weight of the movable objects including the weight of the motor itself, magnetic attraction between the coil slider and magnet plate, and items related to the friction in the machine such as the friction coefficient must be considered. This value is always required for selecting a motor. An example of calculation is shown below:

- Motor model: LİŞ 9000B2/2
  Movable part: Slider
  Weight of the slider: 34 kg
  Magnetic attraction: 27,000 N
- Weight of movable objects (not including the motor): 300 kg
- Friction coefficient: 0.02

When the above conditions are assumed:
Load force = \((300+34) \times 9.8 + 27000\) \times 0.02 = 605 [N]

2.1.2 Required Maximum Force

The required maximum force means the force required for implementing desired acceleration and maximum speed when the load force described above is present. Make sure that the maximum force in the motor specifications is not less than the required maximum force. When checking the requirement, it is desirable to allow a margin of about 10% by taking a load variation into account. An example of calculation is shown below:

- Load force: 605 [N] as calculated in the previous subsection
- Acceleration: 1.5 G
- Maximum speed: 1.5 m/sec (90 m/min)
- Other conditions are the same as those listed in the previous subsection.

When the above conditions are assumed:
Required maximum force = \((300+34) \times 9.8 \times 1.5 + 605\) = 5515 [N]

The maximum force of the LİŞ9000B2/2 is 6,300 N at 1.5 m/sec as listed in Part I, "SPECIFICATIONS," and therefore has a margin of 13.5% for the required maximum force of 5,515 [N].
2.1.3 Root Mean Square Force

The root mean square force means the root mean value of the force required in one duty cycle. The root mean square force must not be greater than the rated continuous force of the motor. If the root mean square force exceeds the rated continuous force, the motor may overheat. It is desirable to allow a margin of about 20% by taking a load variation into account.

The rated continuous force of the motor varies depending on the type of cooling method used for the motor (no cooling, air cooling, or water cooling). It also varies depending on the heat dissipation and other characteristics of the machine. Be extremely careful of force for supporting frictional load and weight along a vertical axis because it sometimes fluctuates largely. Even when the motor is at rest, it keeps producing force to prevent drifting.

An example of calculation is shown below.

For explanation, a simple duty cycle as shown below is assumed. After 0.2-second positioning for a 150-mm stroke, cutting is performed for 5 seconds in the constant feed mode. It is assumed that a cutting load (cutting reaction force) of 1,000 N is applied in the direction of thrust during cutting. After cutting, the machine stops for 0.5 seconds. Other conditions are the same as those listed in Subsections 2.1.1 and 2.1.2.

According to the above conditions, create a force distribution chart for one cycle. The force distribution chart is made as follows:

5,515 N during acceleration is the required maximum force calculated in Subsection 2.1.2. 4,305 N during deceleration is obtained as follows:

 Force required during deceleration=(300+34)×9.8×1.5-605≈4305[N] because the load force contributes to deceleration.
When the motor stops, it also keeps producing force to prevent drifting, a load force of 605 N calculated in Subsection 2.1.1 is required as the force.
The load during cutting is:
605+1000=1605[N]
because a cutting reaction force of 1,000 N is added to the force during stop as a load.

Consequently, the root mean square force is:
\[
\sqrt{5515^2 \times 0.15 + 4305^2 \times 0.15 + 1605^2 \times 5 + 605^2 \times 0.5} = 1876[N]
\]

The continuous force of the LJS 9000B2/2 with air cooling used is 2,160 N (NOTE) as listed in Part I, "SPECIFICATIONS," and therefore the motor can be used with an enough margin when air or water cooling is used.

**NOTE**
The rated continuous force varies depending on the cooling method. For details of the values, see Part I, "SPECIFICATIONS." These values also vary depending on the actual cooling condition.
2.1.4 Overload Duty Characteristic

A linear motor can be used intermittently, even out of its rated continuous operating area, when the maximum force is not exceeded. The overload duty characteristic represents the duty ratio (%) and "on time" for which the motor runs under a given overload condition. The conditions for the "on time" and "off time" of the motor can be calculated as follows:

<1> Obtain the overload ratio using the following expression:
Overload ratio = load force / rated continuous force
Then, the duty ratio (%) and on time of the motor can be determined from the overload ratio and overload duty cycle characteristic curves (shown on the next and subsequent pages).

Example:
To run the LİS 1500B1/4 (no cooling) with a load force of 360 N at very low speed for one minute:
Overload ratio = 360 / 300 = 1.2 (120%)
because the rated continuous force of the LİS 1500B1/4 is 300 N.
From the overload duty characteristic curve for the LİS 1500B1/4 with no cooling, the duty ratio (%) is determined to be 68% when the motor runs with an overload ratio of 120% for one minute.

<2> Obtain the off time of the motor using the following expression.
Off time = on time × (100 / duty ratio (%) - 1)

Example:
From the value obtained in the example in <1>:
Off time = 1 × (100 / 68 - 1) = 0.47 minutes (about 28 seconds)
Therefore, it is necessary to keep the motor stopped for at least 28 seconds after it runs for one minute under the conditions described above.
The following show the overload duty characteristic curves for each motor.

**LıS 300A1/4, LıS 600A1/4, LıS 900A1/4 No cooling**

![Overload duty characteristic curve for LıS motors with no cooling](image)

**LıS 300A1/4, LıS 600A1/4, LıS 900A1/4 Air cooling**

![Overload duty characteristic curve for LıS motors with air cooling](image)
LiS 300A1/4, LiS 600A1/4, LiS 900A1/4 Water cooling


NOTE
A drive amplifier used for the linear motor incorporates a thermal protection unit such as a circuit breaker or thermal circuit. In addition to the conditions described above, the thermal protection unit may restrict the use of the motor. Moreover, the software used to control machining operation has a function of protecting the motor and amplifier from short-time overload. This function may also restrict the use of the motor.
2.1.5 Amount of Travel when Dynamic Brake Is Applied

Because the FANUC Linear Motor LİS is a synchronous motor, a dynamic brake can be applied by short-circuiting the power wires. When an emergency stop is used, for example, because of an abnormal condition, a dynamic brake is put in effect. When a dynamic brake is applied, the moving object coasts before it comes to a complete stop. The coasting distance is calculated as follows:

\[
\text{Coasting distance (m)} = VM \times (t_1+t_2) + MT \times (A \times VM + B \times VM^3)
\]

where

- \(VM\): Motor speed (m/s)
- \(t_1+t_2\): Control delay time, usually about 0.05 sec
- \(MT\): Weight of the moving object (kg)

\(A\) and \(B\):

Values specific to each motor model, which are as listed below:

<table>
<thead>
<tr>
<th>Motor model</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>LİS 300A1/4</td>
<td>7.90 \times 10^{-3}</td>
<td>5.99 \times 10^{-3}</td>
</tr>
<tr>
<td>LİS 600A1/4</td>
<td>3.95 \times 10^{-3}</td>
<td>3.00 \times 10^{-3}</td>
</tr>
<tr>
<td>LİS 900A1/4</td>
<td>2.63 \times 10^{-3}</td>
<td>2.00 \times 10^{-3}</td>
</tr>
<tr>
<td>LİS 1500B2/4</td>
<td>1.24 \times 10^{-3}</td>
<td>3.02 \times 10^{-4}</td>
</tr>
<tr>
<td>LİS 3000B2/2, LİS 3000B2/4</td>
<td>5.32 \times 10^{-4}</td>
<td>1.79 \times 10^{-4}</td>
</tr>
<tr>
<td>LİS 4500B2/2HV</td>
<td>2.33 \times 10^{-4}</td>
<td>8.51 \times 10^{-5}</td>
</tr>
<tr>
<td>LİS 4500B2/2</td>
<td>2.60 \times 10^{-4}</td>
<td>9.04 \times 10^{-5}</td>
</tr>
<tr>
<td>LİS 6000B2/2HV</td>
<td>1.78 \times 10^{-4}</td>
<td>6.16 \times 10^{-5}</td>
</tr>
<tr>
<td>LİS 6000B2/2, LİS 6000B2/4</td>
<td>2.66 \times 10^{-4}</td>
<td>8.87 \times 10^{-5}</td>
</tr>
<tr>
<td>LİS 7500B2/2</td>
<td>1.54 \times 10^{-4}</td>
<td>5.50 \times 10^{-5}</td>
</tr>
<tr>
<td>LİS 7500B2/2</td>
<td>1.54 \times 10^{-4}</td>
<td>5.50 \times 10^{-5}</td>
</tr>
<tr>
<td>LİS 9000B2/2, LİS 9000B2/4</td>
<td>1.77 \times 10^{-4}</td>
<td>5.97 \times 10^{-5}</td>
</tr>
<tr>
<td>LİS 3300C1/2</td>
<td>3.49 \times 10^{-4}</td>
<td>1.16 \times 10^{-4}</td>
</tr>
<tr>
<td>LİS 9000C2/2HV</td>
<td>1.15 \times 10^{-4}</td>
<td>6.29 \times 10^{-5}</td>
</tr>
<tr>
<td>LİS 9000C2/2</td>
<td>1.14 \times 10^{-4}</td>
<td>6.65 \times 10^{-5}</td>
</tr>
<tr>
<td>LİS 11000C2/2HV</td>
<td>9.03 \times 10^{-5}</td>
<td>2.90 \times 10^{-5}</td>
</tr>
<tr>
<td>LİS 11000C2/2</td>
<td>9.02 \times 10^{-5}</td>
<td>3.02 \times 10^{-5}</td>
</tr>
<tr>
<td>LİS 15000C2/2</td>
<td>7.34 \times 10^{-5}</td>
<td>3.75 \times 10^{-5}</td>
</tr>
<tr>
<td>LİS 15000C2/3</td>
<td>7.27 \times 10^{-5}</td>
<td>3.49 \times 10^{-5}</td>
</tr>
<tr>
<td>LİS 15000C2/3HV</td>
<td>7.04 \times 10^{-5}</td>
<td>2.36 \times 10^{-5}</td>
</tr>
<tr>
<td>LİS 10000C3/2HV</td>
<td>1.06 \times 10^{-4}</td>
<td>3.50 \times 10^{-5}</td>
</tr>
<tr>
<td>LİS 10000C3/2</td>
<td>1.08 \times 10^{-4}</td>
<td>3.58 \times 10^{-5}</td>
</tr>
<tr>
<td>LİS 17000C3/2HV</td>
<td>6.24 \times 10^{-5}</td>
<td>2.16 \times 10^{-5}</td>
</tr>
<tr>
<td>LİS 17000C3/2</td>
<td>6.39 \times 10^{-5}</td>
<td>2.21 \times 10^{-5}</td>
</tr>
</tbody>
</table>
Calculation example

The following calculation of a coasting distance that occurs when a dynamic brake is applied assumes the selection conditions used in Subsections 2.1.1 to 2.1.3.

Coasting distance (m) =

\[ 1.5 \times 0.05 + 334 \times (1.77 \times 10^{-4} \times 1.5 + 5.97 \times 10^{-5} \times 1.5^3) = 0.231 \text{ (m)} \]

NOTE

1. Add the coasting distance calculated as above to the required length of the magnet plate that is obtained according to the method described in the following subsection.

2. When only the dynamic brake is used, the required sufficient braking distance may not be obtained (the linear motor may coast longer). In this case, add auxiliary brake systems such as stoppers or dampers at the ends of an axis and an external mechanical brake to protect the machine.
## 2.2 MAGNET PLATE SELECTION

Magnet plates can be combined only with the motor models listed in the following table.

<table>
<thead>
<tr>
<th>Motor model</th>
<th>Magnet plate type</th>
<th>Magnet plate length (mm)</th>
<th>Specification drawing number of the magnet plate</th>
</tr>
</thead>
<tbody>
<tr>
<td>LİS 300A1/4, LİS 600A1/4, LİS 900A1/4</td>
<td>A1 (Width 70mm)</td>
<td>30</td>
<td>A06B-0440-B111#000x</td>
</tr>
<tr>
<td></td>
<td></td>
<td>120</td>
<td>A06B-0440-B113#000x</td>
</tr>
<tr>
<td>LİS 1500B1/4</td>
<td>B1 (Width 98mm)</td>
<td>60</td>
<td>A06B-0440-B212#000x</td>
</tr>
<tr>
<td></td>
<td></td>
<td>240</td>
<td>A06B-0440-B214#000x</td>
</tr>
<tr>
<td></td>
<td></td>
<td>420</td>
<td>A06B-0440-B215#000x</td>
</tr>
<tr>
<td></td>
<td></td>
<td>600</td>
<td>A06B-0440-B217#000x</td>
</tr>
<tr>
<td></td>
<td></td>
<td>960</td>
<td>A06B-0440-B218#000x</td>
</tr>
<tr>
<td></td>
<td></td>
<td>240</td>
<td>A06B-0440-B224#000x</td>
</tr>
<tr>
<td></td>
<td></td>
<td>420</td>
<td>A06B-0440-B225#000x</td>
</tr>
<tr>
<td></td>
<td></td>
<td>600</td>
<td>A06B-0440-B227#000x</td>
</tr>
<tr>
<td></td>
<td></td>
<td>960</td>
<td>A06B-0440-B228#000x</td>
</tr>
<tr>
<td>LİS 3300C1/2</td>
<td>C1 (Width 123mm)</td>
<td>60</td>
<td>A06B-0440-B312#000x</td>
</tr>
<tr>
<td></td>
<td></td>
<td>240</td>
<td>A06B-0440-B314#000x</td>
</tr>
<tr>
<td></td>
<td></td>
<td>420</td>
<td>A06B-0440-B315#000x</td>
</tr>
<tr>
<td></td>
<td></td>
<td>600</td>
<td>A06B-0440-B317#000x</td>
</tr>
<tr>
<td></td>
<td></td>
<td>960</td>
<td>A06B-0440-B318#000x</td>
</tr>
<tr>
<td>LİS 9000C2/2HV, LİS 9000C2/2, LİS 11000C2/2HV, LİS 11000C2/2, LİS 15000C2/2, LİS 15000C2/2, LİS 15000C2/3, LİS 15000C2/3HV</td>
<td>C2 (Width 228mm)</td>
<td>240</td>
<td>A06B-0440-B324#000x</td>
</tr>
<tr>
<td></td>
<td></td>
<td>420</td>
<td>A06B-0440-B325#000x</td>
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<tr>
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<td></td>
<td>600</td>
<td>A06B-0440-B327#000x</td>
</tr>
<tr>
<td></td>
<td></td>
<td>960</td>
<td>A06B-0440-B328#000x</td>
</tr>
<tr>
<td>LİS 10000C3/2HV, LİS 10000C3/2, LİS 17000C3/2HV, LİS 17000C3/2</td>
<td>C3 (Width 331mm)</td>
<td>120</td>
<td>A06B-0440-B333#000x</td>
</tr>
<tr>
<td></td>
<td></td>
<td>240</td>
<td>A06B-0440-B334#000x</td>
</tr>
<tr>
<td></td>
<td></td>
<td>420</td>
<td>A06B-0440-B335#000x</td>
</tr>
<tr>
<td></td>
<td></td>
<td>600</td>
<td>A06B-0440-B337#000x</td>
</tr>
</tbody>
</table>

**NOTE**

1. The magnet plates which can be combined with each motor are determined. Each motor can be combined only with the magnet plates listed in the above table.
2. **x = 0:** Standard type
   1. With protection cover
   2. Without protection cover
Procedure for selecting a magnet plate

<1> Obtain the magnet plate track length (total length of magnet plates).
Magnet plate track length ≥ effective stroke + coil slider length + coasting distance when the dynamic brake is applied + margin for wires and tube (+ magnetic pole sensor length and length required for installing it)

**NOTE**
To use an incremental linear encoder, a magnetic pole sensor is required. The mounting margin may also be required in addition to the length of the magnetic pole sensor itself. For details, see Parts I, "SPECIFICATIONS," and III, "HANDLING, DESIGN, AND ASSEMBLY."

<2> Combine magnet plates so that the magnet plate track length obtained as above is satisfied.
Example of selection:
When the following conditions are assumed:
- Motor model: LİS 6000B2/2
- Effective stroke: 500 mm
- Coasting distance + margin: 100 mm
Magnet plate track length ≥ 537+500+100=1137(mm)

Because the motor model is the LİS 6000B2/2, magnet plates of the B type must be used in combination. To obtain a length of at least 1137 mm, any of the following three cases can be selected, for example:
(a) 420 mm × 1 + 240 mm × 3 = 1140 mm
   This case is a combination for the shortest total length.
(b) 600 mm × 2 = 1200 mm
   Only one type of magnet plate can be used.
(c) 960 mm × 1 + 240 mm × 1 = 1200 mm
   This case may be the optimum selection when many 960-mm magnet plates are used on other axes.

**NOTE**
1 For workability and safety on installation on a machine, it is appropriate to select case (a) or (b). With case (c), workability or safety may be impaired. For installation of a linear motor on a machine, see Part III, "HANDLING, DESIGN, AND ASSEMBLY."
2 To arrange coil sliders in parallel or symmetrical, as many sets of magnet plates as the number of tracks are required. For example, with a symmetrical arrangement, the required number of magnet plates is double the number of them with a single arrangement.
2.3 POWER SUPPLY MODULE (PSM) SELECTION

2.3.1 Selecting a Power Supply Module

Select a power supply module (called a PSM below) required for driving the linear motor as follows.

NOTE

PSM selection described in this subsection assumes the use of linear motors only along one axis. When there is another feed axis or a spindle, consider and add the PSM capacity required for it.

<1> Check the rated continuous output of the linear motor.

Check the rated continuous output of the linear motor to be used according to the cooling condition and maximum speed to be used. Calculate the rated continuous output for each motor model by using the expressions in the following table based on the speed range used.

Example:
- Motor model:
  Symmetrical arrangement of two LİS 300A1/4 machines.
- Cooling condition: Water cooling
- Maximum speed to be used: 2 m/s

According to the following table, when water cooling and 2 m/s is specified, the output for two machines is calculated as follows:

\[ P = (0.1 \times 2 + 0.07) \times 2 = 0.54 \text{ (kW)} \]
Continuous output for PSM selection

<table>
<thead>
<tr>
<th>Model name</th>
<th>Rated force No cooling (N)</th>
<th>Output No cooling (kW)</th>
<th>Rated force Water cooling (N)</th>
<th>Output Water cooling (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LiS 300A1/4</td>
<td>50</td>
<td>0.05V + 0.02</td>
<td>100</td>
<td>0.1V + 0.07</td>
</tr>
<tr>
<td>LiS 600A1/4</td>
<td>100</td>
<td>0.1V + 0.05</td>
<td>200</td>
<td>0.2V + 0.19</td>
</tr>
<tr>
<td>LiS 900A1/4</td>
<td>150</td>
<td>0.15V + 0.1</td>
<td>300</td>
<td>0.3V + 0.22</td>
</tr>
<tr>
<td>LiS 1500B1/4</td>
<td>300</td>
<td>0.3V + 0.1</td>
<td>600</td>
<td>0.6V + 0.41</td>
</tr>
<tr>
<td>LiS 3000B2/2</td>
<td>600</td>
<td>0.6V + 0.16</td>
<td>1200</td>
<td>1.2V + 0.57</td>
</tr>
<tr>
<td>LiS 3000B2/4</td>
<td>600</td>
<td>0.6V + 0.17</td>
<td>1200</td>
<td>1.2V + 0.70</td>
</tr>
<tr>
<td>LiS 4500B2/2HV</td>
<td>900</td>
<td>0.9V + 0.19</td>
<td>1800</td>
<td>1.8V + 0.75</td>
</tr>
<tr>
<td>LiS 4500B2/2</td>
<td>900</td>
<td>0.9V + 0.21</td>
<td>1800</td>
<td>1.8V + 0.84</td>
</tr>
<tr>
<td>LiS 6000B2/2HV</td>
<td>1200</td>
<td>1.2V + 0.25</td>
<td>2400</td>
<td>2.4V + 1.02</td>
</tr>
<tr>
<td>LiS 6000B2/2</td>
<td>1200</td>
<td>1.2V + 0.28</td>
<td>2400</td>
<td>2.4V + 1.12</td>
</tr>
<tr>
<td>LiS 6000B2/4</td>
<td>1200</td>
<td>1.2V + 0.34</td>
<td>2400</td>
<td>2.4V + 1.37</td>
</tr>
<tr>
<td>LiS 7500B2/2HV</td>
<td>1500</td>
<td>1.5V + 0.31</td>
<td>3000</td>
<td>3.0V + 1.25</td>
</tr>
<tr>
<td>LiS 7500B2/2</td>
<td>1500</td>
<td>1.5V + 0.35</td>
<td>3000</td>
<td>3.0V + 1.39</td>
</tr>
<tr>
<td>LiS 9000B2/2</td>
<td>1800</td>
<td>1.8V + 0.43</td>
<td>3600</td>
<td>3.6V + 1.72</td>
</tr>
<tr>
<td>LiS 9000B2/4</td>
<td>1800</td>
<td>1.8V + 0.52</td>
<td>3600</td>
<td>3.6V + 2.09</td>
</tr>
<tr>
<td>LiS 3300C1/2</td>
<td>660</td>
<td>0.66V + 0.15</td>
<td>1320</td>
<td>1.32V + 0.61</td>
</tr>
<tr>
<td>LiS 9000C2/2HV</td>
<td>1800</td>
<td>1.8V + 0.37</td>
<td>3600</td>
<td>3.6V + 1.49</td>
</tr>
<tr>
<td>LiS 9000C2/2</td>
<td>1800</td>
<td>1.8V + 0.36</td>
<td>3600</td>
<td>3.6V + 1.49</td>
</tr>
<tr>
<td>LiS 11000C2/2HV</td>
<td>2200</td>
<td>2.2V + 0.36</td>
<td>4400</td>
<td>4.4V + 1.44</td>
</tr>
<tr>
<td>LiS 11000C2/2</td>
<td>2200</td>
<td>2.2V + 0.35</td>
<td>4400</td>
<td>4.4V + 1.45</td>
</tr>
<tr>
<td>LiS 15000C2/3HV</td>
<td>3000</td>
<td>3.0V + 0.63</td>
<td>7000</td>
<td>7.0V + 3.45</td>
</tr>
<tr>
<td>LiS 15000C2/2</td>
<td>3000</td>
<td>3.0V + 0.61</td>
<td>7000</td>
<td>7.0V + 3.30</td>
</tr>
<tr>
<td>LiS 15000C2/3</td>
<td>3000</td>
<td>3.0V + 0.60</td>
<td>7000</td>
<td>7.0V + 3.24</td>
</tr>
<tr>
<td>LiS 10000C3/2HV</td>
<td>2000</td>
<td>2.0V + 0.42</td>
<td>4000</td>
<td>4.0V + 1.69</td>
</tr>
<tr>
<td>LiS 10000C3/2</td>
<td>2000</td>
<td>2.0V + 0.51</td>
<td>4000</td>
<td>4.0V + 2.02</td>
</tr>
<tr>
<td>LiS 17000C3/2HV</td>
<td>3400</td>
<td>3.4V + 0.72</td>
<td>6800</td>
<td>6.8V + 2.86</td>
</tr>
<tr>
<td>LiS 17000C3/2</td>
<td>3400</td>
<td>3.4V + 0.86</td>
<td>6800</td>
<td>6.8V + 3.45</td>
</tr>
</tbody>
</table>

\( V = \) Maximum speed to be used (m/s)

**NOTE**

The values listed in the above table and the values calculated from the above table are not guaranteed data but reference data for PSM selection.
<2> Calculate the maximum output during acceleration/deceleration. Calculate the maximum output required during acceleration/deceleration of the linear motor. Use the corresponding expression in the following table according to the speed range to be used for the motor model. When multiple motors are to be driven simultaneously, add the values obtained for the motors.

Example:
The selection conditions are assumed to be the same as above.

Two LİS 300A1/4 machines are used with a maximum speed of 2 m/s, so P is calculated as follows by rounding up fractions.

\[ P = (0.7 \times 2 \div 2.3 + 0.6) \times 2 \approx 2.5 \text{ (kW)} \]
Maximum output during acceleration/deceleration for PSM selection (200 V driving)

<table>
<thead>
<tr>
<th>Model name</th>
<th>Output value for PSM selection (kW)</th>
<th>V = Maximum speed to be used (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LİS 300A1/4</td>
<td>0 – 2.3m/s, 0.7*V/2.3 + 0.6, 2.3 – 4m/s</td>
<td>1.3</td>
</tr>
<tr>
<td>LİS 600A1/4</td>
<td>0 – 2.3m/s, 1.4*V/2.3 + 1.3, 2.3 – 4m/s</td>
<td>2.7</td>
</tr>
<tr>
<td>LİS 900A1/4</td>
<td>0 – 2.3m/s, 2.1*V/2.3 + 1.9, 2.3 – 4m/s</td>
<td>4</td>
</tr>
<tr>
<td>LİS 1500B1/4</td>
<td>0 – 2.1m/s, 3.2*V/2.1+3.1, 2.1 – 4m/s</td>
<td>6.3</td>
</tr>
<tr>
<td>LİS 3000B2/2</td>
<td>0 – 1m/s, 3.2*V + 5.3, 1 – 2m/s</td>
<td>8.5</td>
</tr>
<tr>
<td>LİS 3000B2/4</td>
<td>0 – 2m/s, 6.8*V/2 + 5.3, 2 – 4m/s</td>
<td>12.1</td>
</tr>
<tr>
<td>LİS 4500B2/2</td>
<td>0 – 1m/s, 4.5*V + 7.8, 1 – 2m/s</td>
<td>12.3</td>
</tr>
<tr>
<td>LİS 6000B2/2</td>
<td>0 – 1m/s, 6*V + 10.5, 1 – 2m/s</td>
<td>16.5</td>
</tr>
<tr>
<td>LİS 6000B2/4</td>
<td>0 – 2m/s, 13.5*V/2 + 10.7, 2 – 4m/s</td>
<td>24.2</td>
</tr>
<tr>
<td>LİS 7500B2/2</td>
<td>0 – 1m/s, 7.5*V + 13, 1 – 2m/s</td>
<td>20.5</td>
</tr>
<tr>
<td>LİS 9000B2/2</td>
<td>0 – 1m/s, 9.6*V + 18.8, 1 – 2m/s</td>
<td>28.4</td>
</tr>
<tr>
<td>LİS 9000B2/4</td>
<td>0 – 2m/s, 20.3*V/2 + 16, 2 – 4m/s</td>
<td>36.3</td>
</tr>
<tr>
<td>LİS 3300C1/2</td>
<td>0 – 1m/s, 3.3*V + 5.7, 1 – 2m/s</td>
<td>9.0</td>
</tr>
<tr>
<td>LİS 9000C2/2</td>
<td>0 – 1m/s, 9*V + 19.7, 1 – 2m/s</td>
<td>28.7</td>
</tr>
<tr>
<td>LİS 11000C2/2</td>
<td>0 – 1m/s, 11*V + 23.5, 1 – 2m/s</td>
<td>34.5</td>
</tr>
<tr>
<td>LİS 15000C2/2</td>
<td>0 – 1m/s, 16.8*V + 33.8, 1 – 2m/s</td>
<td>50.6</td>
</tr>
<tr>
<td>LİS 15000C2/3</td>
<td>0 – 1.5m/s, 23.3*V/1.5 + 33.8, 1.5 – 3m/s</td>
<td>57.1</td>
</tr>
<tr>
<td>LİS 10000C3/2</td>
<td>0 – 0.8m/s, 8*V/0.8 + 11.9, 0.8 – 2m/s</td>
<td>19.9</td>
</tr>
<tr>
<td>LİS 17000C3/2</td>
<td>0 – 0.8m/s, 13.6*V/0.8 + 36.5, 1 – 2m/s</td>
<td>50.1</td>
</tr>
</tbody>
</table>
### Maximum output during acceleration/deceleration for PSM selection (400 V driving)

<table>
<thead>
<tr>
<th>Model name</th>
<th>Output value for PSM selection (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LİS 3000B2/2</td>
<td>0 – 2m/s: 6.4*V/2 + 5.3, 2 – 4m/s: 11.7</td>
</tr>
<tr>
<td>LİS 4500B2/2HV</td>
<td>0 – 1m/s: 4.5*V + 7.8, 1 – 2m/s: 12.3</td>
</tr>
<tr>
<td>LİS 4500B2/2</td>
<td>0 – 2m/s: 9*V/2 + 7.8, 2 – 4m/s: 16.8</td>
</tr>
<tr>
<td>LİS 6000B2/2HV</td>
<td>0 – 1m/s: 6*V + 10.5, 1 – 2m/s: 16.5</td>
</tr>
<tr>
<td>LİS 6000B2/2</td>
<td>0 – 2m/s: 12*V/2 + 10.5, 2 – 4m/s: 22.5</td>
</tr>
<tr>
<td>LİS 7500B2/2HV</td>
<td>0 – 1m/s: 7.5*V + 13, 1 – 2m/s: 20.5</td>
</tr>
<tr>
<td>LİS 7500B2/2</td>
<td>0 – 2m/s: 15*V/2 + 13, 2 – 4m/s: 28.0</td>
</tr>
<tr>
<td>LİS 9000B2/2</td>
<td>0 – 2m/s: 19.2*V/2 + 18.8, 2 – 4m/s: 38.0</td>
</tr>
<tr>
<td>LİS 3300C1/2</td>
<td>0 – 2m/s: 6.6*V/2 + 5.7, 2 – 4m/s: 12.3</td>
</tr>
<tr>
<td>LİS 9000C2/2HV</td>
<td>0 – 0.8m/s: 7.2*V/0.8 + 20.8, 0.8 – 2m/s: 28.0</td>
</tr>
<tr>
<td>LİS 9000C2/2</td>
<td>0 – 2m/s: 18*V/2 + 19.7, 2 – 4m/s: 37.7</td>
</tr>
<tr>
<td>LİS 11000C2/2HV</td>
<td>0 – 0.8m/s: 8.8*V/0.8 + 21.3, 0.8 – 2m/s: 30.1</td>
</tr>
<tr>
<td>LİS 10000C2/2</td>
<td>0 – 2m/s: 22*V/2 + 23.5, 2 – 4m/s: 45.5</td>
</tr>
<tr>
<td>LİS 15000C2/3HV</td>
<td>0 – 1.2m/s: 23.8*V/1.2 + 34.0, 1.2 – 3m/s: 57.8</td>
</tr>
<tr>
<td>LİS 15000C2/2</td>
<td>0 – 2m/s: 33.6*V + 33.8, 2 – 4m/s: 67.4</td>
</tr>
<tr>
<td>LİS 10000C3/2HV</td>
<td>0 – 0.8m/s: 8*V/0.8 + 23.4, 0.8 – 2m/s: 31.4</td>
</tr>
<tr>
<td>LİS 10000C3/2</td>
<td>0 – 2m/s: 20*V/2 + 23.4, 2 – 4m/s: 43.4</td>
</tr>
<tr>
<td>LİS 17000C3/2HV</td>
<td>0 – 0.8m/s: 13.6*V/0.8 + 36.5, 0.8 – 2m/s: 50.1</td>
</tr>
<tr>
<td>LİS 17000C3/2</td>
<td>0 – 2m/s: 34*V/2 + 36.5, 2 – 4m/s: 70.5</td>
</tr>
<tr>
<td>LİS 17000C3/2</td>
<td>0 – 2m/s: 34*V/2 + 36.5, 2 – 4m/s: 70.5</td>
</tr>
</tbody>
</table>

V = Maximum speed to be used (m/s)

**NOTE**

The values listed in the above table and values obtained using the expressions in the above table can be used only for power supply module selection. They are not guaranteed values.
<3> Determine a PSM. Find a PSM which satisfies the continuous and maximum output conditions determined in steps <1> and <2>. For the PSM specifications, refer to the latest version of "FANUC SERVO AMPLIFIER αi series DESCRIPTIONS" (B-65282EN).

Example:
Find a PSM which satisfies the following conditions obtained in the examples in <1> and <2> above: continuous output of 0.54 kW and short-time (maximum) output of 2.4 kW. It can be seen from the descriptions (B-65282EN) that the αi PS 5.5 (continuous output of 5.5 kW and maximum output of 11 kW) and αi PSR 3 (continuous output of 3 kW and maximum output of 12 kW) are applicable.
2.3.2 Calculating the Amount of Regenerative Energy

NOTE
When you use an amplifier using the power supply regeneration method, you need not calculate the amount.

The following expressions give the amount of energy regenerated in a linear motor. If the amount of regenerative energy exceeds the permissible amount of regenerative energy for the drive amplifier, it is necessary to provide a separate regenerative discharge unit.

\[ P = \frac{(M_T \times V_M^2 - F_F \times V_M \times t_a)}{(2 \times F)} \] \[ \text{.....................................}<1> \]

\[ Q = (9.8 \times M_T - F_F) - V_M \times \left(\frac{D}{100}\right) \] \[ \text{.....................................}<2> \]

- \( P \): Deceleration energy (W)
- \( Q \): Energy generated at a drop by gravity (W)
- \( F_F \): Friction (N)
- \( t_a \): Rapid traverse acceleration/deceleration time (sec)
- \( F \): Rapid traverse count (sec/count)
- \( D \): Duty ratio (%) at rapid traverse downward movement
  * \( D < 50 \)

Obtain the amount of regenerative energy for the horizontal axis using expression \(<1>\). Obtain the amount of regenerative energy for the vertical axis using expression \(<1> + \text{expression }<2>\).

- Amount of regenerative energy for the horizontal axis \(\geq P\)
- Amount of regenerative energy for the vertical axis \(\geq P + Q\)

NOTE
For the permissible amount of regenerative energy for drive amplifiers and the specifications of separate regenerative discharge units, refer to the latest version of "FANUC SERVO AMPLIFIER \(a_i\) series DESCRIPTIONS" (B-65282EN).
2.4 EXTERNAL COOLING UNIT SELECTION

2.4.1 Overview

To forcibly cool a linear motor, an external cooling unit is required. It is desirable to use a chiller (cooler) for water cooling or industrial dry air for air cooling. The cooling unit to be used must satisfy the "cooling conditions" listed in Section 2.2, "SPECIFICATION LIST," in Part I, "SPECIFICATIONS." If it is absolutely necessary to use another cooling medium such as oil, note that the rated continuous force may be reduced by several percent to several tens of percent due to the difference in characteristics between coolants.

For water cooling, it is desirable to use a chiller (cooler) which keeps the room temperature when the ambient temperature of the motor is not high. If a coolant temperature lower than the motor ambient temperature is set, condensation may occur on the motor depending on the ambient condition, resulting in degraded insulation of the motor. For this reason, when selecting a chiller of which coolant temperature is fixed, carefully manage the coolant temperature so that no condensation occurs.

NOTE
If any cooling condition listed in Part I, "SPECIFICATIONS," is not satisfied, the motor output specifications are not guaranteed.

⚠️ CAUTION
If condensation occurs on the motor due to excessive cooling or high humidity, immediately change the coolant temperature and take other measures against condensation. In an environment which keeps condensation for a long time, insulation of the motor may tend to be degraded, resulting in considerable reduction of the life of the motor.
2.4.2 Example of Selection

The cooling unit to be used must have the capacity listed under "Required cooling capacity" in the specification list in Part I, "SPECIFICATIONS." This value is determined under the condition that root mean square force/rated continuous force = 1. Under ordinary use conditions, the capacity is usually lower than the listed value. For example, when root mean square force/rated continuous force = 0.7, the heat output is reduced to $0.7^2 = 0.49$ (49%) as compared with that during continuous operation with the rated continuous force. For this reason, as the required capacity of the cooling unit, the value in the specification list can be reduced to 49%.

An example of calculation is shown below:

Assume the following machine:
- X-axis:
  One LS 9000B2/4, water cooling, root mean square force/rated continuous force = 0.7
- Y-axis:
  One LS 3000B2/4, water cooling, root mean square force/rated continuous force = 0.8

Because the cooling capacity required for the X-axis (LS 9000B2/4) is 2,600 W as listed in Section 1.2, "SPECIFICATION LIST," in Part I, "SPECIFICATIONS," the required cooling capacity under the above condition is:

$$2600 \times 0.7^2 = 1274 \text{[W]}$$

Similarly, the cooling capacity required for the Y-axis (LS 3000B2/4) is:

$$900 \times 0.8^2 = 576 \text{[W]}$$

Consequently, if the motors on both the X-and Y-axes run simultaneously, the maximum required cooling capacity is:

$$1274 + 576 = 1850 \text{[W]}$$

If the motors on both the X-and Y-axes do not run simultaneously, the required cooling capacity is 1274 [W].

To determine the required cooling capacity more precisely, it is advisable to add the duty curves (root mean square force/rated continuous force) for both axes based on the time axis and calculate the cooling capacity at the point where the sum is the maximum.

---

**NOTE**

1. For how to calculate the root mean square force, see Part II, "CONFIGURATIONS AND SELECTION."

2. The cooling capacity calculated as above is required when the internal temperature of the coil slider rises to a temperature near the maximum operating temperature. For this reason, if the machine is apt to be easily deformed by temperature rising, it may be desirable to select a cooling unit with an adequate margin of the required cooling capacity.

3. Use of strong cooling can increase the rated continuous force of the motor to some extent. Carefully use strong cooling so that condensation does not occur on the coil slider due to excessive cooling.
3 LINEAR MOTOR SELECTION FORM

For selecting a FANUC linear motor, fill in a "Linear Motor Selection Form" shown on another page and submit the form to a FANUC sales representative. FANUC experts on linear motors will consider an appropriate motor in detail and FANUC can make give you suggestions and advice at your request.

How to use a "Linear Motor Selection Form"

<1> Make a copy of "Linear Motor Selection Form" shown on another page and enter the linear motor selection conditions in the copy without omission. Entering a permissible range as a selection condition is very useful for consideration by FANUC.

<2> Submit the entered "Linear Motor Selection Form" to a FANUC sales representative.

<3> FANUC experts on linear motors select an appropriate motor by detailed consideration, then the FANUC sales representative informs you of the selection result.

NOTE
1) If there is an omission in the Linear Motor Selection Form, an appropriate motor may not be able to be selected. Be sure to fill in the form without omission.
2) Motor selection at FANUC needs 1 to 2 weeks in ordinary cases. If you are in a rush, write your request in the selection form or make it known to the sales representative.

Explanation of terms in the "Linear Motor Selection Form"

- **Direction of travel**
  If the axis is slanted, enter the angle from a horizontal line.

- **Weight of movable objects**
  Enter the maximum weight of all movable objects (table, tool post, workpiece, and so on), excluding the motor.

- **Type of counterbalance on a vertical axis**
  Enter whether to use a counterbalance on a vertical axis. When using a counterbalance on a vertical axis, also enter its type and weight (or force applied to it).

- **Table support (sliding, rolling, and static pressure)**
  Enter the type of sliding surface. Also enter a special material for the sliding surface if used.
- Friction coefficient
Enter the friction coefficient of the machine sliding surface.

- Load weight
If the required force varies between when the load is lifted and when it is lowered, enter the required force for both cases.

- Low-speed feeding
Enter the force required for very low-speed operation and at a stop. Keep the force within 60% of the rated continuous force.

- Rapid traverse
Enter the force required for rapid traverse at a constant rate. Do not include the force required during acceleration/deceleration.

- Cutting thrust
Enter the maximum reaction force that occurs during cutting.

- Maximum cutting load
Enter the force applied to the linear motor when cutting thrust is produced. The cutting load may vary depending on the reaction force caused from the sliding surface by cutting thrust. Try to enter as accurate values as possible by referencing data measured on similar machines.

- Maximum cutting duty ratio/on time
Enter the duty ratio (%) and on time for which the maximum cutting load is applied. For the duty ratio (%) and on time, see Subsection 2.1.4, "Overload Duty Characteristic."

- Rapid traverse positioning frequency
Enter how many times rapid traverse positioning is to be performed every minute.

- Positioning stroke
Enter the minimum amount of travel for rapid traverse positioning.

- Duty cycle
Draw one cycle of the most extreme operation pattern you expect. Be sure to add the dwell operation if used.
## Linear Motor Selection Form

Enter all items without omission.

<table>
<thead>
<tr>
<th>Company name</th>
<th>Date of entry</th>
<th>Year:</th>
<th>Month:</th>
<th>Day:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department and name of person in charge</td>
<td>Machine type</td>
<td>FANUC Series</td>
<td>Machine name</td>
<td></td>
</tr>
</tbody>
</table>

### Linear Motor Selection Form Details

**Axis name**

**Desired motor specification (model)**

**Power voltage** V

**Maximum cable length (between motor and amplifier)** m

**Effective stroke** mm

**Direction of travel (horizontal or vertical)**

**Weight of movable objects (including the workpiece)** kg

**Type of counterbalance on a vertical axis**

**Table support (sliding, rolling, and static pressure)**

**Friction coefficient**

**Movable part (slider or magnet plate)**

**Slider arrangement (single, serial, parallel, or symmetrical)**

**Cooling of motor (water cooling, oil cooling, air cooling, no cooling)**

**Motor installation size (length x width)** mm

**CNC least input increment** mm

**Rapid traverse rate** m/min

**Acceleration** G

**Cutting feedrate** m/min

<table>
<thead>
<tr>
<th>Load weight</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-speed feeding</td>
<td></td>
</tr>
<tr>
<td>Rapid traverse</td>
<td></td>
</tr>
<tr>
<td>Cutting thrust</td>
<td></td>
</tr>
<tr>
<td>Maximum cutting load</td>
<td></td>
</tr>
</tbody>
</table>

**Maximum cutting duty ratio/on time** %/min

**Rapid traverse positioning frequency** count/min

**Positioning stroke** mm

**Duty cycle (including dwell operation)**

Draw a chart indicating time-speed-load or time-position-load relationships (in landscape orientation) for one cycle. If the space on this form is not enough, draw the chart on another sheet and attach it to this form.

You can enter the root mean square force (N) for one cycle if you can obtain it.

**Type and model of linear encoder**

**Signal pitch of linear encoder** µm

<table>
<thead>
<tr>
<th>Rapid traverse acceleration/deceleration time</th>
<th>msec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cutting feed acceleration/deceleration time</td>
<td>msec</td>
</tr>
<tr>
<td>Positional loop gain</td>
<td>sec⁻¹</td>
</tr>
</tbody>
</table>

**Distance required in decelerating to stop** mm

**Distance required to stop by dynamic braking** mm

### Remarks and Others

**NOTE**

1. When using a unit other than the above, enter a value with its unit.
2. The above table assumes positioning use. Contact us separately for other use.
3. When this form is not filled completely, FANUC may enter tentative values for calculation. In this case, the selection results by this form are not guaranteed.
4. When the force required for acceleration/deceleration or the acceleration/deceleration time is calculated, ideal acceleration/deceleration with a triangle waveform is assumed. Actually, time for servo system delay or stationary stop must be considered.

The selection results by this form do not guarantee the final performance of the machine.
III. HANDLING, DESIGN, AND ASSEMBLY
1 HANDLING THE LINEAR MOTOR

⚠️ WARNING
For the linear motor, very powerful magnets are used. If the linear motor is handled incorrectly, serious accidents including fatal accidents can occur. Read this chapter carefully for thorough understanding, and do not fail to observe the cautions and warnings described in this chapter. Ensure that only persons educated for the handling of the linear motor handle the linear motor.
1.1 COIL SLIDER

Storing the coil slider

The coil slider is an electric component. When storing coil sliders, observe the following:
- Store coil sliders in a temperature range of 0°C to 40°C.
- Store coil sliders in an indoor environment where the coil sliders are not exposed to rain and dust.
- Ensure that coil sliders are not exposed to water (including condensation), oil, chemicals, and so forth.
- Do not machine coil sliders.
- Do not apply a shock to coil sliders.
- Do not flaw the resin surface of coil sliders.

Transporting coil sliders

A large coil slider may not be carried by hand. In such a case, use an auxiliary tool such as a crane for safe transportation. A motor of LÍS 1500B1/4 or a larger size has many tapped holes for assembly to a machine. If it is difficult to transport a coil slider by using a fabric rope, those tapped holes may be used to lift the coil slider.

NOTE
1. For the positions and sizes of tapped holes, see Part I, "SPECIFICATIONS".
2. When using the tapped holes of a coil slider for transportation, transport the coil slider singly. When using the coil slider tap to lift up the coil slider that is attached to another structural member, the coil slider may be broken.
3. To lift up the coil slider using its tapped holes, lift it up from the surface that is not fully coated (surface on which iron is partly exposed). Lifting it up from another surface may break or drop the motor.
1.2 MAGNET PLATE

**WARNING**
For a magnet plate, many very powerful magnets are used. So, a magnet plate can cause medical appliances such as a pacemaker and AICD to malfunction. Ensure that persons wearing these medical appliances do not get closer to a magnet plate. If a person wearing any of those medical appliances must get closer to a magnet plate, the person must be at least 30 cm away from the magnet plate.

**Storing a magnet plate**

When a magnet plate is shipped from FANUC, it is packed so that it does not affect the outside. Until a magnet plate is assembled to a machine, keep the tin plates and cushioning corrugated cardboard attached to it.

For other storage requirements, see the description of coil sliders.
## Transporting a magnet plate

**WARNING**

1. Do not remove the corrugated cardboard and tin plates attached during packing unless the need arises.
2. Ensure that no magnetic materials (including a tool) are brought closer to the magnet plate and that the magnet plate is away from magnetic materials. If a magnetic material such as iron is brought closer to the magnet plate, the magnetic material and the magnet plate can pull each other with a force of up to 5 tons, resulting in a serious injury.
3. When moving a magnet plate on the surface of a magnetic material such as a machine installation face or work table, be sure to face the magnet side of the magnet plate upward and face the iron side of the magnet plate downward, and be sure to slide the magnet plate horizontally relative to the move direction. Do not tilt the magnet plate or slide it on an edge of the magnet plate. Otherwise, the magnet plate can be pulled to the magnetic material to catch your hand or body. Because of an enormous pulling force, it is difficult to relieve your caught hand or body.

![Warning Diagram](image)
1.3 SENSOR

**NOTE**
For the handling of a linear encoder, contact the manufacturer of the linear encoder.

The magnetic pole sensor and position detection circuit are precision electronic components. Handle these components carefully as with ordinary electronic devices.

⚠️ **CAUTION**
Do not conduct tests such as a breakdown voltage test on the magnet pole sensor and position detection circuit. Moreover, do not disassemble these components by removing the screws when unnecessary. Otherwise, the internal circuitry can be damaged and the components can fail.
This chapter provides information about the mechanical design of the linear motor. The linear motor can become uncontrollable in the worst case when its dimensions for installation are incorrect. Be sure to read this section before designing a machine with a linear motor mounted.

The mountable positions of the FANUC Linear Motor LİS series and linear encoder are predetermined. This requirement is related to the operation theory of the linear motor. For the operation theory of the FANUC Linear Motor LİS series, see Appendix.
2.1 MOUNTING COIL SLIDERS

Mounting surface of a coil slider

NOTE
The surface of a coil slider used for mounting onto the machine is predetermined. If the surface of a coil slider used for mounting onto the machine is incorrect, the linear motor does not operate normally.

2.1.1 Mounting Surface Precision on the Machine Side

As a guideline, the machining precision of the mounting surface on the machine side should not exceed 50 µm for both roughness and undulation.

NOTE
It is recommended that the entire mounting surface be used basically to mount the coil slider onto the machine. When it is mounted using only the areas near mounting bolts to reduce the weight through material removal of the mounting surface, be careful not deform the coil slider more than 0.1 mm due to motor operation or expected impacts.
**LīS 300A1/4, LīS 600A1/4, and LīS 900A1/4**

Mount the metallic side provided with screw holes onto the machine. Insert screws through the screw holes from the machine side and fasten the coil slider. On the opposite side, no screw hole is provided. The opposite side is coated with black resin (coating compound) and is to face the magnet plate.

**NOTE**

For forced cooling (air cooling or water cooling) of LīS 300A1/4, LīS 600A1/4, and LīS 900A1/4, an optional cooling plate is required. The cooling plate is to be inserted between the table and coil slider. In mechanical design, consider the thickness of the cooling plate. For the specification of the cooling plate, see Part I, "SPECIFICATIONS". For the method of mounting the cooling plate, see Chapter 3, "ASSEMBLY" in this part.

**LīS 1500B1/4 or models of larger sizes**

Mount the metallic side provided with screw holes onto the machine. Insert screws through the screw holes from the machine side and fasten the coil slider. On the opposite side, no screw hole is provided. The opposite side is coated with black resin (coating compound) and is to face the magnet plate.
### 2.1.2 Attaching Accuracy of Coil Sliders

The mounting margin in the width direction between the coil slider and magnet plate is about 2 mm. This means that if the sum of shifts and distortions in the width direction between the coil slider and magnet plate is within \( \pm 1 \) mm from the true center, the characteristics of the motor are little affected.

![Diagram of coil slider and magnet plate with WM and WL labels](image)

**WM** : Magnetically effective width of the magnet track  
**WL** : Magnetically effective width of the coil slider

**NOTE**

1. Do not mount the coil slider on a place where the coil slider or mounting portion may deform (bend) more than 0.1 mm due to magnetic attraction. Coil slider resin is broken or chipped, probably disabling normal operation of the motor.

2. It is recommended that the entire mounting surface be used basically to mount the coil slider onto the machine. When it is mounted using only the areas near mounting bolts to reduce the weight through material removal of the mounting surface, be careful not deform the coil slider more than 0.1 mm due to motor operation or expected impacts.
2.2 MOUNTING MAGNET PLATES

Direction and mounting hole locations of magnet plates
Mount the metallic side of a magnet plate onto the machine, and face the black resin side toward the coil slider.

When mounting multiple magnet plates, be sure to arrange them so that their "N" marks are oriented in the same direction.

NOTE
If the mounting direction ("N" mark direction) of a magnet plate is incorrect, the motor cannot be driven normally.

The table below indicates reference dimensions for the mounting screw hole pitch (P1), the shortest screw span between adjacent magnet plates (P2), and the gap between magnet plates (G). In accordance with these dimensions, produce mounting holes (screws) on the machine.

<table>
<thead>
<tr>
<th>Type of magnet plate</th>
<th>Applicable model</th>
<th>P1 (mm)</th>
<th>P2 (mm)</th>
<th>G (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B, C</td>
<td>Lis 1500B1/4 and up</td>
<td>90±0.1</td>
<td>60±0.1</td>
<td>(1)</td>
</tr>
<tr>
<td>A</td>
<td>Up to Lis 900A1/4</td>
<td>30±0.1</td>
<td>30±0.1</td>
<td>(0.5)</td>
</tr>
</tbody>
</table>

Mounting surface precision on the machine side
As a guideline, the machining precision of the mounting surface on the machine side should not exceed 50 µm for both roughness and undulation.

NOTE
1. Do not mount the magnet plate on a place where the magnet plate or mounting portion may deform (bend) more than 0.1 mm. In particular, due to repeated deformation caused by passes of the coil slider, the resin of the magnet plate is broken, the magnet is misaligned, or other damages are caused, probably disabling normal operation of the motor.
2. It is recommended that the entire mounting surface be used basically to mount the magnet plate onto the machine. When it is mounted using only the areas near mounting bolts to reduce the weight through material removal of the mounting surface, be careful not to deform the coil slider more than 0.1 mm due to motor operation or expected impacts.
2.3 LINEAR MOTOR AIR GAP

An air gap of a specified width is required between the coil slider and magnet plate of the FANUC Linear Motor L/S series. For the FANUC Linear Motor L/S series, an air gap of 0.5 mm is adopted as the motor specifications. Only for the magnetic attraction, however, the maximum value is adopted as the motor specifications.

The magnetic attraction and maximum force change together with the air gap. When the air gap is set relatively wide (for example, 0.7 mm or more), the maximum force decreases and the magnetic attraction decreases more. Therefore, it is possible to reduce machine deformation caused by magnetic attraction and to decrease the linear guide capacity. Since cogging is also reduced, the control performance is improved. Generally, it is recommended that a relatively wide air gap be set by considering changes in the motor characteristics shown above in terms of security, unless the maximum force exceeding the specifications is required.

When the air gap is significantly uneven, the motor electric coefficient changes in some positions even in the same stroke, making the positions easy to oscillate. This degrades the control performance. Even in a case like this, the effect is reduced since a wide air gap decreases the unevenness proportion of the entire gap.

![Magnetic attraction chart](image)

<table>
<thead>
<tr>
<th>Magnetic attraction [N]</th>
<th>Maximum force ratio [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>LJS 17000C3</td>
<td></td>
</tr>
<tr>
<td>LJS 11000C2</td>
<td></td>
</tr>
<tr>
<td>LJS 10000C3</td>
<td></td>
</tr>
<tr>
<td>LJS 9000B2</td>
<td></td>
</tr>
<tr>
<td>LJS 9000C2</td>
<td></td>
</tr>
<tr>
<td>LJS 7500B2</td>
<td></td>
</tr>
<tr>
<td>LJS 6000B2</td>
<td></td>
</tr>
<tr>
<td>LJS 4500B2</td>
<td></td>
</tr>
<tr>
<td>LJS 3300C1</td>
<td></td>
</tr>
<tr>
<td>LJS 3000B2</td>
<td></td>
</tr>
<tr>
<td>LJS 1500B1</td>
<td></td>
</tr>
<tr>
<td>LJS 900A1</td>
<td></td>
</tr>
<tr>
<td>LJS 600A1</td>
<td></td>
</tr>
<tr>
<td>LJS 300A1</td>
<td></td>
</tr>
</tbody>
</table>

NOTE
1 For the air gap applied when the stainless cover supplied by us is attached to the magnet plate, see the above chart, assuming the stainless cover is part of the magnet plate.
2 For a force constant, see Part I, "SPECIFICATIONS".
There are two types of magnet plates for the FANUC LINEAR MOTOR LIS series: standard type and protective cover mounted type. The entire width is the same for both types, but the magnet plate of the protective cover mounted type is thinner by 0.3 mm, the thickness of the protective cover. Keep the fact in mind to install the machine. The air gap refers to the distance between the coil slider and the magnet plate (or the distance between the coil slider and the protective cover for the protective cover mounted type).

- Magnet plate (standard type)

Rating assurance air gap A = 0.5 (mm)

- Magnet plate (protective cover mounted type)

Rating assurance air gap A = 0.5 mm
Recommended air gap A : 0.7 mm or more

NOTE
1 For detailed dimensions of the coil slider and magnet plate, see Part I, "SPECIFICATIONS."
2 For the protective cover mounted type, an air gap of 0.7 mm or more is recommended to prevent the cover from contorting.
2.5 ACTIVE FORCE AREA OF THE LINEAR MOTOR

The coil slider of the FANUC LINEAR MOTOR LİS series has an area (active force area) in which a thrust force is effectively generated. To satisfy the specifications of the linear motor, the active force area must face the magnet plate. When using the absolute linear encoder, the coil slider overhangs the magnet plate. However, the stroke can be increased by the distance equal to (LS - LA).

For the incremental linear encoder, the stroke cannot be increased since the magnetic pole detector is mounted on the end face of the coil slider. The active force area almost matches an area where magnetic attraction is exerted.

LİS 300A1/4, LİS 600A1/4, and LİS 900A1/4

<table>
<thead>
<tr>
<th>Model name</th>
<th>LS x WS for coil slider</th>
<th>LA x WA for active force area</th>
</tr>
</thead>
<tbody>
<tr>
<td>LİS 300A1/4</td>
<td>73 x 71</td>
<td>71 x 50</td>
</tr>
<tr>
<td>LİS 600A1/4</td>
<td>133 x 71</td>
<td>131 x 50</td>
</tr>
<tr>
<td>LİS 900A1/4</td>
<td>193 x 71</td>
<td>191 x 50</td>
</tr>
</tbody>
</table>
### Lis 1500B1/4 and up

<table>
<thead>
<tr>
<th>Model name</th>
<th>LS x WS for coil slider</th>
<th>LA x WA for active force area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lis 1500B1</td>
<td>297 x 130</td>
<td>261 x 80</td>
</tr>
<tr>
<td>Lis 3000B2</td>
<td>297 x 200</td>
<td>261 x 150</td>
</tr>
<tr>
<td>Lis 4500B2</td>
<td>417 x 200</td>
<td>381 x 150</td>
</tr>
<tr>
<td>Lis 6000B2</td>
<td>537 x 200</td>
<td>501 x 150</td>
</tr>
<tr>
<td>Lis 7500B2</td>
<td>657 x 200</td>
<td>621 x 150</td>
</tr>
<tr>
<td>Lis 9000B2</td>
<td>777 x 200</td>
<td>741 x 150</td>
</tr>
<tr>
<td>Lis 3300C1</td>
<td>417 x 150</td>
<td>381 x 100</td>
</tr>
<tr>
<td>Lis 9000C2</td>
<td>537 x 260</td>
<td>501 x 210</td>
</tr>
<tr>
<td>Lis 11000C2</td>
<td>657 x 260</td>
<td>621 x 210</td>
</tr>
<tr>
<td>Lis 15000C2</td>
<td>897 x 260</td>
<td>861 x 210</td>
</tr>
<tr>
<td>Lis 10000C3</td>
<td>417 x 355</td>
<td>381 x 305</td>
</tr>
<tr>
<td>Lis 17000C3</td>
<td>657 x 355</td>
<td>621 x 305</td>
</tr>
</tbody>
</table>

**NOTE**

For detailed dimensions of the coil slider and magnet plate, see Part I, "SPECIFICATIONS."
2.6 MOUNTING A LINEAR ENCODER

2.6.1 Mounting Rigidity and Noise Protection

The linear motor is controlled using only a feedback signal from the linear encoder. This means that if the mounting rigidity of the linear encoder is insufficient, a feedback signal can pick up noise such as mechanical vibration, resulting in a problem such as degraded precision and uncontrollability. Be sure to mount a linear encoder with a high rigidity so that it does not pick up peripheral vibration. Set the rigidity (natural frequency) of the head mounting portion to 2 kHz or more as a guideline. Moreover, ensure that a linear encoder is mounted with the specified precision.

If a feedback signal from the linear encoder picks up noise from another electric system, a problem similar to the problems mentioned above can occur. Ensure that the feedback signal cable is sufficiently shielded and grounded, and that the feedback signal cable does not run across or along with the motor power line.

2.6.2 Linear Motor and Linear Encoder Directions

To drive a linear motor normally, the positive direction of the linear motor and the positive direction of the linear encoder must match each other.

⚠️ CAUTION
If the direction of the linear motor does not match the direction of the linear encoder, the motor can become uncontrollable in the worst case. In mechanical design and assembly, ensure the matching of the directions.

Positive direction of a linear motor

The positive (plus) direction of a linear motor depends on whether the coil slider is movable or the magnet plate is movable. The positive direction can be determined from the direction of power line running direction.

- When the coil slider is movable

![Diagram of Positive Direction](image)
- When the magnet plate is movable

**Positive direction of a linear encoder**

The positive direction of a linear encoder is the direction in which the encoder counts up. The positive direction of a linear encoder depends on the manufacturer and model. For details, refer to the specifications of a linear encoder used. Examples of positive direction are described below using the HEIDENHAIN's absolute linear encoder LC192F and the Mitutoyo's absolute linear encoder AT353.

<table>
<thead>
<tr>
<th>NOTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>The examples described below are based on the linear encoder specifications that are available to FANUC as of the publication of this manual. The information below is subject to change if the specifications of the linear encoders are updated. For the latest information, contact relevant encoder manufacturer.</td>
</tr>
</tbody>
</table>

- **HEIDENHAIN's absolute linear encoder LC192F (with the head movable)**

  The direction opposite to the "HEIDENHAIN" mark provided on the side of the linear encoder unit represents the positive direction.

<table>
<thead>
<tr>
<th>HEIDENHAIN</th>
<th>Main linear encoder unit fixed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head movable</td>
<td>Positive direction</td>
</tr>
</tbody>
</table>

- **HEIDENHAIN's absolute linear encoder LC192F (with the main linear encoder unit movable)**

  The direction toward the "HEIDENHAIN" mark provided on the side of the linear encoder unit represents the positive direction.

<table>
<thead>
<tr>
<th>HEIDENHAIN</th>
<th>Main linear encoder unit movable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head fixed</td>
<td>Positive direction</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NOTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>For the LC491F, the &quot;HEIDENHAIN&quot; mark is provided on the top of the unit.</td>
</tr>
</tbody>
</table>
- Mitutoyo's absolute linear encoder AT353 (with the head movable)

The position where the "AT353" mark is provided on the main encoder unit represents the positive direction.

- Mitutoyo's absolute linear encoder AT353 (with the main linear encoder unit movable)

The position where the "Mitutoyo" mark is provided on the main encoder unit represents the positive direction.

**When the positive position of the motor does not match that of the linear encoder**

When the positive position of the motor cannot match that of the linear encoder due to restrictions on machine design or other reasons, reverse the positive direction of the motor by changing the phase order of motor power lines. This enables the positive position of the motor to match that of the linear encoder.

**NOTE**

1. When connection was made with the phase order of the power lines changed, normal connection may be erroneously conducted during maintenance. Therefore, take appropriate measures by, for example, preparing dedicated power lines or describing it explicitly in the maintenance manual of the machine to prevent a failure.

2. This method can be applied only when the absolute linear encoder is used. When the incremental linear encoder is used, never use this method because this direction may be different from that for the magnetic pole sensor, probably making it uncontrollable in the worst case.
2.6.3 Incremental Linear Encoder and Magnetic Pole Sensor Mounting Positions

For LİS 300A1/4, LİS 600A1/4, and LİS 900A1/4

To use an incremental linear encoder, a magnetic pole sensor is required. The positional relationships of these components are predetermined. The following positional relationships and expressions must be satisfied at the same time.

Mount a linear motor, magnetic pole sensor, and linear encoder at the following position in the figure above where the linear encoder outputs the reference mark signal (reference signal):

\[ P = 30 \times N + 10.4 \text{ (mm)} \quad \text{N: Natural number} \]

<table>
<thead>
<tr>
<th>Magnet end face on the magnetic pole sensor side</th>
<th>L (mm)</th>
<th>M: Natural number</th>
</tr>
</thead>
<tbody>
<tr>
<td>N pole</td>
<td>L=30×M+17.5±0.5 (mm)</td>
<td></td>
</tr>
<tr>
<td>S pole</td>
<td>L=30×M+2.5±0.5 (mm)</td>
<td></td>
</tr>
</tbody>
</table>

⚠️ CAUTION

1. Before mounting a magnetic pole sensor and linear encoder, check that the positive direction of the linear motor matches the positive direction of the linear encoder. If a positive direction mismatch exists, the motor can become uncontrollable in the worst case. For the method of checking, see Subsection 2.4.2, "Linear Motor and Linear Encoder Directions".

2. If a magnetic pole sensor or linear encoder is mounted at an incorrect position, the power factor can drop, and a soft thermal (OVC) alarm can be issued. In addition, the motor can become uncontrollable in the worst case. Before turning on the power to the machine after machine assembly, recheck the positional relationships.
NOTE
With the FANUC Linear Motor LİS series, an incremental linear encoder that outputs the reference mark signal (Z-phase signal) at one position only is required. Specify this requirement when ordering an incremental linear encoder. If an incremental linear encoder has two positions where the reference mark signal is output, a count miss alarm may be issued when the second reference mark signal is detected.

For LİS 1500B1 and LİS 3300C1

For the LİS 1500B1/4 and LİS 3300C1/2, the magnetic pole sensor cannot be directly attached to the coil slider. For this purpose, the positional relationship for mounting the linear encoder and the magnetic pole sensor is predetermined.

Mount a linear motor, magnetic pole sensor, and linear encoder at the following position in the figure above where the linear encoder outputs the reference mark signal:

\[ P = 60 \times N \ (\text{mm}) \quad N: \text{Natural number} \]

<table>
<thead>
<tr>
<th>Magnet end face on the magnetic pole sensor side</th>
<th>L (mm)</th>
<th>M: Natural number</th>
</tr>
</thead>
<tbody>
<tr>
<td>N pole</td>
<td>( L = 60 \times M + 27 \pm 0.5 ) (mm)</td>
<td></td>
</tr>
<tr>
<td>S pole</td>
<td>( L = 60 \times M + 57 \pm 0.5 ) (mm)</td>
<td></td>
</tr>
</tbody>
</table>
2. MECHANICAL DESIGN  HANDLING, DESIGN, AND ASSEMBLY

CAUTION

1. Before mounting a magnetic pole sensor and linear encoder, check that the positive direction of the linear motor matches the positive direction of the linear encoder. If a positive direction mismatch exists, the motor can become uncontrollable in the worst case. For the method of checking, see Subsection 2.4.2, "Linear Motor and Linear Encoder Directions".

2. If a magnetic pole sensor or linear encoder is mounted at an incorrect position, the power factor can drop, and a soft thermal (OVC) alarm can be issued. In addition, the motor can become uncontrollable in the worst case. Before turning on the power to the machine after machine assembly, recheck the positional relationships.

NOTE

With the FANUC Linear Motor LiS series, an incremental linear encoder that outputs the reference mark signal (Z-phase signal) at one position only is required. Specify this requirement when ordering an incremental linear encoder. If an incremental linear encoder has two positions where the reference mark signal is output, a count miss alarm may be issued when the second reference mark signal is detected.

LiS 3000B2 or models of larger sizes (except the LiS 3300C1)

To use an incremental linear encoder, a magnetic pole sensor is required. Mount a magnetic pole sensor with screws of M6×15 mm in the concave on the power line or terminal side of the coil slider. At this time, ensure that the bottom surface (facing the magnet plate) of the magnetic pole sensor is flush with the bottom surface (facing the magnet plate) of the coil slider.

NOTE

If the bottom surface of the magnetic pole sensor is projected relative to the bottom surface of the coil slider, the magnetic pole sensor can rub against the magnet plate.

The positional relationship between the linear motor with the magnetic pole sensor and the incremental linear encoder is predetermined. The relationship and the expressions in the following figure must be satisfied at the same time.
Mount a linear motor and linear encoder at the following position in the figure above where the linear encoder outputs the reference mark signal (reference signal):

<table>
<thead>
<tr>
<th>Magnet end face on the magnetic pole sensor side</th>
<th>L (mm)</th>
<th>M: Natural number</th>
</tr>
</thead>
<tbody>
<tr>
<td>N pole</td>
<td>$L=60 \times M+27 \pm 0.5$ (mm)</td>
<td></td>
</tr>
<tr>
<td>S pole</td>
<td>$L=60 \times M+57 \pm 0.5$ (mm)</td>
<td></td>
</tr>
</tbody>
</table>

**CAUTION**

1. Before mounting a magnetic pole sensor and linear encoder, check that the positive direction of the linear motor matches the positive direction of the linear encoder. If a positive direction mismatch exists, the motor can become uncontrollable in the worst case. For the method of checking, see Subsection 2.4.2, "Linear Motor and Linear Encoder Directions."

2. If a magnetic pole sensor or linear encoder is mounted at an incorrect position, the power factor can drop, and a soft thermal (OVC) alarm can be issued. In addition, the motor can become uncontrollable in the worst case. Before turning on the power to the machine after machine assembly, recheck the positional relationships.

**NOTE**

With the FANUC Linear Motor LĪS series, an incremental linear encoder that outputs the reference mark signal (Z-phase signal) at one position only is required. Specify this requirement when ordering an incremental linear encoder. If an incremental linear encoder has two positions where the reference mark signal is output, a count miss alarm may be issued when the second reference mark signal is detected.
2.6.4 Absolute Linear Encoder Mounting Position

For LiS 300A1/4, LiS 600A1/4, and LiS 900A1/4

The positional relationship between the linear motor and the absolute linear encoder is predetermined. The following positional relationships and expressions must be satisfied at the same time.

Mount a linear motor and linear encoder at the following position in the figure above:

- For N pole:
  \[ L = 30 \times M + 17.5 \pm 0.5 \text{ (mm)} \]

- For S pole:
  \[ L = 30 \times M + 2.5 \pm 0.5 \text{ (mm)} \]

**CAUTION**

1. Before mounting a linear encoder, check that the positive direction of the linear motor matches the positive direction of the linear encoder. If a positive direction mismatch exists, the motor can become uncontrollable in the worst case. For the method of checking, see Subsection 2.4.2, "Linear Motor and Linear Encoder Directions".

2. If a linear encoder is mounted at an incorrect position, the power factor can drop, and a soft thermal (OVC) alarm can be issued. In addition, the motor can become uncontrollable in the worst case. Before turning on the power to the machine after machine assembly, recheck the positional relationships.
- Example using the HEIDENHAIN 's absolute linear encoder LC192F or LC491F

Mount a linear motor and linear encoder at the following position in the figure above:

<table>
<thead>
<tr>
<th>Magnet end face on the power line side</th>
<th>L (mm)</th>
<th>M: Natural number</th>
</tr>
</thead>
<tbody>
<tr>
<td>N pole</td>
<td>L=30×M+17.5±0.5 (mm)</td>
<td></td>
</tr>
<tr>
<td>S pole</td>
<td>L=30×M+2.5±0.5 (mm)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Encoder model</th>
<th>S (mm) M: Natural number</th>
</tr>
</thead>
<tbody>
<tr>
<td>LC192F</td>
<td>S=30×N-1.5</td>
</tr>
<tr>
<td>LC491F</td>
<td></td>
</tr>
<tr>
<td>Without mounting spur</td>
<td>S=30×N-3.5</td>
</tr>
<tr>
<td>With mounting spur</td>
<td>S=30×N-20</td>
</tr>
</tbody>
</table>

**CAUTION**
1 Before mounting a linear encoder, check that the positive direction of the linear motor matches the positive direction of the linear encoder. If a positive direction mismatch exists, the motor can become uncontrollable in the worst case. For the method of checking, see Subsection 2.4.2, "Linear Motor and Linear Encoder Directions".
2 If a linear encoder is mounted at an incorrect position, the power factor can drop, and a soft thermal (OVC) alarm can be issued. In addition, the motor can become uncontrollable in the worst case. Before turning on the power to the machine after machine assembly, recheck the positional relationships.

**NOTE**
1 Note that the measurement length ML start point of LC192F and LC491F differs from the origin of the encoder.
2 For details of the linear encoders LC192F and LC491F, contact HEIDENHAIN, or their sales representative.
- Example using the Mitutoyo's absolute linear encoder AT353 or AT553

Mount a linear motor and linear encoder at the position where the ▲ mark of the linear encoder head matches the ▼ mark of the main linear encoder unit in the figure above.

<table>
<thead>
<tr>
<th>Magnet end face on the power line side</th>
<th>L (mm)</th>
<th>M: Natural number</th>
</tr>
</thead>
<tbody>
<tr>
<td>N pole</td>
<td>L=30×M+17.5±0.5 (mm)</td>
<td></td>
</tr>
<tr>
<td>S pole</td>
<td>L=30×M+2.5±0.5 (mm)</td>
<td></td>
</tr>
</tbody>
</table>

⚠️ CAUTION
1 Before mounting a linear encoder, check that the positive direction of the linear motor matches the positive direction of the linear encoder. If a positive direction mismatch exists, the motor can become uncontrollable in the worst case. For the method of checking, see Subsection 2.4.2, "Linear Motor and Linear Encoder Directions".
2 If a linear encoder is mounted at an incorrect position, the power factor can drop, and a soft thermal (OVC) alarm can be issued. In addition, the motor can become uncontrollable in the worst case. Before turning on the power to the machine after machine assembly, recheck the positional relationships.

NOTE
For details of the linear encoders AT353 and AT553, contact Mitutoyo, or their sales representative.
**LiS 1500B1/4 or models of larger sizes**

The positional relationship between the linear motor and the absolute linear encoder is predetermined. The following positional relationships and expressions must be satisfied at the same time.

Mount a linear motor and linear encoder at the following position in the figure above:

\[ S = 60 \times N \text{ (mm)} \quad N: \text{Natural number or 0} \]

<table>
<thead>
<tr>
<th>Magnet end face on the power line (terminal) side</th>
<th>L (mm)</th>
<th>M: Natural number</th>
</tr>
</thead>
<tbody>
<tr>
<td>N pole</td>
<td>( L=60 \times M+27 \pm 0.5 ) (mm)</td>
<td></td>
</tr>
<tr>
<td>S pole</td>
<td>( L=60 \times M+57 \pm 0.5 ) (mm)</td>
<td></td>
</tr>
</tbody>
</table>

**CAUTION**

1. Before mounting a linear encoder, check that the positive direction of the linear motor matches the positive direction of the linear encoder. If a positive direction mismatch exists, the motor can become uncontrollable in the worst case. For the method of checking, see Subsection 2.4.2, "Linear Motor and Linear Encoder Directions".

2. If a linear encoder is mounted at an incorrect position, the power factor can drop, and a soft thermal (OVC) alarm can be issued. In addition, the motor can become uncontrollable in the worst case. Before turning on the power to the machine after machine assembly, recheck the positional relationships.
- Example using the HEIDENHAIN's absolute linear encoder LC192F or LC491F

![Diagram of linear motor and linear encoder setup]

Mount a linear motor and linear encoder at the following position in the figure above:

<table>
<thead>
<tr>
<th>Magnet end face on the power line (terminal) side</th>
<th>L (mm)</th>
<th>M: Natural number</th>
</tr>
</thead>
<tbody>
<tr>
<td>N pole</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S pole</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Encoder model</th>
<th>S (mm)</th>
<th>M: Natural number</th>
</tr>
</thead>
<tbody>
<tr>
<td>LC192F</td>
<td>S=60×N-1.5</td>
<td></td>
</tr>
<tr>
<td>Without mounting spur</td>
<td>S=60×N-3.5</td>
<td></td>
</tr>
<tr>
<td>With mounting spur</td>
<td>S=60×N-20</td>
<td></td>
</tr>
<tr>
<td>LC491F</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**CAUTION**
1. Before mounting a linear encoder, check that the positive direction of the linear motor matches the positive direction of the linear encoder. If a positive direction mismatch exists, the motor can become uncontrollable in the worst case. For the method of checking, see Subsection 2.4.2, "Linear Motor and Linear Encoder Directions".
2. If a linear encoder is mounted at an incorrect position, the power factor can drop, and a soft thermal (OVC) alarm can be issued. In addition, the motor can become uncontrollable in the worst case. Before turning on the power to the machine after machine assembly, recheck the positional relationships.

**NOTE**
1. Note that the measurement length ML start point of LC192F and LC491F differs from the origin of the encoder.
2. For details of the linear encoders LC192F and LC491F, contact HEIDENHAIN, or their sales representative.
- Example using the Mitutoyo's absolute linear encoder AT353 or AT553

Mount a linear motor and linear encoder at the position where the ▲ mark of the linear encoder head matches the ▼ mark of the main linear encoder unit in the figure above.

<table>
<thead>
<tr>
<th>Magnet end face on the power line side</th>
<th>L (mm)</th>
<th>M: Natural number</th>
</tr>
</thead>
<tbody>
<tr>
<td>N pole</td>
<td>L=60\times M+27\pm 0.5 (mm)</td>
<td></td>
</tr>
<tr>
<td>S pole</td>
<td>L=60\times M+57\pm 0.5 (mm)</td>
<td></td>
</tr>
</tbody>
</table>

⚠️ CAUTION
1. Before mounting a linear encoder, check that the positive direction of the linear motor matches the positive direction of the linear encoder. If a positive direction mismatch exists, the motor can become uncontrollable in the worst case. For the method of checking, see Subsection 2.4.2, "Linear Motor and Linear Encoder Directions".
2. If a linear encoder is mounted at an incorrect position, the power factor can drop, and a soft thermal (OVC) alarm can be issued. In addition, the motor can become uncontrollable in the worst case. Before turning on the power to the machine after machine assembly, recheck the positional relationships.

NOTE
For details of the linear encoders AT353 and AT553, contact Mitutoyo, or their sales representative.
### 2.6.5 Distance Coded Linear Encoder Mounting Position

**For \( L_iS \) 300A1/4, \( L_iS \) 600A1/4, and \( L_iS \) 900A1/4**

The mounting position of the HEIDENHAIN's distance coded linear encoder must follow that of an absolute linear encoder. The following positional relationships and expressions must be satisfied at the same time.

Mount a linear motor and linear encoder at the following position in the figure above:

\[
S = 30 \times N \text{ (mm)} \quad N: \text{Natural number or 0}
\]

<table>
<thead>
<tr>
<th>Magnet end face on the magnetic pole sensor side</th>
<th>( L ) (mm)</th>
<th>( M ): Natural number</th>
</tr>
</thead>
<tbody>
<tr>
<td>N pole</td>
<td>( L=30\times M+17.5\pm0.5 ) (mm)</td>
<td></td>
</tr>
<tr>
<td>S pole</td>
<td>( L=30\times M+2.5\pm0.5 ) (mm)</td>
<td></td>
</tr>
</tbody>
</table>

**CAUTION**

1. Before mounting a linear encoder, check that the positive direction of the linear motor matches the positive direction of the linear encoder. If a positive direction mismatch exists, the motor can become uncontrollable in the worst case. For the method of checking, see Subsection 2.4.2, "Linear Motor and Linear Encoder Directions".

2. If a linear encoder is mounted at an incorrect position, the power factor can drop, and a soft thermal (OVC) alarm can be issued. In addition, the motor can become uncontrollable in the worst case. Before turning on the power to the machine after machine assembly, recheck the positional relationships.

3. The distance coded linear encoder is an incremental encoder. The magnetic pole sensor and position detection circuit C must be connected in addition to the connections in the above figure.
LiS 1500B1/4 or models of larger sizes

The mounting position of the HEIDENHAIN's distance coded linear encoder must follow that of an absolute linear encoder. The following positional relationships and expressions must be satisfied at the same time.

Mount a linear motor and linear encoder at the following position in the figure above:

\[ S = 60 \times N \text{ (mm)} \quad N: \text{Natural number or 0} \]

<table>
<thead>
<tr>
<th>Magnet end face on the power line (terminal) side</th>
<th>( L ) (mm)</th>
<th>M: Natural number</th>
</tr>
</thead>
<tbody>
<tr>
<td>N pole</td>
<td>( L=60\times M+27\pm0.5 ) (mm)</td>
<td></td>
</tr>
<tr>
<td>S pole</td>
<td>( L=60\times M+57\pm0.5 ) (mm)</td>
<td></td>
</tr>
</tbody>
</table>

⚠️ CAUTION

1 Before mounting a linear encoder, check that the positive direction of the linear motor matches the positive direction of the linear encoder. If a positive direction mismatch exists, the motor can become uncontrollable in the worst case. For the method of checking, see Subsection 2.4.2, "Linear Motor and Linear Encoder Directions".

2 If a linear encoder is mounted at an incorrect position, the power factor can drop, and a soft thermal (OVC) alarm can be issued. In addition, the motor can become uncontrollable in the worst case. Before turning on the power to the machine after machine assembly, recheck the positional relationships.

3 The distance coded linear encoder is an incremental encoder. The magnetic pole sensor and position detection circuit C must be connected in addition to the connections in the above figure.
### 2.7 THERMOSTAT CONNECTION

A coil slider has a built-in thermostat used to prevent the motor from overheating. The specification of the thermostat is as follows:
- Actuation temperature: 90°C±5°C (temperature inside the motor)
- Normal close (Usually, the contact is closed. The contact is opened at 90°C±5°C.)
- Use 24 VDC (1A or less).

From the coil slider, two leads or connector pins are extended. These leads or pins are to be connected to the I/O (PMC) of the CNC. The leads have no polarity. Configure a system (such as a PMC ladder) so that when the thermostat is actuated (the contact is opened), alarm information is passed from the PMC to the CNC and the machine stops safely for an emergency stop. The normal method of connection is shown below.

**In normal operation (when the motor is not overheated)**

![Diagram showing normal operation](image)

**When the motor is overheated**

![Diagram showing overheated case](image)

---

**CAUTION**

1. Without connecting a thermostat, the motor can be driven. In such a case, however, the motor cannot be protected from overheating. So, be sure to connect a thermostat according to the method described above before driving the motor.
2. If an emergency stop is performed immediately after an overheat is detected, the motor can coast, for example, during acceleration, or an axis drop can occur. It is recommended that when an overheat is detected, the machine be stopped safely by using a brake as required before performing an emergency stop.
When multiple linear motors are used, two methods of thermostat connection are available. The customer can freely choose between the two methods. Each method has an advantage and disadvantage.

**Serial connection of multiple thermostats**

In this case, only one signal lead system is connected to the PMC. However, which motor overheated cannot be identified easily.

**Parallel connection of multiple thermostats**

In this case, signal lead systems as many as the number of coil sliders are connected to the PMC. However, which motor overheated can be easily identified.
2.8 GROUND LEAD CONNECTION

Ground lead connection is very important to safety, conformance to the European standards, and improved noise protection. A typical example of connection is shown below.

**NOTE**

1. Connect all ground leads securely.
2. When an absolute linear encoder is used, a magnetic pole sensor and position detection circuit are unnecessary. The feedback lead from the linear encoder head is directly connected to SVM.
3. For some types of linear encoders, it is recommended that the main linear encoder unit be grounded. For details, refer to the specifications of each linear encoder or contact the manufacturer of each linear encoder.
4. Use ground leads that conform to the European standard (EN) and UL in thickness, color, type, and so forth.
5. The amount of leak current flowing through the linear motor may exceed the value specified in EN60335-1. Take appropriate measures by, for example, adopting a structure that prevents the operator from contacting conductive parts near the motor during energization.
2.9 MOTOR AND POWER LINE PROTECTION

In order to obtain a desired force, one amplifier may be used to drive multiple linear motors. If a motor fails or a power line is broken in such a case, a current larger than the specified level flows into other motor. In this case, an alarm may be issued because of an insufficient force, or an overheat alarm may be issued because of an excessive current flowing into a drivable motor. In the worst case, an abrupt increase in current can burn a power line or motor. Take protection measures as shown below.

As shown above, insert a fuse between the servo amplifier module and each coil slider. If an excessive current flows through a power line, an inserted fuse can shut down power. When a fuse with a built-in microswitch is used, whether the fuse has blown can be known by applying the signal to the PMC. With this function, the machine can be stopped more safely with damage minimized when a fuse blows; for example, the machine can be stopped after retracting the machine.
2.10 MOTOR HEAT-UP AND COOLING

2.10.1 Temperature Increase on the Mounting Surface of Coil Sliders

The figures below show the temperature increase curves of LİS 900A1/4 and lower models, and LİS 1500B1/4 and higher models in the cases of no cooling and water cooling.

From the curves above, an increase in temperature on the machine mounting surface of a coil slider can be approximately known by making root mean square force/continuous rated force calculations.
2.10.2 Temperature Increase on the Surface of the Magnet Plate

A magnet plate itself dissipates almost no heat. So, an increase in temperature on a magnet plate is mainly caused by radiant heat from the coil slider and slight heat conduction through the air. This means that under an ordinary use condition, the temperature on the surface of a magnet plate increases by about 5 K at most. However, the temperature can increase more if the magnet plate faces the coil slider at all times in an area and the operation condition is relatively severe. In many cases, the magnet plate need not be cooled. To suppress or shield an increase in temperature by all means, however, take measures such as blowing air onto the magnet surface or building a cooling mechanism under the mounting surface of the magnet plate.

NOTE
1. The customer is to prepare a cooling mechanism for a magnet plate, and equipment and components required for cooling a magnet plate.
2. When cooling a magnet plate, be careful not to cause condensation by excessive cooling.
2.10.3 Cooling Plate Addition

The coil sliders of LIS 1500B1/4 and higher models have a built-in cooling tube. An optional cooling plate is available with the coil sliders of LIS 900A1/4 and lower models. For further cooling, improved continuous rated force, or higher-level heat shielding, the customer is to prepare an additional cooling plate (cooling mechanism). A relatively higher effect can be expected from the use of a cooling plate with a higher cooling capability or from the installation of a cooling tube on the sides of the coil slider.

NOTE

1. Be careful not to cause condensation on the coil slider by excessive cooling.
2. The rated force cannot be improved beyond the specified value of the driven amplifier by any highly efficient cooling.

2.10.4 Cooling Water

Water is used for water cooling. However, tap water may contain metallic ions. If tap water is used for a long time, scales (contaminant layers and lumps) build up, and can degrade heat exchange efficiency and can clog the cooling tube. So, use ion exchange water.

Copper is employed for a cooling tube used with the linear motor. So, as an anti-corrosive agent to be added to cooling water, use an agent that does not corrode copper. Moreover, do not use a strong alkaline anti-corrosive agent.

Cooling oil may be used instead of cooling water. When cooling oil is used, however, a degraded cooling efficiency results due to a characteristic difference between water and oil, and the continuous rated force decreases accordingly. So, when using cooling oil, consider an output margin of ten percent to several tens percent.

NOTE

On cooling water, an anti-corrosive agent, and cooling oil, a restriction may be imposed not only from the motor but also from the chiller. So, consult with a chiller supplier as well to select a cooling medium that does not adversely affect the motor and chiller.
2.10.5 Checking the Normal Operation of Cooling Systems

When the linear motor is operated using forced cooling, abnormal flow of a coolant may cause overheat or a burnout of the linear motor. Therefore, it is necessary to prepare a system that always monitors the cooling systems and stops the linear motor safely in case of an abnormality.

When cooling piping is disconnected at some midpoint, it may take some time until the cooling unit detects it. In the worst case, the motor may burn out before the cooling unit detects a failure. In addition, when, for example, cooling piping is disconnected near the motor, a lot of coolant is applied to the motor, probably causing defective insulation or other failures. So, the system is recommended to stop the motor by always monitoring the cooling systems instead of waiting for the cooling unit itself to detect a failure.

For example, as shown in the figure below, create a system that has a sensor for monitoring the status returned to the cooling unit and stops the linear motor using a PMC ladder or other program upon detection of an abnormality. This method can stop the motor safely even when the cooling unit itself fails or cooling piping is disconnected, unless an abnormality occurs in the sensor.

![Diagram of cooling system](image)

NOTE
1. Please prepare components such as the sensor and PMC ladder required for this system by yourself.
2. Overheat and a burnout of the motor cannot be prevented only by this system. Be sure to make thermostat wiring described earlier.
2.11 VERTICAL AXIS BALANCER

If a linear motor is used with the vertical axis when no balancer or mechanical brake mechanism is used, the linear motor needs to preserve its position with the continuous rated force that can be output by the linear motor. If a stop state is caused for a long time by a force greater than the continuous rated force, the probability that an overheat occurs increases. Since the continuous rated force of a linear motor is relatively small, a balancer is often required with the vertical axis. If the power to the machine is turned off, a gradual drop occurs with the vertical axis. To prevent this from occurring, a balancer may be required.

If the acceleration exceeds 1G, a balancing effect using a counter weight cannot be achieved. In such a case, a balancer that dissipates less heat and has a superior response characteristic is needed.

Many types of balancers are available: weight, pneumatic balancer, hydraulic balancer, and so forth. Select a balancer that is most suitable for a machine designed. If the friction of a balancer is large, heat can be generated, or a backlash can be caused when a reverse axis operation is performed. Be careful at the time of design.
2.12 CONSIDERATION OF MAGNETIC ATTRACTION

Although magnetic attraction varies with the magnetic gap, in the worst case, it exerts force three times as large as the maximum force of the motor between the coil slider and the magnet plate. This force is constant, and is exerted even when the power to the motor is turned off. In mechanical design, take the points below into consideration.

Design of a light and high-rigidity frame

A mechanical frame that can withstand magnetic attraction and has a sufficiently high rigidity to maintain precision is required. On the other hand, a light mechanical frame is required to achieve higher acceleration. When high speed and high precision are needed, a higher gain is required. For this purpose, consider setting a resonance frequency as high as possible for the machine.

NOTE
Do not mount the motor on a place where the frame bends 0.1 mm or more if the motor moves. Repeated movement may break or chip resin, probably resulting in a motor failure.

Low-friction design

If the friction coefficient is high, a large frictional force results due to high magnetic attraction. Heat is generated by a large frictional force, and a degraded efficiency results. So, a design for ensuring low friction is needed.
2.13 AUXILIARY BRAKE MEASURES

The linear motor allows the dynamic brake to be applied by connecting the power line. If an object being moved weighs much or moves at high speed, a longer coasting distance is required. If there is no sufficient stroke margin, a collision against a stroke end can occur, resulting in a damage to the machine. So, a mechanical brake or shock absorber needs to be additionally installed.

The motor itself does not have a mechanical brake, so that a mechanical brake is needed to preserve the position at power-off time. This is because strong magnetic attraction can cause the motor to move freely to the magnetically stablest position even with the horizontal axis. Note that with the vertical axis, in particular, the motor makes a downward movement.
2.14 PROTECTION AGAINST DUST AND WATER

If magnetic dust such as metallic dust is located near a magnet plate, the dust may be attracted to the magnet plate. In particular, dust larger than the air gap between the coil slider and magnet plate is caught between the gap, resulting in a failure. In order to remove dust that builds up on the magnet plate, it is strongly recommended that a scraper be installed. Moreover, if the motor is exposed to coolant ceaselessly, the insulation of the motor can degrade. Consider a structure that can minimize the penetration of coolant.

Usually, the penetration of foreign matter is prevented using a bellows cover or telescopic cover. In addition, increasing the internal pressure by air purge operation is very effective. Besides coolant penetrating into the motor from the outside, condensation may occur on the motor because of excessive cooling or excessively high humidity. If condensation lasts for a long time, the insulation of the motor can degrade. In such a case, take anti-condensation measures such as reviewing the cooling condition and blowing dry air to the motor.

The penetration of foreign matter may not be prevented by a dust and waterproof cover or by air purge operation. In particular, an axis installed horizontally allows more metallic dust or coolant to penetrate. Moreover, for a high-speed moving axis, the securing of sealing performance tends to be difficult. In such a case, review the installation location of a linear motor axis. For example, keep a linear motor axis away from the machining spot as much as possible, or mount a linear motor axis on the top of the machine. These measures are very effective.

In any case, the penetration of dust and coolant cannot be prevented completely. So, be sure to conduct periodic maintenance (including cleaning).

For reference information, a typical axis structure is shown below.
NOTE
If sufficient dust and water protection is provided, foreign matter may penetrate unexpectedly near the motor, causing a failure or reducing the life of the motor remarkably. Be sure to conduct period maintenance according to Part V, "MAINTENANCE".
2.15  AXIS DESIGN WITH A LOW GRAVITY CENTER

For high-acceleration machines, load should be imposed uniformly on the linear guide surface. For this purpose, such a design that the center of the driving source or the motor is closer to the gravity center of a moving object is desirable. Such a design is also expected to improve efficiency.

If the gravity center is deviated in high-speed operation, machine operation and precision may be adversely affected.

2.16  SCREWS FOR FIXING THE LINEAR MOTOR

A magnet plate has a powerful magnetic attraction force. When magnetic screws are used, they are attracted abruptly to the magnet, resulting in very inefficient workability. In such a case, use, for example, nonmagnetic stainless screws. Such screws are not attracted to the magnet, and therefore improve workability. In addition, use nonmagnetic tools. Nonmagnetic tools are not attracted to the magnet, so that workability and safety usually attainable can be maintained.

For securing a coil slider, ordinary magnetic screws may be used because the coil slider itself does not exert magnetic attraction force. When securing a coil slider, use those screws that are stronger than stainless steel and have a strength equivalent to that of high tensile steel.

When selecting any type of screw, consider the load and magnetic attraction of the linear motor sufficiently. Tighten each screw securely within the specified tightening torque. Control torque, and be careful not to exceed the screw strength limit.

⚠️ CAUTION

When securing a coil slider and magnet plate with screws, be sure to use all screw holes and tighten the screw securely. For a long-stroke axis, in particular, a very large number of screws need to be used with the magnet plate. Be sure not to omit screws. Moreover, be sure not to secure a coil slider and magnet plate only by using means other than screws (for example, by using adhesive only).
2.17 CONFORMANCE TO STANDARDS

Machine design and component selection considering the following are needed so that machines incorporating the linear motor conform to the CE marking of Europe:
- Machine design, cabling, and so forth conforming to Article 19 of EN60204-1
- Machine design and component selection conforming to the machine commands of Europe
- Use of components conforming to the European standards
- Conformance to the standards related to electric wiring and cabling, insulation, and dust and water protection
- Ensuring a use condition that guarantees the rating of the motor
- Conformance to the EMC commands
- Conformance to the standards related to safety

Conformance to other standards such as the UL standard of the U.S.A. may need to be considered separately. Referring to each relevant standard for details, perform machine design and component selection without failing to satisfy each standard.

The FANUC linear motor conforms to the EMC commands. Take necessary action according to the guideline titled "To Conform to the EMC Commands (A-72937)" released by FANUC separately.

NOTE
1. To obtain "To Conform to the EMC Commands (A-72937)", contact your FANUC sales representative.
2. For details of the standards such as the EN and UL standards, refer to each standard.
2.18 MAGNETIC LEAKAGE AND MAGNETIC SHIELDING

Powerful permanent magnets are used for a magnet plate, so that a magnetic material, if any near the magnet plate, can be magnetized. This section describes the method of shielding magnetic leakage from a magnet plate.

2.18.1 Level of Geomagnetism

According to a publication such as a chronological table of science, the geomagnetism is 1 to 6 mT. On the other hand, the FANUC laboratory finds that a geomagnetism of about 20 mT is observed at a location far from a magnet plate. The level of 20 mT is found in the routine life environment and poses no problem.

2.18.2 Magnetic Leakage

A magnet plate manufactured by FANUC consists of a base iron plate on which permanent magnets are attached. The base iron plate is sufficiently thick to allow little downward magnetic leakage from the magnet plate. On the magnet side, there is little magnetic leakage in the area that faces the coil slider. Magnetic leakage occurs in other areas where the magnet plate is exposed. Even in this case, the level of magnetic leakage is as low as the level found in the daily life environment at a location 20 cm or more away upward or sideward from the magnet plate. There is little magnetic leakage downward from the magnet plate.
2.18.3 Magnetic Shielding

As shown below, let \( L_f \) (mm) be the thickness of the iron plate for magnetic shielding, and let \( L_g \) (mm) be the distance between the ion plate and magnets.

![Diagram showing magnetic shielding](image)

If an iron with a high transmittance (with a less amount of carbon contained) is used at this time, no magnetic leakage occurs through the shielding iron plate when:

\[
L_f = \frac{11.4}{1 + \frac{L_g}{5}} \quad \text{For } L_i \geq 1500B1/4 \text{ or larger sizes}
\]

\[
L_f = \frac{5.7}{1 + \frac{L_g}{5}} \quad \text{For } L_i \leq 900B1/4 \text{ or linear motors of smaller sizes}
\]

The graph below shows the values of \( L_f \) when various values are assigned to \( L_g \).

![Graph showing magnetic shielding values](image)

* Large linear motor = \( L_i \) 1500B1/4 or larger sizes
  Small linear motor = \( L_i \) 900A1/4 or smaller sizes

Magnetic leakage can be prevented by selecting an installation location and a shielding plate thickness with some margin relative to the expressions and graph above.
2.19 NAMEPLATE ATTACHMENT AND SERIAL NUMBER MANAGEMENT

One of the nameplates shown below and a laminated sheet are packed together with the coil sliders of all models.

For maintenance, attach the nameplate to the following location where:
- The nameplate is always visible at the time of maintenance.
- The nameplate is easily visible without removing components.
- The nameplate is not easily detached.

Next, to protect the nameplate, attach the laminated sheet over the nameplate. The recommended nameplate attachment locations include:
- Inside of the door of the cabinet
- Near the main power supply of the machine
- Near the operator's panel or the back of the operator's panel

In addition, record and keep the combinations of machine numbers and motor serial numbers so that which machine incorporates a motor of which serial number can be identified easily after machine shipment.
2.20 INDICATION OF WARNING

Be sure to indicate a warning to notify the operators of the presence of magnets mounted on the machine and prevent an accident from occurring. For example, attach a label or sticker that clearly indicates the mounting location of a magnet plate by providing an illustration at a position that is accessed for maintenance at all times or at an easily noticeable position. Ensure that such a label or sticker is not easily removed or is hidden behind a component. An example of warning label is given below.

⚠️ WARNING
Under this cover, very powerful magnets are mounted. Mishandling can cause a serious accident. So, before opening this cover, fully understand the possible risks involved and prepare a safe work environment by referring to page XX of the operator's manual of the machine.
- Do not operate this machine if you wear a medical appliance such as a pacemaker.
- Take off any unnecessary magnetic materials.

Mounting location of a magnet plate
A magnet plate is mounted at the following location under the cover:

Table
Magnet plate (800 mm long), black
Linear guide

NOTE
The customer is to prepare a warning label or sticker.
3 ASSEMBLY

⚠️ WARNING
For the linear motor, very powerful magnets are used. If the linear motor is handled incorrectly, serious accidents including fatal accidents can occur. Read this chapter carefully for thorough understanding, and do not fail to observe the cautions and warnings described in this chapter. Ensure that only persons educated for the handling of the linear motor handle the linear motor.
3.1 LINEAR MOTOR MOUNTING PROCEDURES

This section introduces four procedures for mounting a linear motor on the machine. Depending on the structure of the machine, select the safest procedure.

3.1.1 Procedure #1 for Mounting a Linear Motor on the Machine

If the total length of magnet plates for one axis is greater than the total length of a coil slider by a factor of 2 or more, the linear motor can be mounted using the procedure below.

<1> Shift the movable table to one end of the axis, then secure a magnet plate (half of the total length).

<2> Shift the movable table onto the magnet plate. Note that if the table is magnetic, the table may be attracted toward the magnet plate. Place a spacer as thick as the magnet plate in the area where no magnet plate is mounted, then place a coil slider on the spacer.

<3> Shift the movable table onto the coil slider, then secure the coil slider with screws.
<4> Shift the movable table onto the magnet plate again, then mount a remaining magnet plate. Note that when the movable table is shifted, the movable table is pulled toward the magnet plate by magnetic attraction.

⚠️ CAUTION

Powerful magnetic attraction is exerted at all times. When securing magnet plates and a coil slider, be sure to securely tighten all screws. Do not tighten the screws temporarily. Until the magnet plates have been secured, do not remove the tin plate and corrugated board attached onto the top face of each magnet plate.
3.1.2 Procedure #2 for Mounting a Linear Motor on the Machine

If the total length of magnet plates for one axis is greater than the total length of a coil slider by a factor of 2 or more, the linear motor can be mounted using the procedure below.

<1> Secure a coil slider to the movable table.

<2> Mount a magnet plate on a half side of the axis, then mount the movable table on the other half side where no magnet plate is mounted.

<3> Shift the movable table onto the magnet plate, then mount a remaining magnet plate. Note that when the movable table is shifted, the movable table is pulled toward the magnet plate by magnetic attraction.

**CAUTION**

Powerful magnetic attraction is exerted at all times. When securing magnet plates and a coil slider, be sure to securely tighten all screws. Do not tighten the screws temporarily. Until the magnet plates have been secured, do not remove the tin plate and corrugated board attached onto the top face of each magnet plate.
3.1.3 Procedure #3 for Mounting a Linear Motor on the Machine

This procedure mounts a coil slider and magnet plate separately then performs integration.

<1> Mount a magnet plate on the actual axis, and mount a coil slider onto the movable table on a temporary axis.

<2> Connect the temporary axis to the actual axis, then shift the movable table to the actual axis. Note that when the movable table is shifted, the movable table is pulled toward the magnet plate by magnetic attraction.

<3> After shifting the movable table, disconnect the temporary axis.

⚠️ CAUTION
Powerful magnetic attraction is exerted at all times. When securing magnet plates and a coil slider, be sure to securely tighten all screws. Do not tighten the screws temporarily. Until the magnet plates have been secured, do not remove the tin plate and corrugated board attached onto the top face of each magnet plate.
3.1.4 Procedure #4 for Mounting a Linear Motor on the Machine

⚠️ WARNING
Procedure #4 described in this subsection is most affected by the magnetic attraction of magnet plates. Do not use this procedure if the use of this procedure is avoidable. This procedure is very dangerous. Do not use this procedure if any other safer mounting procedure is usable.

<1> Mount a coil slider and magnet plate separately as done in Subsection 3.1.3.
<2> Hang the coil slider with a crane and lower it slowly, then secure it onto the guide. At this time, do not use a lifting tool equipped with a spring, such as an air balance.

⚠️ WARNING
1 Use a crane that is more powerful than the magnetic attraction.
2 As the coil slider gets closer to the magnet plate, greater magnetic attraction is exerted (inversely proportional to the square of distance). Ensure that the machine (or magnet plate in this example) is not pulled up.
3 When performing this operation, be sure to keep the coil slider and magnet plate horizontal. Do not perform this operation with the magnet plate tilted upward.

⚠️ CAUTION
Powerful magnetic attraction is exerted at all times. When securing magnet plates and a coil slider, be sure to securely tighten all screws. Do not tighten the screws temporarily. Until the magnet plates have been secured, do not remove the tin plate and corrugated board attached onto the top face of each magnet plate.
3.2 MOUNTING A COOLING PLATE AND CONNECTING A COOLING TUBE

This section describes how to mount a cooling plate on the linear motor and connect the cooling tube.

3.2.1 LS 300A1/4, LS 600A1/4, LS 900A1/4, and LS 1500B1/4

When performing forced air cooling or forced water cooling with LS 300A1/4, LS 600A1/4, and LS 900A1/4, mount a cooling plate between the slider and table so that the cooling tube extends in the same direction as the power line. The mounting hole pitch of a cooling plate is the same as the mounting screw pitch of the coil slider. A cooling plate is inserted and secured by pulling the coil slider toward the table with setscrews. Then, connect an external chiller to the cooling tube with tube joints.

![Diagram of cooling plate installation]

**NOTE**
1. The cooling plate is optional. The size of a cooling plate varies from one model to another. Order an appropriate cooling plate according to the motor model used.
2. When an incremental linear encoder is used, a magnetic pole sensor is required. When a cooling plate is mounted, the method of mounting a magnetic pole sensor changes. See Section 3.5, "MOUNTING A MAGNETIC POLE SENSOR".
3. Assembly Handling, Design, and Assembly

NOTE
3 The cooling tube is made of relatively thin copper. If a large force is applied onto the cooling tube, the cooling tube can be easily deformed or broken. Be careful when attaching a joint to the cooling tube. When the coil slider is movable, relay the cooling tube in the middle to ensure that no external force is applied to the cooling tube of the cooling plate. The customer is to prepare piping components such as tube joints.

The LİS 1500A1/4 incorporates cooling piping. Since the copper pipe juts out of the coil slider, connect the pipe to the cooling unit through a tube joint or the like. For the dimensions and other details, see Chapter 2, "SPECIFICATIONS", in Part I, “SPECIFICATIONS".
3.2.2 **LīS 3000B2 and Lager Motors**

For the LīS 3000B2 and larger-sized motors incorporate cooling piping. The connection part of the piping has tapered female threads (Rc 1/4), so connect a male thread piping component (joint) to it.

When attaching a piping component to the coil slider, hold the joint on the coil slider side to fix it. When mounting male piping components, fix the joint on the coil slider side with a wrench. Do not move the wrench and use it only for fixing the joint on the coil slider side.

---

**CAUTION**

If the joint on the coil slider side is moved, the resin of the coil slider can crack, and can disable the motor from being used in the worst case. Be sure not to turn the joint on the coil slider side.

**NOTE**

1. When the coil slider is movable, relay the tube in the middle to ensure that no external force is applied to the tube joint.
2. When an absolute linear encoder system is used, the magnetic pole sensor shown above is not required.
3.3 POWER LINE AND THERMOSTAT LINE CONNECTION

This section describes the method of linear motor power line connection and thermostat line connection. Connect the leads correctly according to the model used.

3.3.1 LİS 300A1/4, LİS 600A1/4, and LİS 900A1/4

For the LİS 300A1/4, LİS 600A1/4, and LİS 900A1/4, the power lines and thermostat lines directly jut out of the coil slider. The specifications of the lines are shown below.

<table>
<thead>
<tr>
<th>Line type</th>
<th>Sheath color</th>
<th>Conductor cross section (mm²)</th>
<th>Average outside diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power line (U phase)</td>
<td>Red</td>
<td>2.0</td>
<td>2.6</td>
</tr>
<tr>
<td>Power line (V phase)</td>
<td>White</td>
<td>2.0</td>
<td>2.6</td>
</tr>
<tr>
<td>Power line (W phase)</td>
<td>Black</td>
<td>2.0</td>
<td>2.6</td>
</tr>
<tr>
<td>Power line (ground)</td>
<td>Green / Yellow</td>
<td>2.0</td>
<td>2.6</td>
</tr>
<tr>
<td>Thermostat line 1</td>
<td>Black</td>
<td>0.35</td>
<td>1.28</td>
</tr>
<tr>
<td>Thermostat line 2</td>
<td>Black</td>
<td>0.35</td>
<td>1.28</td>
</tr>
</tbody>
</table>

**NOTE**
1. The length of the power lines and thermostat lines is approximately 350 mm.
2. The power lines and thermostat lines have no crimp contacts.
3. The thermostat lines have no polarities.
4. The cables are not movable ones. When the coil slider is movable, be sure to connect it to a movable relay cable.


### 3.3.2 LiS 1500B1/4 and LiS 3300C1/2

#### Terminal and connector allocation

![Diagram of terminal and connector allocation]

*For thermostat. No polarity applicable. (Pins 1 and 2)*

#### Cables usable for power lines

<table>
<thead>
<tr>
<th>Model</th>
<th>AWG</th>
<th>Nominal cross-sectional area (mm²)</th>
<th>Cable diameter NOTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>LiS 1500B1/4</td>
<td>UL1015 AWG#10</td>
<td>5.5 or 6.0</td>
<td>φ4.9 to φ5.2</td>
</tr>
<tr>
<td>LiS 3300C1/2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE**

1. If the diameter of a cable is not within the allowable range specified above, the waterproof capability of the terminal is not guaranteed. Be sure to select a cable that satisfies the diameter range specified above.
2. Bend a power line outside the terminal. If a power line is bent inside the terminal, the waterproof capability of the terminal is not guaranteed.
3. When the coil slider is movable, be sure to use movable cables. Do not attach a movable cable to each terminal, but attach a movable cable to a relay terminal block in the middle.

#### Cable usable for the thermostat

<table>
<thead>
<tr>
<th>AWG</th>
<th>Nominal cross-sectional area (mm²)</th>
<th>Cable diameter NOTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL1015 AWG#23×2</td>
<td>0.3×2</td>
<td>φ4.6 to φ5.0</td>
</tr>
</tbody>
</table>

**NOTE**

1. If the diameter of a cable is not within the allowable range specified above, the drip protection capability of the terminal is not guaranteed. Be sure to select a cable that satisfies the diameter range specified above.
2. When the coil slider is movable, be sure to use movable cables.
3.3.3 LIS 3000B2/2 to LIS 9000B2/4

Terminal and connector allocation

Cables usable for power lines

<table>
<thead>
<tr>
<th>Model</th>
<th>AWG</th>
<th>Nominal cross-sectional area (mm²)</th>
<th>Cable diameter</th>
<th>NOTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIS 3000B2/2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIS 3000B2/4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIS 4500B2/2</td>
<td>UL1015 AWG#10</td>
<td>5.5 or 6.0</td>
<td>φ4.9 to φ5.2</td>
<td></td>
</tr>
<tr>
<td>LIS 4500B2/2HV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIS 6000B2/2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIS 6000B2/4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIS 6000B2/2HV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIS 7500B2/2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIS 7500B2/2HV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIS 9000B2/2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIS 9000B2/4</td>
<td></td>
<td>10.0</td>
<td>φ6.2 to φ6.5</td>
<td></td>
</tr>
</tbody>
</table>

NOTE
1 If the diameter of a cable is not within the allowable range specified above, the drip protection capability of the terminal is not guaranteed. Be sure to select a cable that satisfies the diameter range specified above.
2 Bend a power line outside the terminal. If a power line is bent inside the terminal, the drip protection capability of the terminal is not guaranteed.
3 When the coil slider is movable, be sure to use movable cables. Do not attach a movable cable to each terminal, but attach a movable cable to a relay terminal block in the middle.
### Cable usable for the thermostat

<table>
<thead>
<tr>
<th>AWG</th>
<th>Nominal cross-sectional area (mm²)</th>
<th>Cable diameter</th>
<th><strong>NOTE</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>UL1015 AWG#23×2</td>
<td>0.3×2</td>
<td>φ4.6 to φ5.0</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE**

1. If the diameter of a cable is not within the allowable range specified above, the drip protection capability of the terminal is not guaranteed. Be sure to select a cable that satisfies the diameter range specified above.
2. When the coil slider is movable, be sure to use movable cables.
### 3.3.4 Lis 9000C2/2 to Lis 11000C2/2 and Lis 15000C2/3HV

**Terminal and connector allocation**

**Cables usable for power lines**

<table>
<thead>
<tr>
<th>Model</th>
<th>AWG</th>
<th>Nominal cross-sectional area (mm²)</th>
<th>Cable diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lis 9000C2/2HV</td>
<td>UL1015 AWG#10</td>
<td>5.5 or 6.0</td>
<td>φ4.9 to φ5.2</td>
</tr>
<tr>
<td>Lis 9000C2/2</td>
<td>UL1015 AWG#10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lis 11000C2/2HV</td>
<td>UL1015 AWG#10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lis 11000C2/2</td>
<td>UL1015 AWG#10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lis 15000C2/3HV</td>
<td>UL1015 AWG#8</td>
<td>8 or 10</td>
<td>φ6.2 to φ6.5</td>
</tr>
</tbody>
</table>

**NOTE**

1. If the diameter of a cable is not within the allowable range specified above, the drip protection capability of the terminal is not guaranteed. Be sure to select a cable that satisfies the diameter range specified above.
2. Bend a power line outside the terminal. If a power line is bent inside the terminal, the drip protection capability of the terminal is not guaranteed.
3. When the coil slider is movable, be sure to use movable cables. Do not attach a movable cable to each terminal, but attach a movable cable to a relay terminal block in the middle.

**Cable usable for the thermostat**

<table>
<thead>
<tr>
<th>AWG</th>
<th>Nominal cross-sectional area (mm²)</th>
<th>Cable diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL1015 AWG#23×2</td>
<td>0.3×2</td>
<td>φ4.6 to φ5.0</td>
</tr>
</tbody>
</table>

**NOTE**

1. If the diameter of a cable is not within the allowable range specified above, the drip protection capability of the terminal is not guaranteed. Be sure to select a cable that satisfies the diameter range specified above.
2. When the coil slider is movable, be sure to use movable cables.
### Terminal and connector allocation

- For thermostat. No polarity applicable. (Pins 1 and 2)
- Magnet plate
- Power line, grounding, 2 locations
- Power line, phase U, 2 locations
- Power line, phase V, 2 locations
- Power line, phase W, 2 locations

### Cables usable for power lines

<table>
<thead>
<tr>
<th>Model</th>
<th>AWG</th>
<th>Nominal cross-sectional area (mm²)</th>
<th>Cable diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>LİS 15000C2/2</td>
<td>UL1015 AWG#10</td>
<td>5.5 or 6.0</td>
<td>ϕ4.9 to ϕ5.2</td>
</tr>
<tr>
<td>LİS 15000C2/3</td>
<td>UL1015 AWG#8</td>
<td>8 or 10</td>
<td>ϕ6.2 to ϕ6.5</td>
</tr>
</tbody>
</table>

**NOTE**
1. If the diameter of a cable is not within the allowable range specified above, the drip protection capability of the terminal is not guaranteed. Be sure to select a cable that satisfies the diameter range specified above.
2. Bend a power line outside the terminal. If a power line is bent inside the terminal, the drip protection capability of the terminal is not guaranteed.
3. When the coil slider is movable, be sure to use movable cables. Do not attach a movable cable to each terminal, but attach a movable cable to a relay terminal block in the middle.

### Cable usable for the thermostat

<table>
<thead>
<tr>
<th>AWG</th>
<th>Nominal cross-sectional area (mm²)</th>
<th>Cable diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL1015 AWG#23×2</td>
<td>0.3×2</td>
<td>ϕ4.6 to ϕ5.0</td>
</tr>
</tbody>
</table>

**NOTE**
1. If the diameter of a cable is not within the allowable range specified above, the drip protection capability of the terminal is not guaranteed. Be sure to select a cable that satisfies the diameter range specified above.
2. When the coil slider is movable, be sure to use movable cables.
### Terminal and connector allocation

![Diagram of terminal and connector allocation](image)

**Power line, grounding**
- Power line, phase U
- Power line, phase W
- Power line, phase V

For thermostat. No polarity applicable.
(Pins 1 and 2)

**Cables usable for power lines**

<table>
<thead>
<tr>
<th>Model</th>
<th>AWG</th>
<th>Nominal cross-sectional area (mm²)</th>
<th>Cable diameter NOTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>LİS 10000C3/2HV</td>
<td>UL1015 AWG#10</td>
<td>8 or 10</td>
<td>φ6.2 to φ6.5</td>
</tr>
<tr>
<td>LİS 10000C3/2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LİS 17000C3/2HV</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE**
1. If the diameter of a cable is not within the allowable range specified above, the drip protection capability of the terminal is not guaranteed. Be sure to select a cable that satisfies the diameter range specified above.
2. Bend a power line outside the terminal. If a power line is bent inside the terminal, the drip protection capability of the terminal is not guaranteed.
3. When the coil slider is movable, be sure to use movable cables. Do not attach a movable cable to each terminal, but attach a movable cable to a relay terminal block in the middle.

---

### Cable usable for the thermostat

<table>
<thead>
<tr>
<th>AWG</th>
<th>Nominal cross-sectional area (mm²)</th>
<th>Cable diameter NOTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL1015 AWG#23×2</td>
<td>0.3×2</td>
<td>φ4.6 to φ5.0</td>
</tr>
</tbody>
</table>

**NOTE**
1. If the diameter of a cable is not within the allowable range specified above, the drip protection capability of the terminal is not guaranteed. Be sure to select a cable that satisfies the diameter range specified above.
2. When the coil slider is movable, be sure to use movable cables.
3.3.7 LİS 17000C2/2

Terminal and connector allocation

Cables usable for power lines

<table>
<thead>
<tr>
<th>Model</th>
<th>AWG</th>
<th>Nominal cross-sectional area (mm²)</th>
<th>Cable diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>LİS 17000C2/2</td>
<td>UL1015 AWG#10</td>
<td>5.5 or 6.0</td>
<td>φ4.9 to φ5.2</td>
</tr>
</tbody>
</table>

**NOTE**
1. If the diameter of a cable is not within the allowable range specified above, the drip protection capability of the terminal is not guaranteed. Be sure to select a cable that satisfies the diameter range specified above.
2. Bend a power line outside the terminal. If a power line is bent inside the terminal, the drip protection capability of the terminal is not guaranteed.
3. When the coil slider is movable, be sure to use movable cables. Do not attach a movable cable to each terminal, but attach a movable cable to a relay terminal block in the middle.

Cable usable for the thermostat

<table>
<thead>
<tr>
<th>AWG</th>
<th>Nominal cross-sectional area (mm²)</th>
<th>Cable diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL1015 AWG#23×2</td>
<td>0.3×2</td>
<td>φ4.6 to φ5.0</td>
</tr>
</tbody>
</table>

**NOTE**
1. If the diameter of a cable is not within the allowable range specified above, the drip protection capability of the terminal is not guaranteed. Be sure to select a cable that satisfies the diameter range specified above.
2. When the coil slider is movable, be sure to use movable cables.
3.3.8 Connection to Terminals

Follow the procedure below to connect the power lines to the coil slider of terminal type. The required parts other than the power lines are supplied with the coil slider.

1. Strip the insulated cables as shown above.
2. Draw the four insulated cables through gaskets.
3. Press crimp contacts to connect them to the four insulated cables as shown below.

Make sure that the end face of the crimp contact touches the end face of the power cable outer jacket and then crimp the contact.

4. Insert the four insulated cables that were crimped and then insert the gaskets into the terminal. At this time, insert the gaskets so that their end faces do not appear from terminal surface A.
5 Use M4 screws to secure the four insulated cables that were crimped. The recommended tightening torque is 1.3 to 1.4 Nm.

6 Attach cover A so that the claws of cover A engage with the holes of the terminal.

7 Attach cover B with the convex portion of cover B aligned with the concave portion of the terminal and then secure the cover with M3 screws. The recommended tightening torque is 0.6 to 0.7 Nm.

8 Attach the cap to the terminal.

**NOTE**

One set of crimp contacts, gaskets, and other components are supplied for each coil slider. Be careful not to loose them.
3.4 ASSEMBLING THE MAGNET PLATE WITH PROTECTION COVER

3.4.1 Notes on Attachment

The width of the magnet plate with a protection cover is 15.5 mm. Since the protection cover itself is slightly warped, however, an air gap of 0.5 mm may cause rubbing. Therefore, when the protection cover is attached, set the air gap to 1.0 to 1.5 mm, which is wider than usual.

When the air gap becomes wider, the maximum force is reduced. Widening the air gap also reduces magnetic attraction, improving the feed smoothness. For reduction in the maximum force and magnetic attraction, see Section 2.3, "LINEAR MOTOR AIR GAP" earlier.

3.4.2 Precision of Joined Magnet Plates

When multiple magnet plates are joined, the straightness of the datum planes of the magnet plates must be ±0.1 mm or less for proper attachment of the protection cover. Measure the straightness by, for example, pushing the plates against the stoppers with a height of approximately 1 mm, as shown in the figure below.
3.4.3 Attachment of Covers

1. Place the cover on the magnetic surface.

2. Temporarily secure the cover with the accompanying mounting screws.
3. Move the cover 5 mm and tighten the screws. (When only one magnet plate is used, tighten the screws without moving the cover.)

4. Place the next cover on the magnetic surface.
5 Temporarily secure the cover with the accompanying screws and move the cover 5 mm to close the gap.

6 The gap between the joined magnet plates is closed, as shown in the following figure. If another magnet plate is joined, repeat the same steps. Finally, confirm that the surface is flat.
3.4.4 Attachment of the Magnet Plate Protection Sheet

To attach the magnet plate protection sheet, follow the procedure below. For detailed specifications of the magnet plate protection sheet, see Chapter 2, "SPECIFICATIONS", in Part I, "SPECIFICATIONS".

Example of attachment:

1. Put both ends of the magnet plate protection sheet [A] between end plates [B] and [C] and then secure them with fastening screws [F].
2. Temporarily secure end plates [B] and [C] on one side onto machine base [D] using fastening screws [G].
3. Attach magnet plate protection sheet [A] flatly on magnet plate [E]. Since slight magnetic attraction is exerted, take it into consideration.
4. Lightly pull end plates [B] and [C] on the other side to hold magnet plate protection sheet [A] under proper tension and then secure the end plates by turning tightening screws [G].
5. Turn tightening screws [G] to secure end plates [B] and [C] that were temporarily secured in step 2.

NOTE
1. The end plates and screws need to be prepared by yourself.
2. The end plates must be made of non-magnetic material such as SUS303 or SUS304.
3. The height of the end plate must not greater than that of the magnet plate protection sheet on the magnet plate.
4. If the magnet plate protection sheet on the magnet plate bends, it may contact the coil slider. Do not use such a stainless sheet unless the sheet is confirmed to have no problems.
3.5 MOUNTING A LINEAR ENCODER

A linear encoder must be mounted at a specified location. If a linear encoder is mounted at an incorrect location, the motor can become uncontrollable in the worst case. Mount a linear encoder correctly and securely according to Chapter 2, "MECHANICAL DESIGN", in this part.

⚠️ CAUTION
If the motor becomes uncontrollable, the machine can be damaged. Before turning on the power to the machine, be sure to check the mounting location of the linear encoder.
3.6  MOUNTING A MAGNETIC POLE SENSOR

NOTE
When an absolute linear encoder is used, no magnetic pole sensor and position detection circuit are required.

3.6.1  Mounting a Magnetic Pole Sensor on LiS 300A1/4, LiS 600A1/4, and LiS 900A1/4

A magnetic pole sensor must be mounted at a specified location. For the mounting location, see Chapter 2, "MECHANICAL DESIGN". When a cooling plate for forcibly cooling is mounted, a spacer needs to be attached to the magnetic pole sensor as shown below. A spacer is delivered with the cooling plate. When the cooling plate is not used, the spacer is not required.

Run the power line and thermostat line through the groove on the side of the magnetic pole sensor. Run the cooling tube of the cooling plate between the spacer and table.

NOTE
For the mounting of a magnetic pole sensor for LiS 1500B1/4 and up, see Part 2, "MECHANICAL DESIGN". For position detection circuit connection, see Part I, "SPECIFICATIONS".
IV. START-UP
1

PREPARATION FOR START-UP

For the start-up of an axis with a linear motor mounted, the items below are required or desirable for convenience. Prepare the following beforehand:

- Descriptions (B-65382EN) (this manual)
- Oscilloscope (for an incremental linear encoder)
- DC power supply (for an absolute linear encoder)  
  Capable of constant current control. 5 to 10A, up to about 30V  
  * When using a heavy axis or an axis with many motors, consult with FANUC beforehand.
- FANUC AC SERVO MOTOR $\alpha i/\beta i$ series Parameter Manual (B-65270EN)
- SERVO GUIDE or SD (servo waveform measurement software) and its operating environment

NOTE

1 The customer is to prepare a personal computer, oscilloscope, and DC power supply.
2 To obtain SERVO GUIDE, SD, a serial check board, and FANUC AC SERVO MOTOR $\alpha i/\beta i$ series Parameter Manual, contact your FANUC sales representative.
2 CHECKING MOUNTING STATE

**CAUTION**
If a linear motor or linear encoder is mounted incorrectly, the motor can become uncontrollable in the worst case. Before turning on the power, check that the linear motor and linear encoder are mounted correctly.

Before turning on the power, check that the coil slider, magnet plate, and linear encoder are mounted correctly, and that the type of amplifier used and the power line and signal line connections are correct, according to Part II, "SPECIFICATIONS", and Part III, "HANDLING, DESIGN, AND ASSEMBLY".

**NOTE**
If a motor or linear encoder is mounted using a method not described in this manual, contact FANUC beforehand to check if the motor can be operated normally and safely.
3 CHECKING FEEDBACK OUTPUT SIGNAL

⚠️ CAUTION
Turn on the power to the machine here. However, do not excite the motor when performing the work described below.
3.1 CONFIRMATION WITH THE POSITION DETECTION CIRCUIT

NOTE

The operation described below is required only when an incremental linear encoder is used. The operation described below is not required when an absolute linear encoder is used.

Open the cover of the position detection circuit, and check the waveform with the signal check lands placed on the periphery of the printed circuit board.

Check the analog signal inside the circuit to check the waveform output from the linear encoder.
Connect the probe GND of the oscilloscope to the reference voltage T1 (= 2.5 V) then check 0° (phase A) 90° (phase B).

If the coil slider moves in the direction opposite to the power line extension direction, ensure that the output waveform of the linear encoder is in the positive direction (phase B is 90° ahead of phase A). (Fig. 2.1)

![Fig. 2.1 Waveform where phase B is ahead](image1)

Fig. 2.1 Waveform where phase B is ahead

Fig. 2.2 shows a waveform pattern where the signal waveform of phase A is 90° ahead of the signal waveform of phase B. In this case, the mounting direction of the scale needs to be reversed, or the connections of phase A and phase B in the signal cable need to be reversed. For phase reversion, connect phase A and phase B reversely in cable K5.

![Fig. 2.2 Waveform where phase A is ahead](image2)

Fig. 2.2 Waveform where phase A is ahead
3.2 CONFIRMATION ON THE CNC SCREEN

The direction of the linear encoder is checked by the amount of deviation on the servo adjustment screen. At this time, the power lines must not be connected.

First display the servo adjustment screen to enable the observation of positional deviation. Externally move the linear motor in the positive direction. The positive direction (+ direction) of the linear motor depends on whether either the coil slider or the magnet plate moves. The direction is determined according to the power cable jutting direction.

- When the coil slider is movable

![Diagram]

Power lines

Slider movable

Slide movable

Magnet plate fixed

Positive direction

- When the magnet plate is movable

![Diagram]

Power lines

Slider fixed

Positive direction

Magnet plate movable

The direction of the linear encoder is determined by the amount of positional deviation displayed during movement. The judgment criterion depends on the settings of parameters for the movement direction.

When the direction of the linear encoder is correct

The movement direction is

111: Negative deviation is indicated.

-111: Positive deviation is indicated.

When the above indication is not shown, reverse the mounting direction of the linear encoder or change places between the A phase and the B phase of the signal cables. When reversing phases, change places between the A phase and the B phase of cables K5.

For the direction of the absolute linear encoder, the same method can be used. To reverse the direction of the linear encoder, however, reversing of the mounting directions can only be performed.

When the mounting direction of the linear encoder cannot be changed, the power line connection of the linear motor can also be changed (UVW → UWV) to reverse the positive direction of the motor.

NOTE

When the incremental encoder is used, never change power line wiring in order to reverse the motor direction. This may make the positive direction of the magnetic pole opposite to that of the motor, probably entering an uncontrollable state.
To drive the linear motor, the parameters for the linear motor need to be set. For information on how to set basic parameters required to start up linear motor mounting axes, refer to "FANUC AC SERVO MOTOR αi/βi series Parameter Manual" (B-65270EN) separately supplied.
The table below lists those troubles that often occur when a machine with a linear motor mounted is started up, and their causes.

<table>
<thead>
<tr>
<th>Trouble</th>
<th>Possible cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>The linear motor does not operate.</td>
<td>The power line connection is not made. The power line connection is incorrect.</td>
</tr>
<tr>
<td>Stop-time excessive error alarm Loss of control</td>
<td>The power line connection is incorrect. The signal line of the linear encoder is disconnected. The directions of the A/B phase signals are reversed. The AMR conversion coefficient is incorrect.</td>
</tr>
<tr>
<td>Move-time excessive error alarm</td>
<td>The power line connection is incorrect.</td>
</tr>
<tr>
<td>OVC (soft thermostat) alarm</td>
<td>The power line connection is incorrect. A very heavy load is imposed. The setting for cooling in the OVC parameter is incorrect. The positional relationship of the linear encoder is incorrect.</td>
</tr>
<tr>
<td>Soft phase alarm</td>
<td>The reference mark signal (reference signal) output position is not within the normal range. The reference mark signal includes noise.</td>
</tr>
<tr>
<td>Disconnection alarm</td>
<td>The linear encoder signal line is disconnected. The pole sensor signal line is disconnected.</td>
</tr>
<tr>
<td>Count error alarm</td>
<td>The reference mark signal includes noise. The A/B phase signal includes noise.</td>
</tr>
<tr>
<td>$\alpha$ pulse coder soft disconnection</td>
<td>Bit 7 of No. 1707 (FS15)/No. 2013 (FS16) is set to 1. (For the absolute linear encoder) The directions of the A/B phase signals are reversed. (For the incremental linear encoder)</td>
</tr>
</tbody>
</table>

**NOTE**

To protect against a malfunction and alarm arising from noise, observe the following:
- Do not omit connector connections, but make connector connections as specified (including shielding).
- Do not relay an analog signal from the linear encoder through a terminal block or the like.
- Make a ground connection securely between the power distribution board (involving the NC and amplifier) and the machine.
- Connect the shield of the feedback cable securely to ground in the power distribution board.
V. MAINTENANCE
The linear motor is an electric component. In particular, a flaw on the coil slider can degrade insulation, resulting in a failure. So, check the external view of the linear motor periodically for any abnormality.
1.1 COIL SLIDER

Check the external view of the coil slider and maintain the coil slider as described below.

Periodic checking of the external view
Check the external view at least once in every month. By making a frequent check at short intervals, you can protect against trouble beforehand.

Checking of water and oil
Check if the coil slider is exposed to water or oil ceaselessly. If so, the insulation can gradually degrade, reducing the life of the motor remarkably. If such a state lasts, consider a structure that prevents the coil slider from being exposed to water and oil. When the coil slider or magnet plate is exposed to a water-soluble coolant for an extended period of time, resin may be seriously damaged. Consider a structure that prevents a coolant from entering the motor surface.

Chipped resin
If the material inside the coil slider is exposed because of chipped resin, replace the coil slider immediately. If the resin is chipped but the inside material is not exposed, the use of the coil slider can be continued. However, frequently check if the chipping of the resin gets worse.

Cracked resin
If the resin is cracked, replace the coil slider immediately. If the coil slider is used without being replaced, a failure (such as insulation degradation) can occur abruptly.

Peeled cable sheath and terminal crack
If the material in question is replaceable, replace it immediately. If the material in question is directly built into the main coil slider unit, it is not replaceable. In this case, replace the coil slider. However, by patching the trouble, the material in question may be used only temporarily.

Play in assembly
If there is play although the mounting screws are tightened firmly, replace the coil slider immediately after checking that the play is not caused by the machine. If the coil slider is used without being replaced, a failure or accident can occur abruptly.
Scratch on the surface (facing the magnet plate)

Only when a scratch in question is as slight as the removal of a part of the black protective coating, the continued use of the coil slider is enabled by recoating the coil slider. For recoating, contact FANUC. For other scratches, replace the coil slider as soon as possible. Particularly when a material inside the coil slider is exposed, replace the coil slider immediately. If a scratch is caused by foreign matter caught in the gap between the coil slider and magnet plate, remove the foreign matter immediately, and take measures to prevent foreign matter from being caught in the gap.
1.2 MAGNET PLATE

Check the external view of the coil slider and maintain the coil slider as described below.

Periodic checking of the external view
Check the external view at least once in every month. By making a frequent check at short intervals, you can protect against trouble beforehand.

When a magnet is exposed or floating
Replace the magnet plate immediately. If the magnet plate is used without being replaced, a failure can occur.

When the resin is cracked or chipped
Replace the magnet plate as soon as possible. If the magnet plate is used without being replaced, a failure can occur.

When the resin on the magnet plate surface has a flaw
If a flaw in question is a slight scratch, and no magnet is exposed, the use of the magnet plate can be continued. If a magnet is exposed, replace the magnet plate immediately. If a flaw is caused by foreign matter caught in the gap between the coil slider and magnet plate, remove the foreign matter immediately, and take measures to prevent foreign matter from being caught in the gap.

When the protection cover is unstuck
Replace the cover as soon as possible. If the cover is used without being replaced, a failure can occur.

When the protection cover has a flaw
If a flaw in question is a slight scratch and the magnet plate is not exposed, the cover can be used continuously. If part of the magnet plate is exposed, replace the cover as soon as possible.

Deformed or lost mounting screws
By using new mounting screws, secure the magnet plate tightly.

Play in assembly
If there is play although the mounting screws are tightened firmly, replace the magnet plate immediately after checking that the play is not caused by the machine. If the magnet plate is used without being replaced, a failure or accident can occur abruptly.
1.3 MAGNETIC POLE SENSOR (FOR AN INCREMENTAL SYSTEM)

Check the external view of the coil slider and maintain the coil slider as described below.

Periodic checking of the external view
Check the external view at least once in every month. By making a frequent check at short intervals, you can protect against trouble beforehand.

Deformed or lost mounting screws
By using new mounting screws, secure the magnetic pole sensor tightly.

Play in assembly
If there is play although the mounting screws are tightened firmly, replace the magnetic pole sensor immediately after checking that the play is not caused by the machine. If the magnetic pole sensor is used without being replaced, a failure or accident can occur abruptly.
2.CHECKING ELECTRIC CHARACTERISTICS

The linear motor is an electronic component, and has a life as with other ordinary electric components. Depending on the environment in which a linear motor is used, the insulation performance degrades abruptly, reducing the life remarkably. Check the electric characteristics periodically.

⚠️ WARNING
When making resistance and insulation checks, turn off the power and disconnect the terminal to prevent an electric shock from occurring. Perform insulation processing for those terminals that are not used.
2.1 CHECKING INSULATION RESISTANCE

Measure an insulation resistance between each winding and motor frame using an insulation resistance meter (500 VDC). Judge the measurements according to the following table.

<table>
<thead>
<tr>
<th>Insulation resistance</th>
<th>Judgment</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 MΩ or higher</td>
<td>Acceptable</td>
</tr>
<tr>
<td>10 to 100 MΩ</td>
<td>The winding has begun deteriorating. There is no problem with the performance at present. Be sure to perform periodic inspection.</td>
</tr>
<tr>
<td>1 to 10 MΩ</td>
<td>The winding has considerably deteriorated. Special care is in need. Be sure to perform periodic inspection.</td>
</tr>
<tr>
<td>Lower than 1 MΩ</td>
<td>Unacceptable. Replace the coil slider.</td>
</tr>
</tbody>
</table>

**CAUTION**

If a voltage is kept applied to the motor at the time of insulation resistance measurement, the insulation of the motor can degrade. Make an insulation resistance measurement in a shortest possible time.

2.2 CHECKING WINDING RESISTANCE

By using a milliohm meter, make a winding resistance measurement as described below. Insulate those terminals that are not used for measurement. For winding resistance values, see Part I, "SPECIFICATIONS".

- Measure the resistance values between U and V, V and W, and W and U of the coil slider.
- Check that the variations among measured values are within ±1%.
- Check that each measured value is within ±5% of two times the resistance value described in Part I, "SPECIFICATIONS".

If a resistance value not satisfying the above is measured, replace the coil slider immediately.

**NOTE**

1. For a linear motor based on the terminal specification, detach the power line, and make a measurement at the terminal.
2. For a linear motor based on the power line specification, make a measurement at the tip of the power line (lead on the motor side).
3 CLEANING

WARNING
When performing cleaning, turn off the power to the machine, ensure that the motor does not move freely, and be careful not to be electrically shocked.

Reasons for cleaning

The linear motor has a gap of 0.5 mm (nominal) between the coil slider and magnet plate. If foreign matter is caught in the gap, the motor can fail. Moreover, a buildup of oil can adversely affect the motor. To prevent trouble caused by dust and oil, clean the linear motor periodically.

If an axis with a linear motor mounted is not shielded or is insufficiently shielded, magnetic dust can be attracted to or near the top surface of the magnet plate. If such dust is left, it can be caught in the gap between the coil slider and magnet plate, resulting in a damage to the motor in the worst case. So, for an axis with a structure that can catch dust, cleaning must be performed frequently.

Method of cleaning

Magnetic dust attached onto the surface of the magnet plate can be removed relatively easily by scraping off the dust toward the stroke end of the magnet plate with a spatula made of hard rubber.

Wipe off any oil attached onto the coil slider or magnet plate softly with alcohol. Do not use a large amount of alcohol and do not rub the surface of the coil slider and magnet plate intensely. Otherwise, the protective coating on the surface can be adversely affected.

When a low-viscosity fluid such as a coolant adheres to the magnet plate or when relatively-small non-magnetic chips adhere to it, blowing with compressed air may be sufficient.

CAUTION
Do not use an agent other than alcohol. Otherwise, the resin used for the motor can be eroded, resulting in a damage to the motor.
# ORDERING DRAWING NUMBER

## NOTE

When placing a formal order, refer to "FANUC LINEAR MOTOR LİS series Order List (B-65381EN)". For details including the specifications, dimensions, and applicable amplifiers, see Part I, "SPECIFICATIONS".

<table>
<thead>
<tr>
<th>Model name</th>
<th>Coil slider</th>
<th>Magnet plate</th>
<th>Cooling plate</th>
<th>Magnetic pole sensor</th>
<th>position detection circuit</th>
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<td>A06B-0440-B338#000x</td>
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</tr>
</tbody>
</table>

*1 Select a magnet plate suitable for the coil slider and axis length required.
   The specifications vary with value x in the magnet plate number.
   0: Standard type, 1: With protection cover, 2: Without protection cover

*2 Option required for forced cooling (air cooling or water cooling) of LİS 300A1/4, LİS 600A1/4, and LİS 900A1/4. A spacer for the magnetic pole sensor is delivered with this option.

*3 Required when an incremental linear encoder is used. Not required when an absolute linear encoder is used.

*4 To be specified only when a signal needs to be distributed to two systems from one linear encoder.
The FANUC Linear Motor LÍŚ series uses a linear encoder for a motor position signal. The linear motor is controlled using only this signal. If a linear encoder is mounted or set incorrectly, the linear motor cannot be operated normally. This appendix briefly describes the operation theory of the linear motor as a basic knowledge.

⚠️ CAUTION
If a linear motor or linear encoder is mounted or connected incorrectly, the motor can become uncontrollable in the worst case. Before turning on the power, ensure that the linear motor and linear encoder are mounted and connected correctly.
B.1 OPERATION THEORY OF THE LINEAR MOTOR (OVERVIEW)

The linear motor viewed from the side is outlined in the illustration below.

![Linear Motor Diagram]

**NOTE**
The illustration above shows an incremental encoder system. For an absolute encoder system, no magnetic pole sensor is required.

When the coil slider is to be moved to or stopped at a particular position, a proper current calculated from the positional relationship between the coil slider and magnet plate needs to be flown for each phase of the coil slider. Thus, the coil generates proper magnetism for controlling the motor position. The positional relationship between the coil slider and magnet plate can be determined from the position signal sent from the linear encoder.

![Positional Relationship Diagram]

Before the positions of the coil slider and magnet plate can be known from the position signal sent from the linear encoder, the positional relationship between the motor (coil slider, magnet plate, and magnetic pole sensor) and linear encoder must be predetermined. So, the motor and linear encoder need to be mounted at specified positions as described in Part III, "HANDLING, DESIGN, AND ASSEMBLY".

Actually, however, the inside of the linear encoder may involve a deviation of up to several millimeters. If this deviation is excessively large, the linear encoder cannot return the correct position of the motor. This means that a current that is not reflecting the correct position is flown into the motor, and therefore the power factor and precision of the motor can degrade. To compensate for this current phase shift, the AMR offset parameter is used. With this parameter, the position of zero-degree electric angle of the motor (exciting phase from phase U) and the reference position of the linear encoder are taken into consideration for compensation to flow current in the correct phase. Usually, an AMR offset in the range ±45° can be set. (Depending on the servo software, an AMR offset in the range ±60° can be set.)
**B.2 ROLE OF THE MAGNETIC POLE SENSOR**

When an incremental linear encoder is used, line motor axis operation is initially in a special state. So, a magnetic pole sensor is needed. The role of a magnetic pole sensor used with an incremental linear encoder is described below.

---

**System activation (power-on)**

1. **Linear motor exciting**
   - Because an incremental system is used, the motor does not know where the motor is positioned.

   ![Diagram of Linear motor exciting](image)

2. **Detection of the reference position of the linear encoder**
   - The reference position (phase Z signal) of the linear encoder is detected. At this time, move the linear motor to the position where the reference position of the linear encoder is detected, according to magnetic pole information (which is the N pole, and which is the S pole) obtained from the magnetic pole sensor.

   ![Diagram of Detection of the reference position](image)

3. **Switching to the linear encoder**
   - When the reference position of the linear encoder is detected, current control is switched from the magnetic pole sensor to the linear encoder. After this point, the signal from the magnetic pole sensor is used to check the matching of the position waveform of the linear encoder with the magnetic pole.

   ![Diagram of Switching to the linear encoder](image)
NOTE
1 Even after the reference position of a linear encoder is detected, and current control is switched to the linear encoder, the signal from the Magnetic pole sensor is used to check the linear encoder for an error. So, even after the reference position of the linear encoder is detected, ensure that the Magnetic pole sensor is not detached from the magnet plate. If the Magnetic pole sensor is detached from the magnet plate, an alarm is issued.
2 The reference position of an incremental linear encoder needs to be detected each time the power to the system is turned on after turning off the power to the system.
3 If a Magnetic pole sensor is mounted in an incorrect position, an alarm is issued, and the motor may not operate normally.
4 If an absolute linear encoder is used, the position of the motor is established when the power is turned on. So, the reference position (phase Z signal) of the linear encoder need not be detected. When the power is turned on, position control based on the signal from the linear encoder starts.
As shown below, the magnet side of a magnet plate (that faces the coil slider) is completely coated with epoxy resin selected to endure a severe use environment.

If foreign matter is caught between the coil slider and magnet plate, epoxy resin protects the magnets. The most suitable type of epoxy resin is selected. So, resin may be flawed or chipped, but a serious and unrecoverable failure such as the peeling of the entire resin coating involving other peripheral components is unlikely to occur. If a slight flaw not extending to a magnet occurs, apply epoxy resin of heat resistant type A or higher onto the flaw to recover the original height. With such a remedy, the epoxy resin coating can be practically used permanently.

If a damage that reaches a magnet occurs, a large and hard foreign material is caught. In such a case, the probability that the coil slider is also damaged is very high. In this case, perform maintenance according to Part V, "MAINTENANCE". Moreover, take measures to prevent foreign matter from being caught in order to protect against similar trouble.

NOTE
It is recommended that periodic maintenance be performed according to Part V, "MAINTENANCE" in order to use the linear motor safely for a longer time.
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- Addition of models
- Change of model names
- Correction of errors