MITSUBISHI ELECTRIC
Changes for the Better

Servo

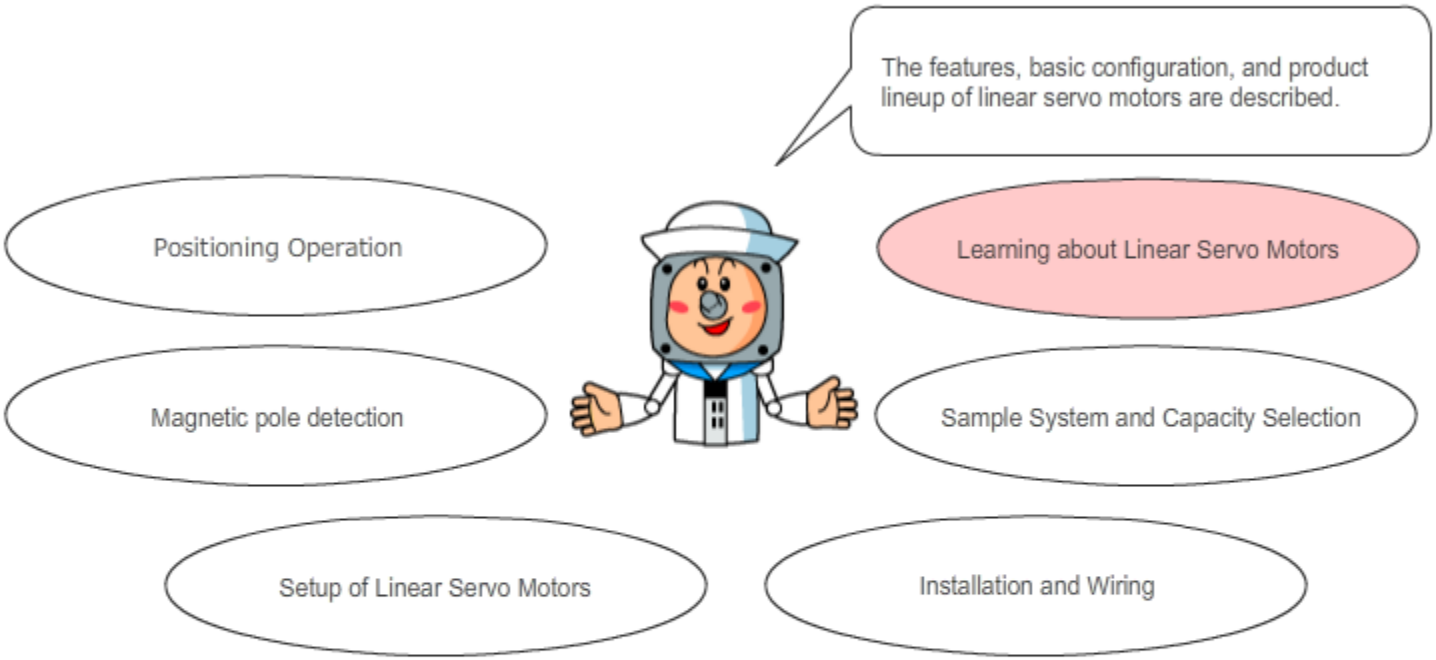
MELSERVO Basics (Linear servo motor)

This course is an online training system (e-learning) for those who want to learn how to construct a servo system using linear servo motors.

L(NA)00190ENG

Introduction Purpose of the Course

This course targets those who establish a servo system using linear servo motors for the first time and describes the procedures for installation, wiring, test operations, and monitoring.



A basic knowledge of AC servos is required to take this course.

Beginners are recommended to take the following course:
• "Servo MELSERVO Basics (MR-J4)" course

Introduction Course Structure

The contents of this course are as follows.
We recommend that you start from Chapter 1.

Chapter 1 - Learning about Linear Servo Motors

This chapter describes the features and application examples of linear servo motors and the features of LM series.

Chapter 2 - Sample System and Capacity Selection

This chapter introduces the sample system in this course and explains how to select the capacity.

Chapter 3 - Installation and Wiring

This chapter describes the precautions on handling and installing linear servo motors, and procedures for installation, wiring, and power-on of a servo amplifier.

Chapter 4 - Setup of Linear Servo Motors

This chapter describes how to set parameters of a servo amplifier using MR Configurator2.
(Setting of servo motor series and servo motor types, linear encoder pole selection, and resolution setting)

Chapter 5 - Magnetic Pole Detection

This chapter describes the magnetic pole detection (necessity of initial magnetic pole detection), how to perform the magnetic pole detection, and the precautions on the magnetic pole detection.

Chapter 6 - Positioning Operation

This chapter describes the positioning operation in the test operation mode using MR Configurator2, connection of controllers, settings (axis numbers, system setting, and positioning control parameters), powering on of the power supply, and home position return.

Final Test

5 sections in total (18 questions) Passing grade: 60% or higher.

Introduction How to Use This e-Learning Tool

Go to the next page		Go to the next page.
Back to the previous page		Back to the previous page.
Move to the desired page		"Table of Contents" will be displayed, enabling you to navigate to the desired page.
Exit the learning		Exit the learning. Window such as "Contents" screen and the learning will be closed.

Introduction Cautions for Use

Safety precautions

When you learn by using actual products, please fully read "Safety Instructions" in the corresponding manuals and use them correctly.

Precautions in this course

- The displayed screens of the software version that you use may differ from those in this course.

The following shows the software used in this course and each software version.

For the latest version of each software, check the Mitsubishi Electric FA Website.

- Setup software	MR Configurator2 Ver.1.27D
- Capacity selection software	MRZJW3-MOTSZ111E Ver.D1
- Engineering software	MELSOFT MT Works2 Ver.1.100E

Reference materials

The following is the reference related to the learning. (You can learn without it.)
Click the reference name to download.

Name of reference	File format	File size
Recording paper	Compressed file	7.72 kB

Chapter 1 Learning about Linear Servo Motors

This chapter describes the features and application examples of linear servo motors and the features of LM series.

Chapter 1 - Learning about Linear Servo Motors

1.1 What is a Linear Servo Motor?
1.2 Features of Linear Servo Motors
1.3 Application Examples of Linear Servo Motors
1.4 LM Series Linear Servo Motors
1.5 Lineup of LM Series
1.6 Structure of LM Series
1.7 Features of LM Series
1.8 Supported Servo Amplifiers
1.9 Summary

Chapter 2 - Sample System and Capacity Selection

Chapter 3 - Installation and Wiring

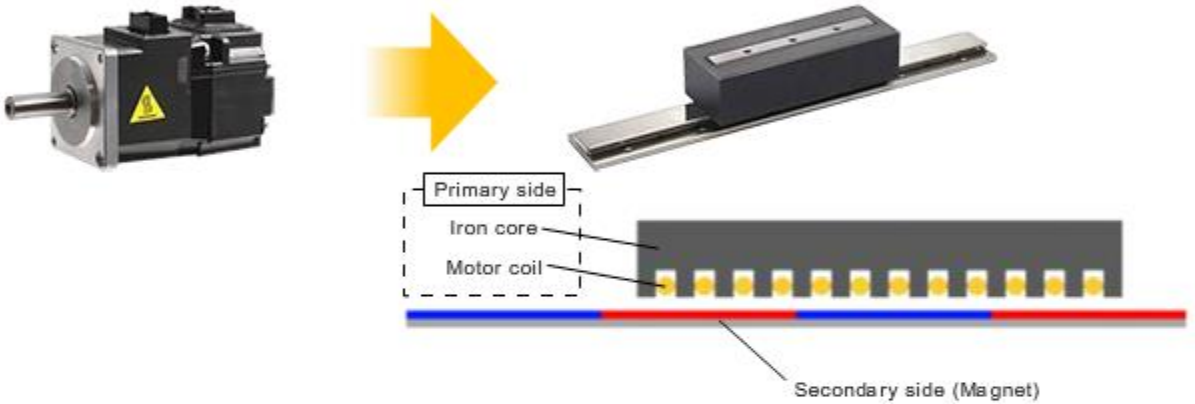
Chapter 4 - Setup of Linear Servo Motors

Chapter 5 - Magnetic Pole Detection

Chapter 6 - Positioning Operation

1.1 What is a Linear Servo Motor?

A linear servo motor has the structure in which a part of a rotary servo motor is unfolded and straightened.
The operating principles of linear servo motors are the same as the those of rotary servo motors. However, linear servo motors perform linear movements, while rotary servo motors perform rotary movements.



Linear servo motor (Cross-section view)

1.2 Features of Linear Servo Motors

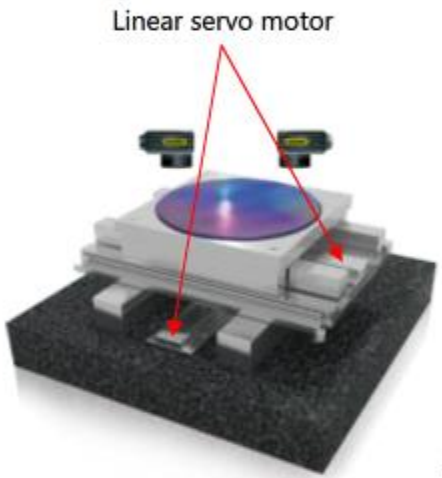
A Linear servo motor can be connected directly with a device and performs linear movements without a transmission mechanism such as a ball screw.
Therefore, using the linear servo motor enables high-speed and high-accuracy positioning operations.

The linear servo motor has the following features.

- Enables simple and compact mechanism, and increases machine rigidity
- Smooth, quiet operations
- High-speed driving part improves productivity.

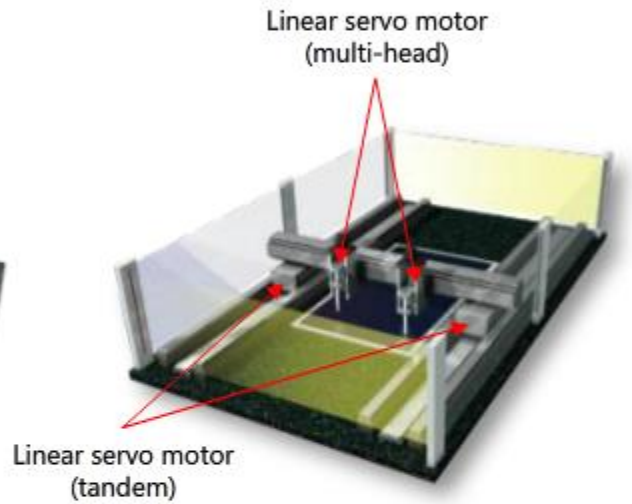
1.3 Application Examples of Linear Servo Motors

A system with linear servo motors does not require transmission mechanism such as a ball screw, enabling high-speed and high-accuracy controls, and easy maintenance. Therefore, linear servo motors are used in various systems as shown below.



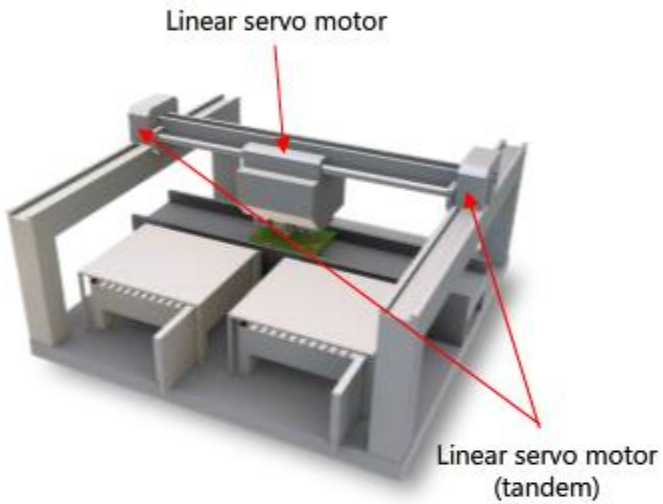
Alignment system

- System that requires high-accuracy positioning



Automatic assembly system

- Large system (tandem)
- System that needs to shorten tact time (multi-head)



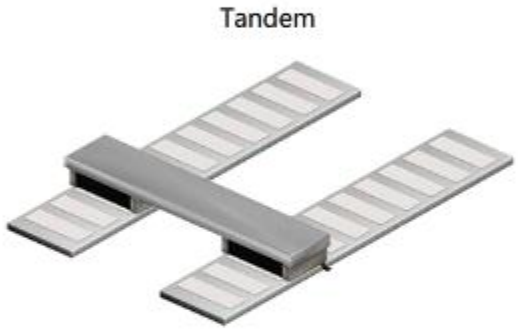
Mounter

- System that requires high-speed positioning

1.4 LM Series Linear Servo Motors

By using LM series linear servo motors (hereinafter referred to as "LM series") together with an SSCNET III/H compatible servo system controller and MELSERVO-J4 series servo amplifiers, you can configure a high-speed and high-accuracy linear motion system. By using the system, you can easily perform tandem operations requiring the high-accuracy synchronization between two axes.

LM Series Linear Servo Motors



The LM series has the following features.

- The following four types of linear servo motors are provided in LM Series for various applications: Core type, core type (liquid cooling), core type with magnetic attraction counter-force, and coreless type.
- Tandem operations are easily achieved with a single command to two axes by the SSCNET III/H synchronization. The advanced synchronous control can also be used.
- The MELSERVO-J4 series servo amplifier maximizes the performance of the LM series, achieving the highly-responsive servo control.

1.5 Lineup of LM Series

Select from the following four types of LM series linear servo motors suitable for your application: Core type, core type (liquid cooling), core type with magnetic attraction counter-force, and coreless type.

▲ Thrust

Core type (natural/liquid cooling)

LM-F series

Maximum speed: 2 m/s
Rated thrust : 300 N to 3000 N (natural cooling)
600 N to 6000 N (liquid cooling)
Maximum thrust: 1800 N to 18000 N
(natural/liquid cooling)

Compact core type linear servo motor.
The integrated liquid-cooling system
doubles the continuous thrust.

Press feeders

NC machine tools

Material handlings

Coreless

LM-U2 series

Maximum speed: 2 m/s
Rated thrust: 50 N to 800 N
Maximum thrust: 150 N to 3200 N

No cogging,
small speed fluctuation.
No magnetic attraction force,
longer life of the linear guides.

Screen printing systems Scanning exposure systems

Core type

LM-H3 series

Maximum speed: 3 m/s
Rated thrust: 70 N to 960 N
Maximum thrust: 175 N to 2400 N

Core type suitable for space-saving,
high speed and high acceleration/deceleration.

LCD assembly machines

Semicon-ductor mounting systems

Core type with magnetic attraction counter-force

LM-K2 series

Maximum speed: 2 m/s
Rated thrust: 120 N to 2400 N
Maximum thrust: 300 N to 6000 N

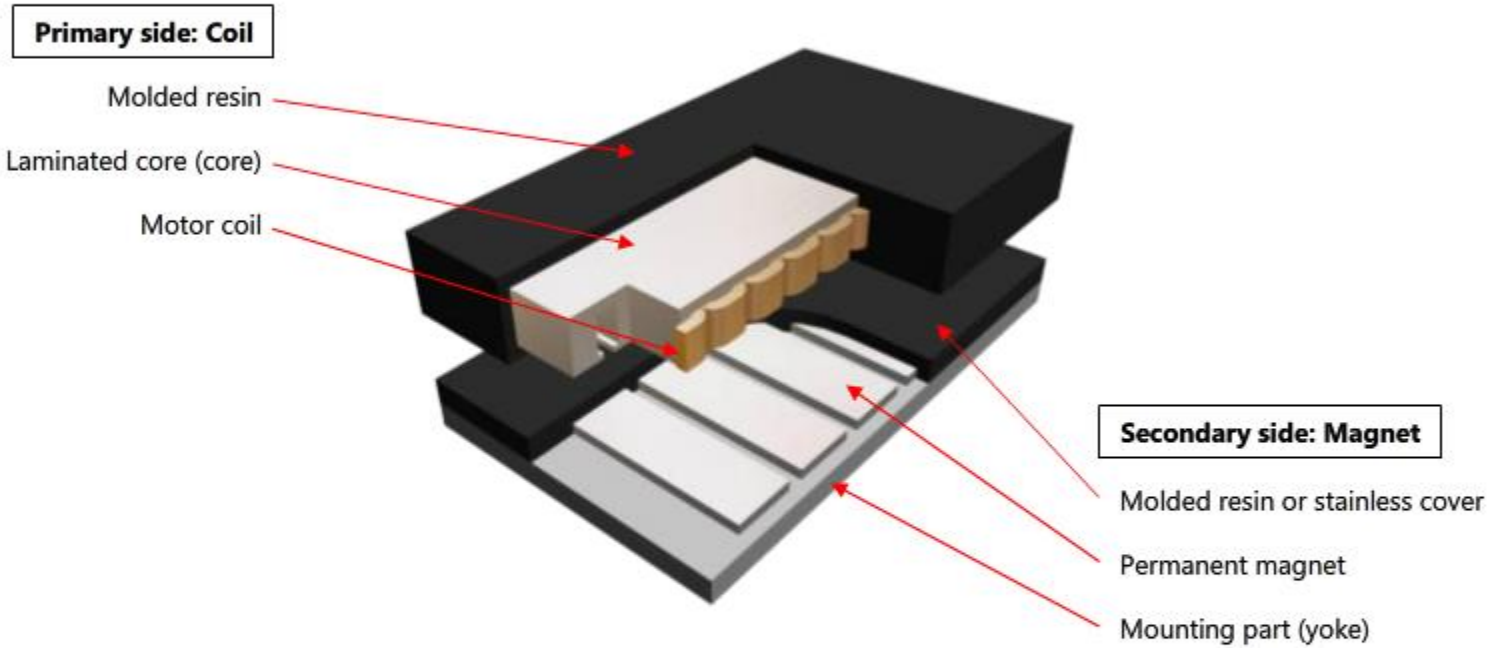
Longer life of the linear guides
due to the magnetic attraction
counter-force structure.
Low audible noise.

◀ Feed speed-oriented

Positioning-oriented ▶

1.6 Structure of LM Series

A linear servo motor has the combined structure of the primary side consisting of a laminated core (core) and motor coils, and the secondary side consisting of a mounting part (yoke) and permanent magnets. (for core type)



Primary side: Coil

The primary side has a laminated core (core) with winding and is covered with the molded resin.

Secondary side: Magnet

The secondary side has permanent magnets on the mounting part (yoke) and is covered with the molded resin or stainless cover.

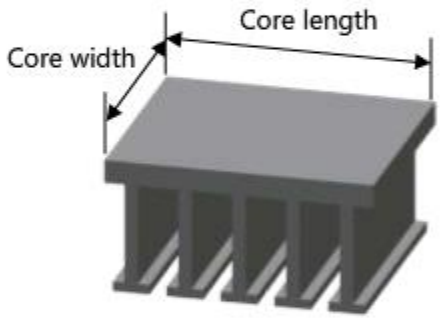
1.7 Features of LM Series

1.7.1 Features of LM Series - Compact and High-thrust Motor

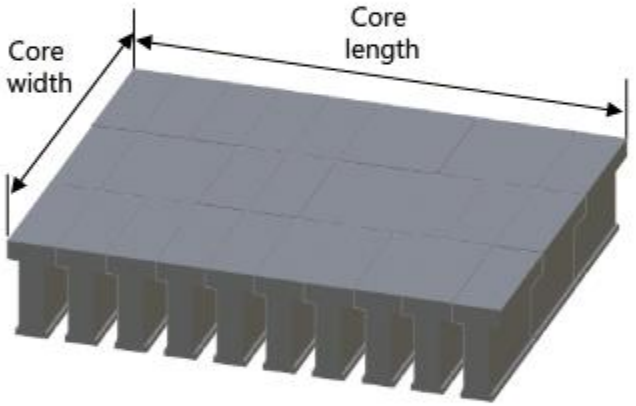
The LM series are compact and low-heat-generating linear servo motors that have a core structure with building-block type coils that shortens core ends and enables high-density winding. (for core type)

Conventional type

Integrated core
A dedicated mold is required to produce cores depending on changes in motor size.



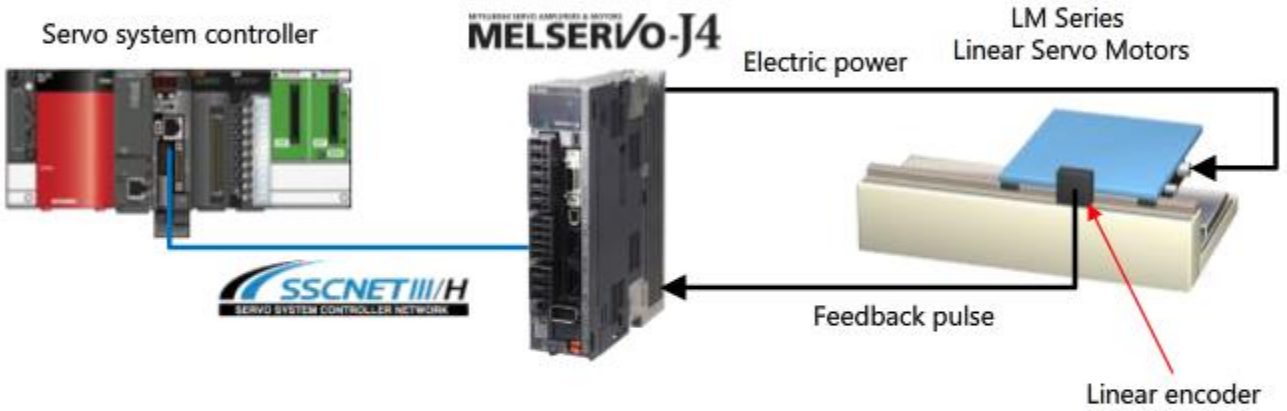
Building-block type



Standard core
A dedicated mold is not required to produce cores. As a result, variations of thrust, motor length, and motor width can be expanded.

1.7.2 Features of LM Series - High Speed and High Accuracy

By using the LM series together with the MELSERVO-J4 series, the industry-leading servo amplifiers, highly-responsive and high-accuracy servo controls can be performed. In addition, by using various control functions of the MELSERVO-J4 series, such as the advanced vibration suppression control, the LM series can be driven to maximize the system performance.



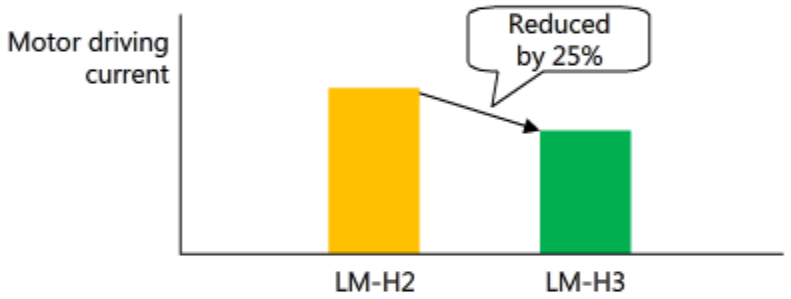
1.7.3 Features of LM Series - Energy-saving and Space-saving Motors

The LM-H3 series saves more energy and space than the prior model (LM-H2 series).

■ Reducing the electric power for driving motors

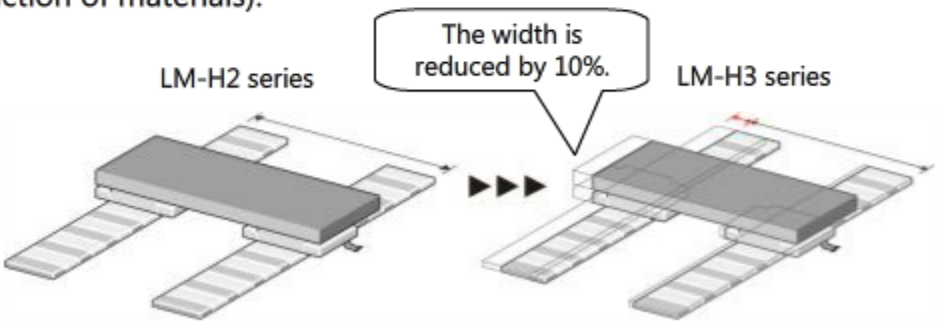
The LM-H3 series has achieved a reduction of 25%* in motor driving current by a new magnetic design with optimized magnet form, contributing to power conservation for machines. Compared to the prior model, the mass of the coil (Primary side: Coil) has been reduced by approximately 12%*, which also contributes to saving energy for driving the moving part.

* For 720 N rated linear servo motor



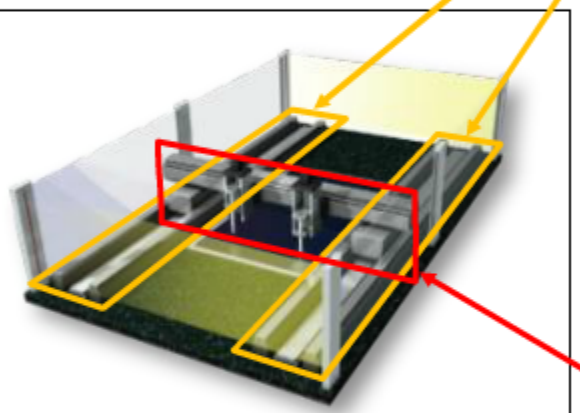
■ Space saving

For LM-H3, widths of the motor coil and the magnet are reduced by 10% from the prior model. The increased thrust to current ratio results in using the servo amplifier in smaller capacity, contributing to more compact machine (reduction of materials).



1.7.4 Features of the LM Series - Tandem and Multi-head

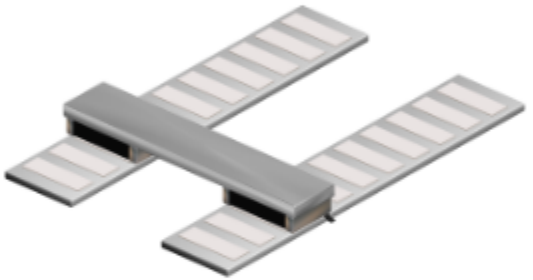
Tandem and multi-head configurations are easily achieved with the LM series. The LM series supports various system configurations flexibly.



Automatic assembly system

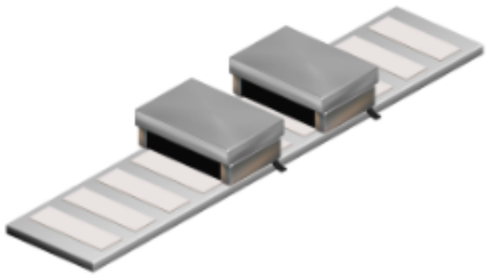
■ Tandem

The linear servo motors in a tandem configuration are suitable for large systems that require highly-accurate synchronous operations between two axes. Tandem operations are easily achieved with a single command to two axes by the SSCNET III/H synchronization. The advanced synchronous control can also be used.



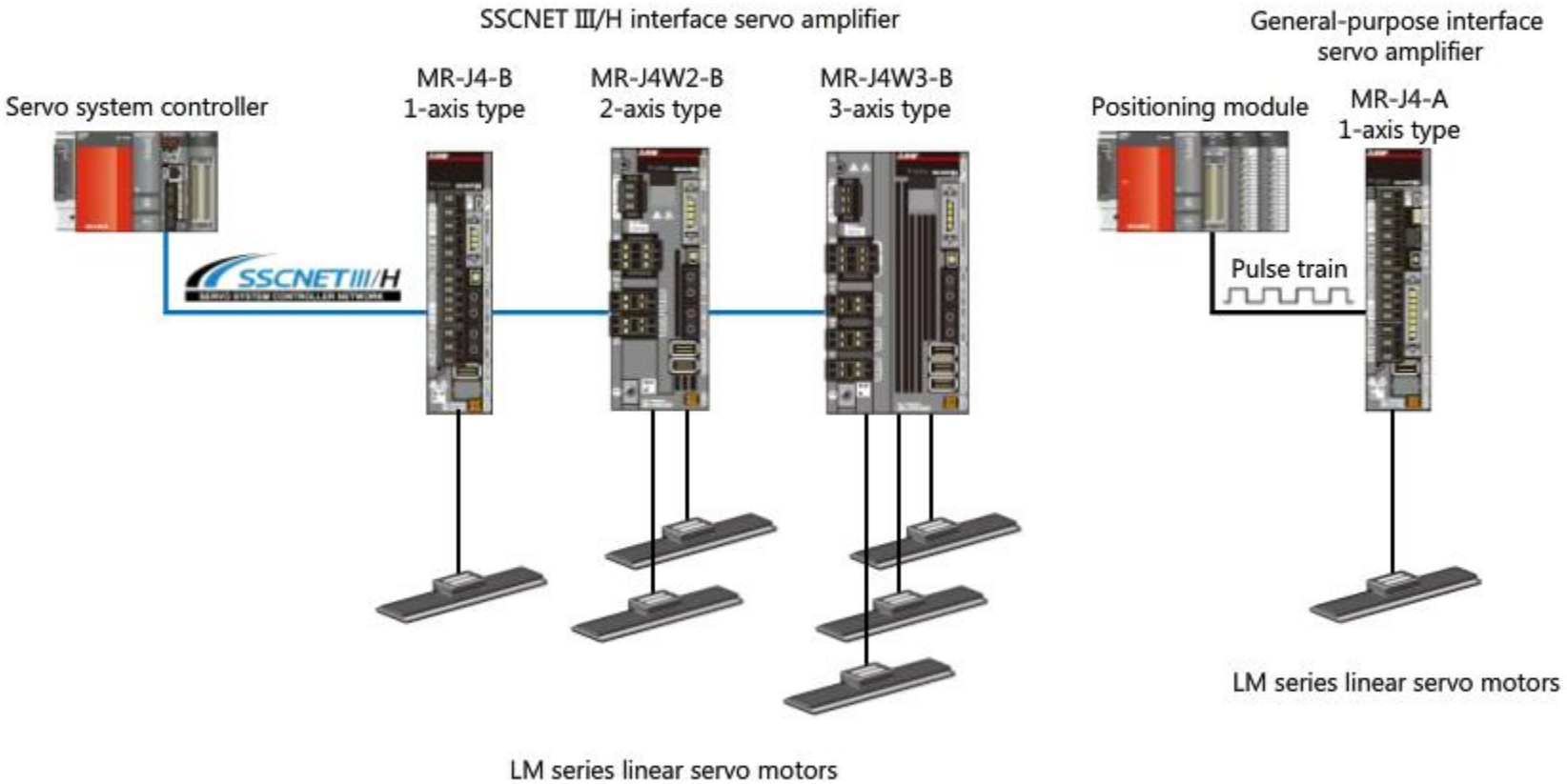
■ Multi-head

Multi-head systems enable control of two coils (Primary side coils) independently, thereby simplifying machine mechanisms. These systems are suitable for machines that require short tact time.



1.8 Compatible Servo Amplifiers

The LM series can be used with the SSCNET III/H interface and general-purpose interface servo amplifiers.
In addition, 1-axis servo amplifiers, 2-axis and 3-axis type servo amplifiers can be used to drive the LM series linear servo motors.
For the details of the MELSERVO-J4 series, refer to the "Servo MELSERVO Basics (MR-J4)" course.



1.9 Summary of This Chapter

In this chapter, you have learned:

- What is a Linear Servo Motor?
- Features of Linear Servo Motors
- Application Examples of Linear Servo Motors
- LM Series Linear Servo Motors
- Lineup of LM Series
- Structure of LM Series
- Features of LM Series
- Supported servo amplifiers

Important points

Features of Linear Servo Motors	• A Linear servo motor can be connected directly with a device and performs linear movements without a transmission mechanism such as a ball screw. Therefore, using the linear servo motor enables high-speed and high-accuracy positioning operations.
Application Examples of Linear Servo Motors	• A system with linear servo motors does not require transmission mechanism such as a ball screw, enabling high-speed and high-accuracy controls, and easy maintenance. Therefore, linear servo motors are used in various systems.
Lineup of LM Series	• You can select from the following four types of LM series linear servo motors suitable for your application: Core type, core type (liquid cooling), core type with magnetic attraction counter-force, and coreless type. You can select any type of linear servo motors depending on the usage.
Structure of LM Series	• A linear servo motor has the combined structure of the primary side consisting of a laminated core (core) and motor coils, and the secondary side consisting of a mounting part (yoke) and permanent magnets. (for core type)
Features of LM Series	• The LM series motors are compact low-heat-generating linear servo motors that have a core structure with building-block type coils that shortens core ends and enables high-density winding. • You can configure tandem and multi-head systems easily by using the LM series.

Chapter 2 Sample System and Capacity Selection

This chapter introduces the sample system in this course and explains how to select the capacity.

Chapter 1 - Learning about Linear Servo Motors

Chapter 2 - Sample System and Capacity Selection

2.1 Sample System
2.2 Selecting the Capacity of Linear Servo Motors
2.3 Selecting Linear Encoders
2.4 List of System Configuration
2.5 Summary of This Chapter

Chapter 3 - Installation and Wiring

Chapter 4 - Setup of Linear Servo Motors

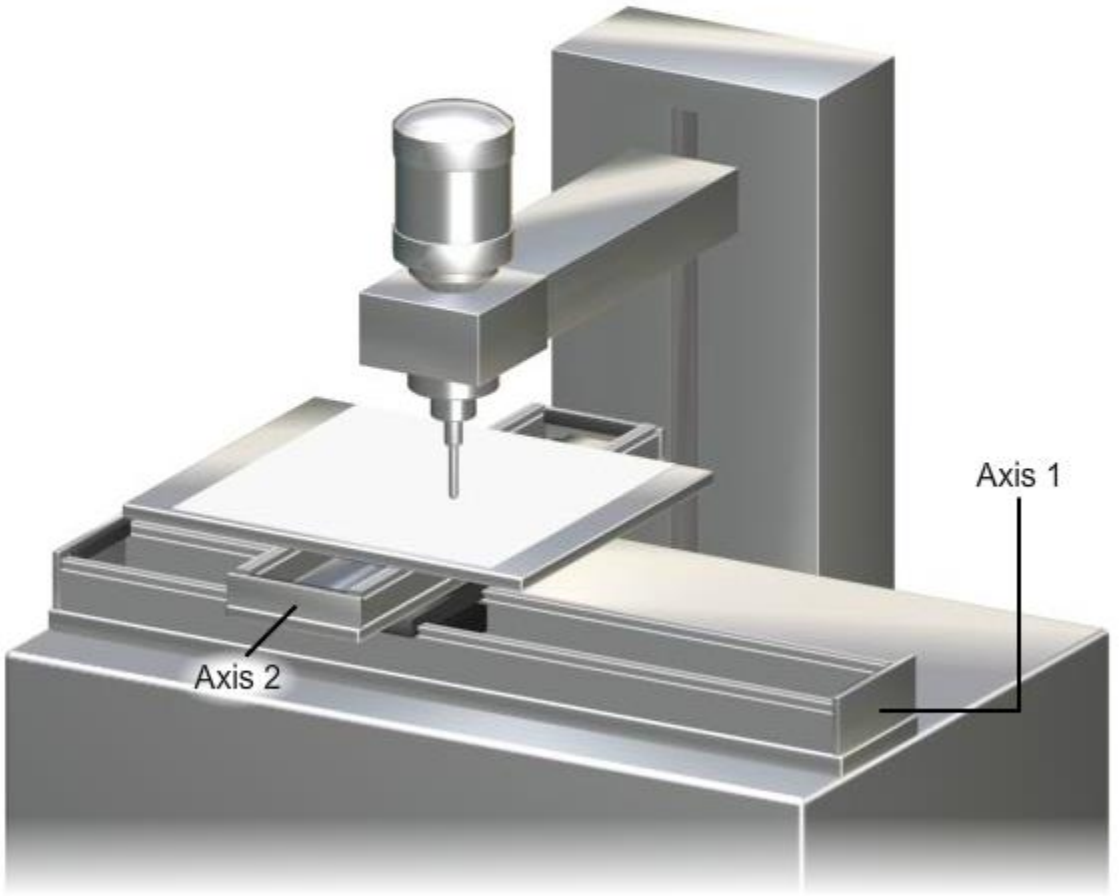
Chapter 5 - Magnetic Pole Detection

Chapter 6 - Positioning Operation

2.1 Sample System

In this course, you will learn an X-Y table as a sample system.
Please check the following PDF file for the operation pattern diagram and the machine specifications.

Sample system details <PDF>



2.2 Selecting the Capacity of Linear Servo Motors

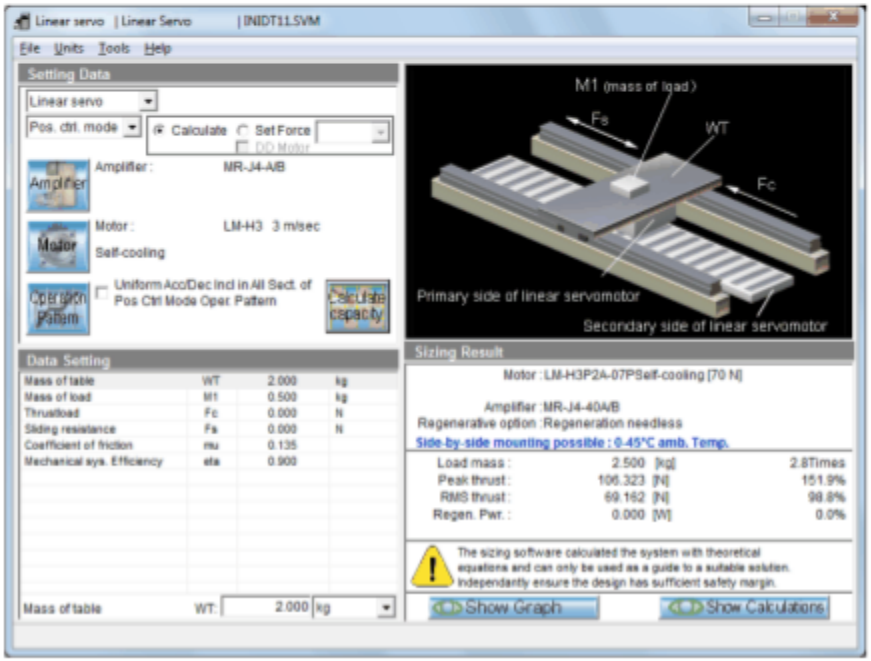
First, you have to select the optimal capacity of the servo amplifiers and the linear servo motors that are used in the sample system.
To select the capacity, use AC servo capacity selection software (free software).

AC servo capacity selection software

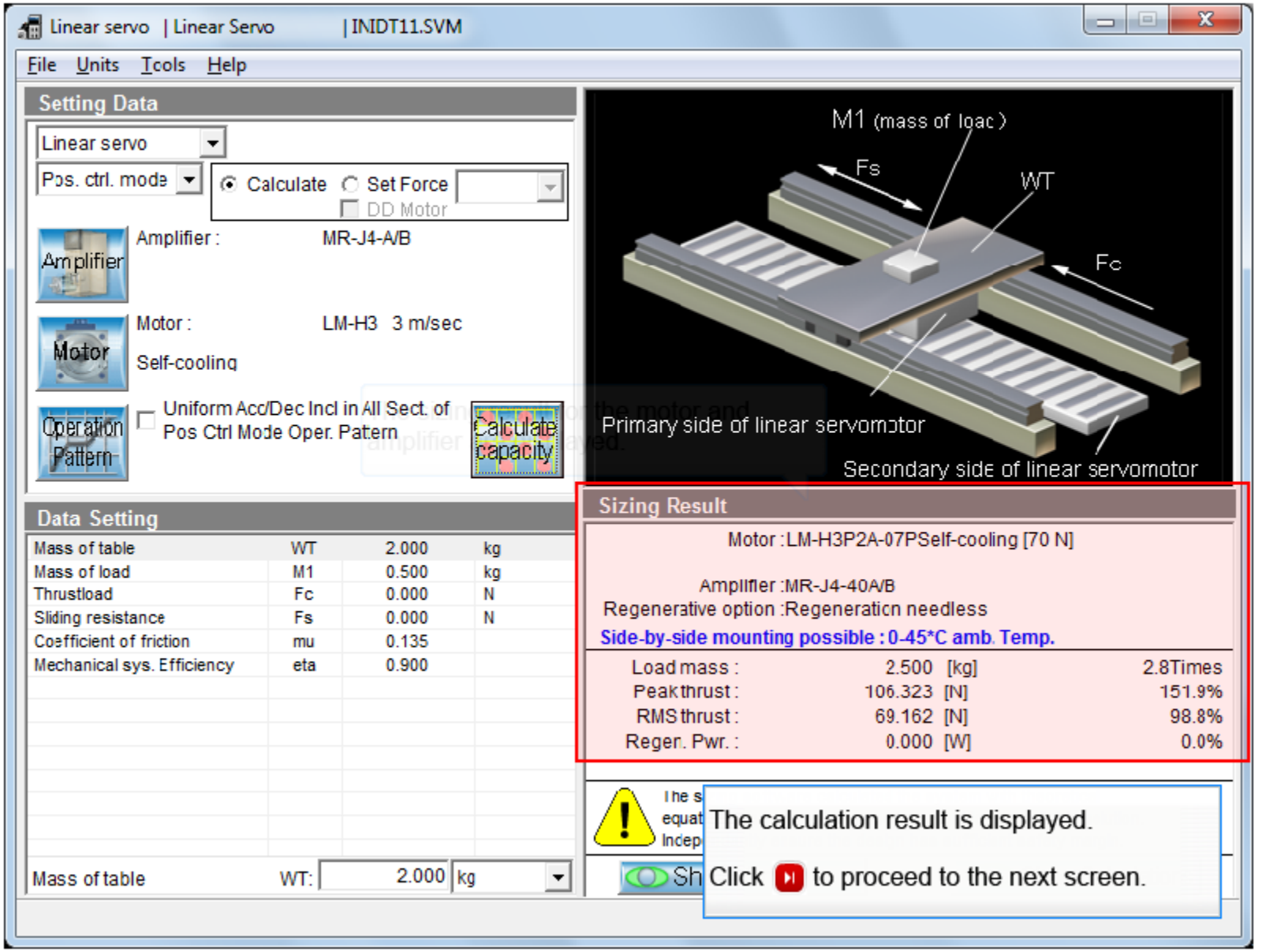
Download this software from the Mitsubishi Electric FA Website.
By setting the machine specifications and operation pattern, you can select the most suitable servo amplifiers, linear servo motors, and regenerative options.

On the next page, you can simulate the capacity selection with the AC servo capacity selection software by using actual windows.

Capacity Selection Software: MRZJW3-MOTSZ111E



2.2 Selecting the Capacity of Linear Servo Motors



2.3 Selecting Linear Encoders

To use a linear servo motor, you have to select a linear encoder.
Linear encoders are typically classified into the following types.
The sample system uses an incremental type linear encoder compatible with Mitsubishi serial interfaces.

Linear encoder type	
Mitsubishi serial interface compatible	Absolute position type
	Incremental type
A/B/Z-phase differential output type*	Incremental type

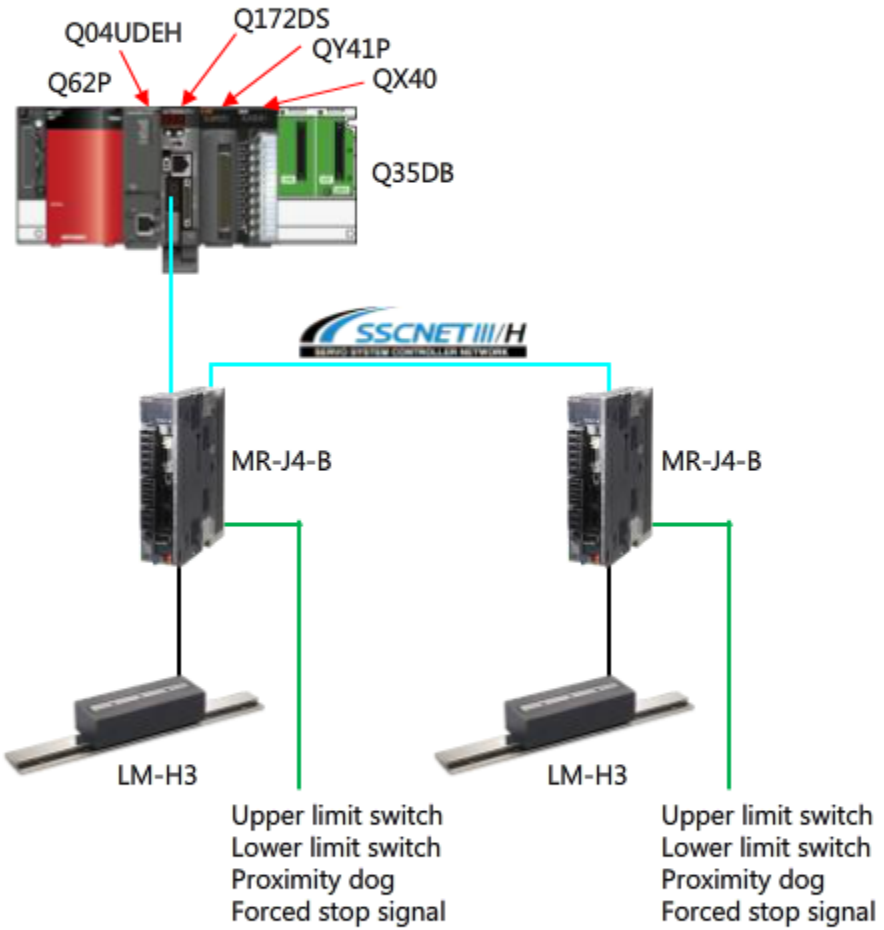
The MR-J4 series servo amplifiers are compatible with various serial interface encoders with a minimum resolution of 0.005 μm or larger and A/B/Z-phase differential output type* linear encoders.
Select linear encoders suitable for your machine by checking specifications (resolution, rated speed, effective measurement length, etc.) of the linear encoders in "LINEAR ENCODER INSTRUCTION MANUAL." For the details of specifications, performance, and warranty of linear encoders, contact the manufacturer of each linear encoder.

* The MR-J4-B-RJ/MR-J4-A-RJ servo amplifiers are compatible with A/B/Z-phase differential output type linear encoders.

List of linear encoders (as of March, 2015) <PDF>

2.4 List of System Configuration

The following shows the configuration of the sample system used in this course.



Type		Model	Qty
Controller			
	PLC CPU	Q04UDEHCPU	1
	Power supply module	Q62P	1
	Base unit	Q35DB	1
	Input module	QX40	1
	Output module	QY41P	1
	Servo system controller (Motion CPU)	Q172DSCPU	1
Servo amplifier		MR-J4-40B	2
Linear servo motor (Primary side)		LM-H3P2A-07P-BSS0	2
Linear servo motor (Secondary side)		LM-H3S20-480-BSS0	2
Linear encoder		Incremental type	2
Encoder cable		MR-EKCBL2M-H	2
Junction cable for linear servo motor		MR-J4THCBL03M	2
Encoder connector set		MR-J3CN2	2
SSCNET III cable		MR-J3BUS015M	2
Personal computer communication cable (USB cable)		MR-J3USBCBL3M	1
Engineering environment		MT Works2 (including MR Configurator2)	1
OS		SW8DNC-SV22QL (pre-installed)	1

2.5 Summary of This Chapter

In this chapter, you have learned:

- Sample System
- Selecting the Capacity of Linear Servo Motors
- Selecting Linear Encoders
- List of System Configuration

Important points

Selecting the Capacity of Linear Servo Motors	• You have to select servo amplifiers and linear servo motors in combination within the appropriate capacity range.
Selecting Linear Encoders	• To use a linear servo motor, you have to select a linear encoder. • Select linear encoders suitable for your machine by checking specifications (resolution, rated speed, effective measurement length, etc.) of the linear encoders in "LINEAR ENCODER INSTRUCTION MANUAL." • For the details of specifications, performance, and warranty of linear encoders, contact the manufacturer of each linear encoder.

Chapter 3 Installation and Wiring

This chapter describes the precautions on handling and installing linear servo motors, and procedures for installation, wiring, and power-on of a servo amplifier.

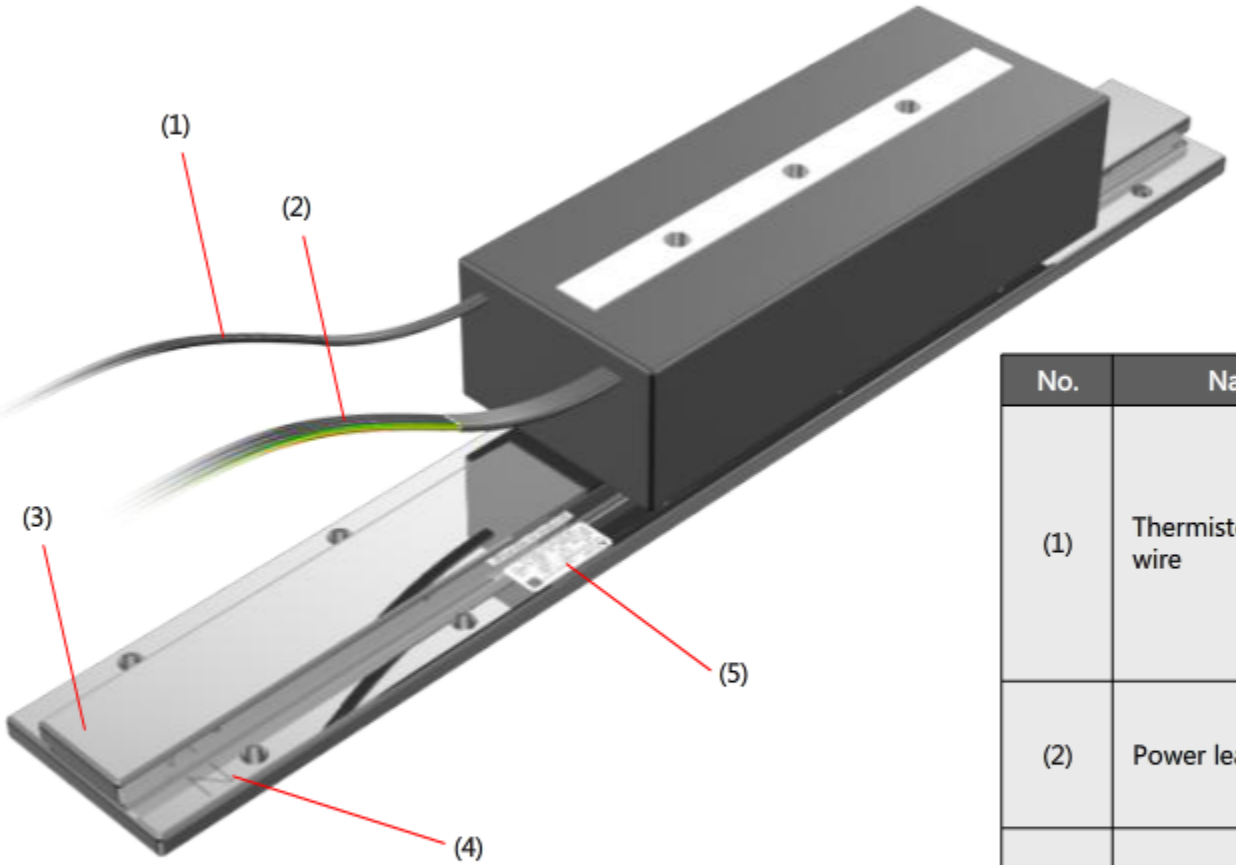
Chapter 1 - Learning about Linear Servo Motors
Chapter 2 - Sample System and Capacity Selection
Chapter 3 - Installation and Wiring

3.1 Names and Functions of Parts in a Linear Servo Motor
3.2 Handling of Linear Servo Motors
3.3 Linear Slider
3.4 Installing Linear Servo Motors
3.5 Installing and Grounding Servo Amplifiers
3.6 Wiring Servo Amplifiers and Linear Servo Motors
3.7 Turning On Power Supplies
3.8 Summary of This Chapter

Chapter 4 - Setup of Linear Servo Motors
Chapter 5 - Magnetic Pole Detection
Chapter 6 - Positioning Operation

3.1 Names and Functions of Parts in a Linear Servo Motor

The following shows the names and functions of parts in the LM series, taking LM-H3 series as an example.



No.	Name	Application
(1)	Thermistor lead wire	A lead wire with round crimp terminals for connecting thermistors. Temperature information on the primary side is returned to the servo amplifier through this wire.
(2)	Power lead wire	A lead wire with round crimp terminals for connecting power supplies
(3)	SUS cover	A stainless cover for protecting magnets on the secondary side
(4)	"N" Mark	A mark for checking a magnetic pole. This mark indicates the direction of the north pole.
(5)	Name plate	A name plate seal indicating a model name and rating

3.2 Handling of Linear Servo Motors

Strong magnets are used on the secondary side of a linear servo motor.
Incorrect handling of linear servo motors may cause a serious accident. Handle them with care.

CAUTION

Strong magnet - Handle carefully

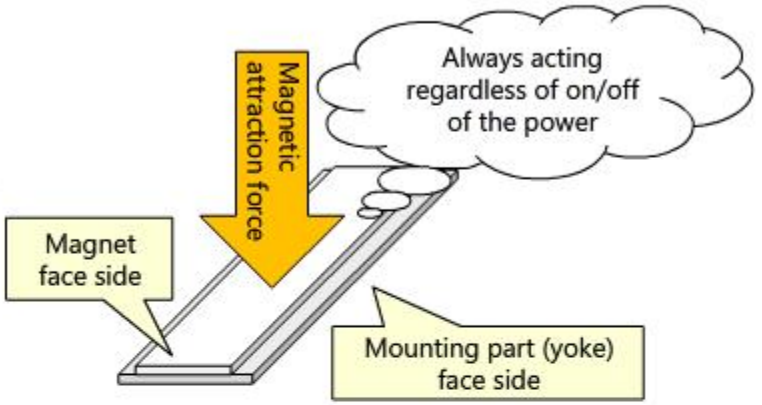
On the secondary side, large force of attraction is generated between the product and magnetic substance. Your hands may be caught.
Keep any equipment, which may malfunction due to magnetic force, away from the product.
Any person who is wearing a pacemaker should not handle the product.

Please read "LINEAR SERVO MOTOR INSTRUCTION MANUAL" carefully beforehand and use the products correctly.

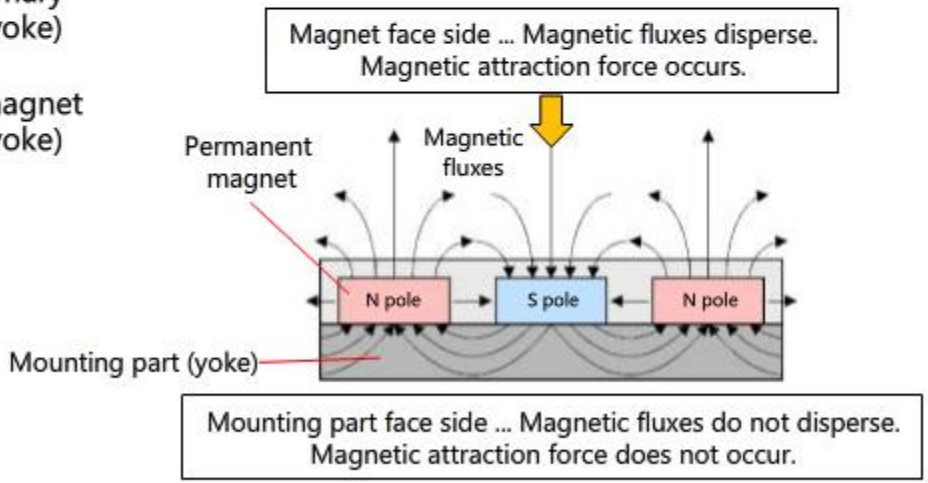
3.2.1 Handling of Linear Servo Motors - Magnetic Attraction Force

■ Magnetic attraction force

The secondary side of the linear servo motor contains a strong permanent magnet, so a magnetic attraction force (the force by which a magnet attracts magnetic bodies) is generated toward magnetic bodies such as iron.
This magnetic attraction force is always acting regardless of linear motor power on/off.



The magnetic fluxes generating from the permanent magnet disperse in the air from the magnet face side (facing the primary side), and most of them do not leak to the mounting part (yoke) surface side for its structure.
Because of this, a magnetic attraction force occurs on the magnet face side of the secondary side, not on the mounting part (yoke) surface side.



3.2.1 Handling of Linear Servo Motors - Magnetic Attraction Force

The permanent magnet used for the linear servo motor is very strong.
When an A4-sized iron sheet is fully attracted, the magnetic attraction force becomes as high as 2.5 t.
Use abundance of caution with the handling.

Magnetic Attraction Force ≒ 400 [kPa]

When an iron plate of A4 size is completely
Attracted to a permanent magnet...

A4
(21 × 29.7 cm)

■ For your safety

The magnetic attraction force is in inverse proportion to square of the distance to a magnetic body, so it drastically increases when the distance becomes small.
When mounting the secondary side of linear side motor, ensure the sufficient distance from the magnetic bodies around it and securely fix those magnetic bodies.

3.2.2 Handling of Linear Servo Motors - Other Precautions

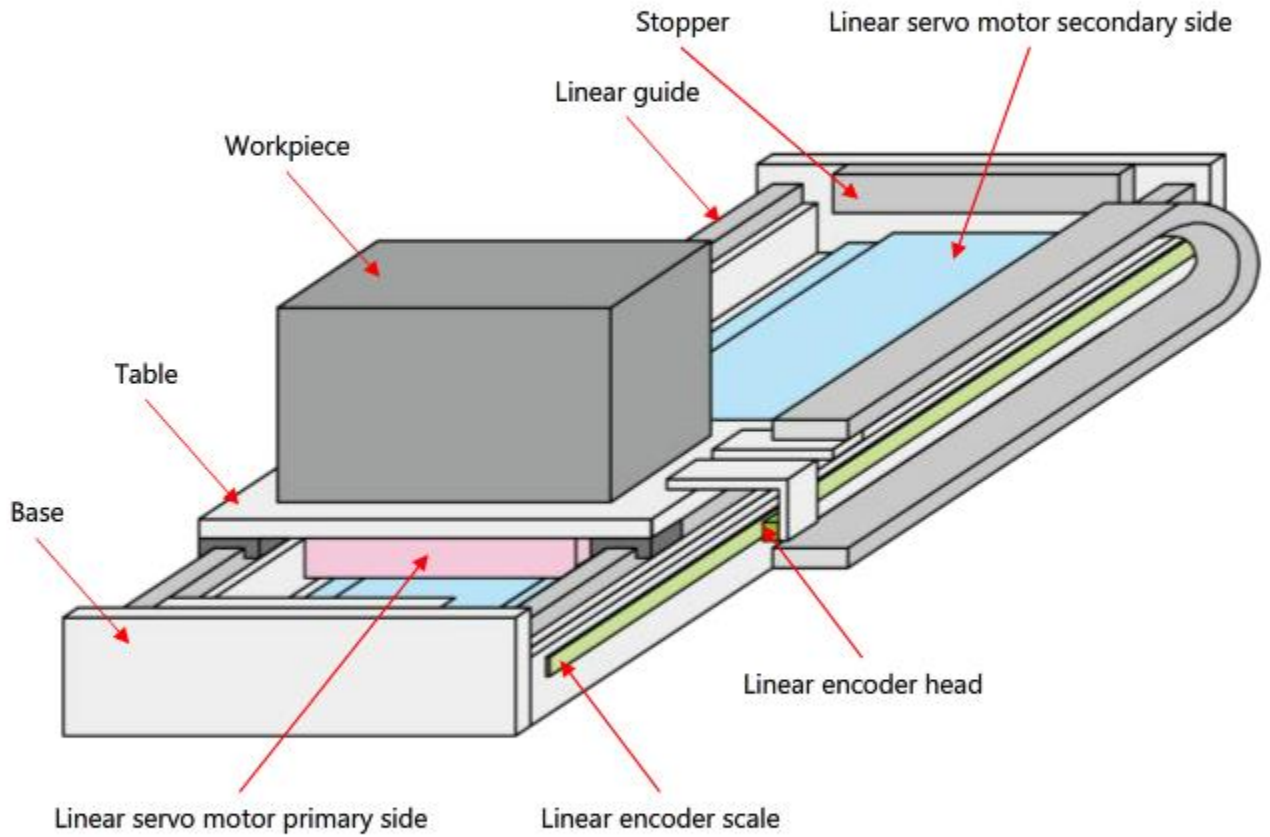
Linear servo motors shall be handled by the engineers who have full knowledge of the products.
Special attention is required for the following points.

	One who uses a medical device such as a pacemaker must keep away from the product and equipment.
	Do not wear metals such as watches, pierced earrings, necklaces, etc.
	Use nonmagnetic tools. (Example) Explosion-proof beryllium copper alloy safety tools: bealon (NGK)
	Do not put magnetic cards, watches, portable phones, etc. close to the motor.
	Do not apply a shock or stress on the molded parts of the product. (Otherwise, the linear servo motor may be damaged.)
	Display the message "Caution! Strong Magnet" or the like and take actions by giving cautions to the surrounding, etc.

3.3 Linear Slider

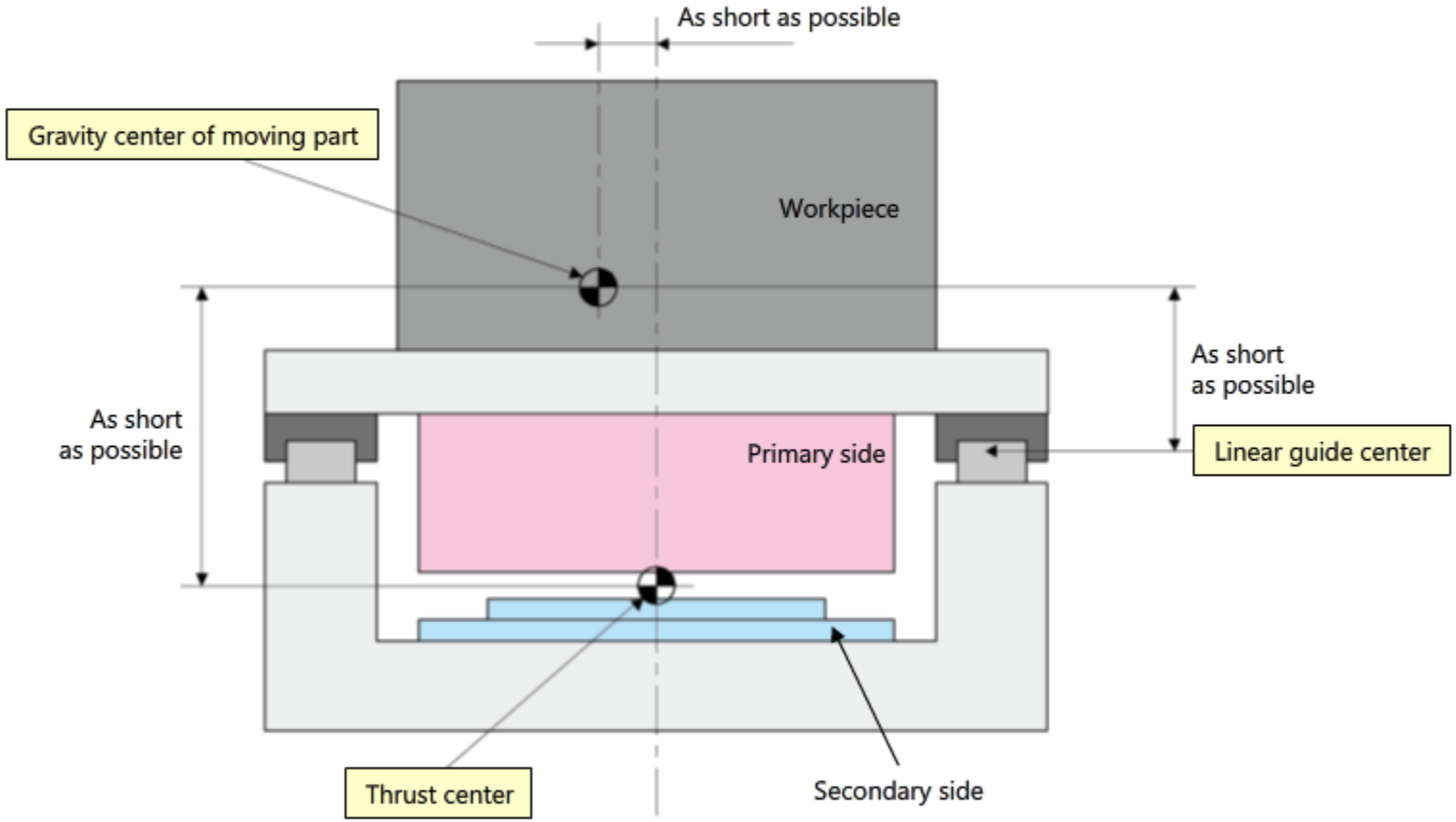
3.3.1 Basic Structure of a Linear Slider

The following figure shows the basic structure of a linear slider in which a linear servo motor is built in.



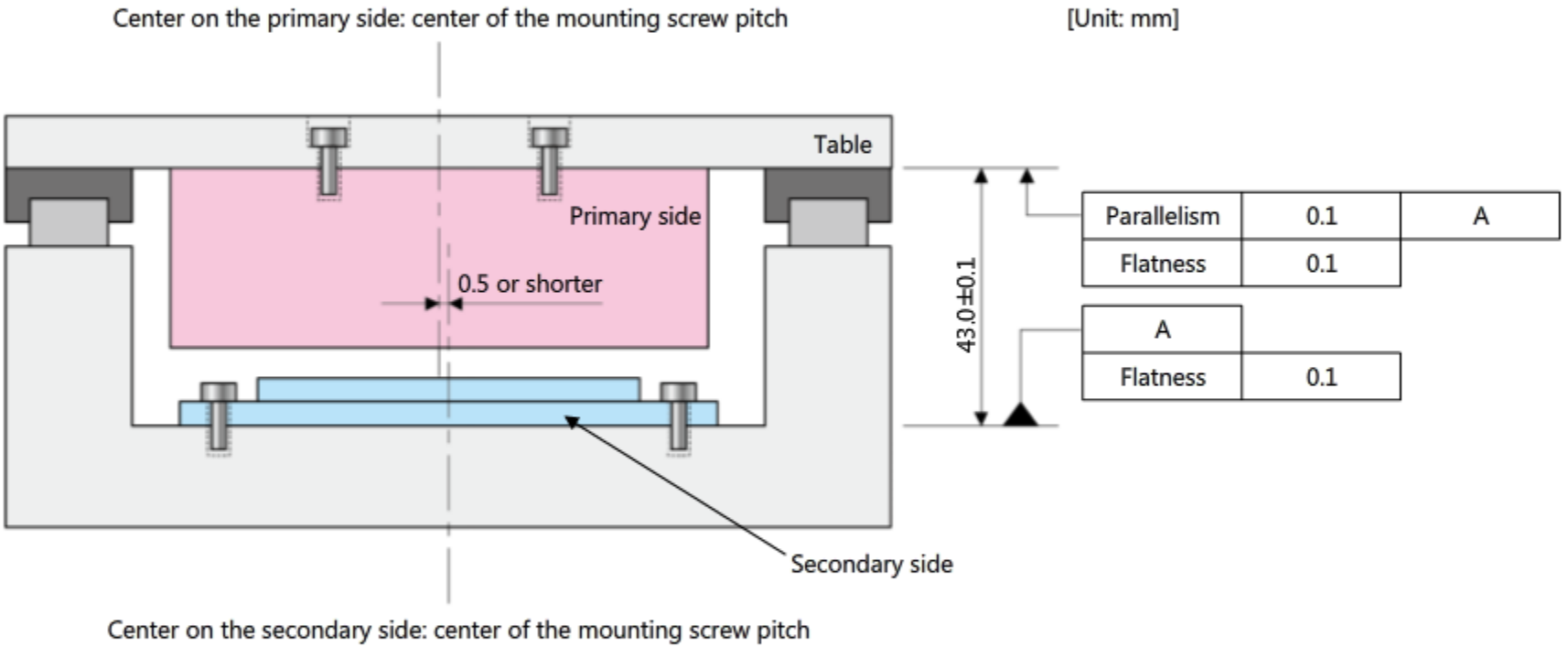
3.3.2 Instructions on the Structure of a Linear Slider

The following figure shows the instructions on the structure of a linear slider.
Inappropriate structure design may negatively affect the operation and the accuracy of the machine. Design a linear slider so that the thrust center of a linear servo motor is close to the gravity center of a moving object.



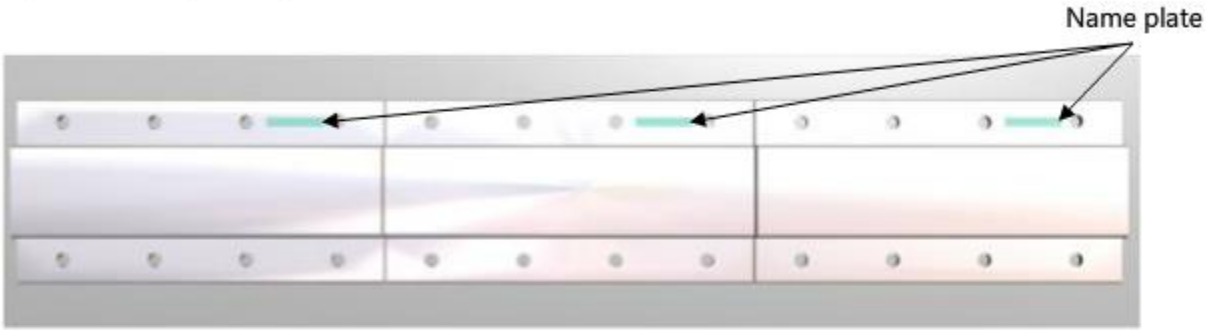
3.4 Installing Linear Servo Motors

Install a linear servo motor as follows. (For LM-H3P3)



3.4.1 Installing the Secondary Side (Magnet)

When using multiple secondary sides, arrange the name plates attached to the products in the same direction to keep the layout of magnetic poles.



Then, install them by the following procedure to reduce the clearance between the secondary sides.

1) Securely fix the secondary side to be the installation reference with bolts.

2) Place another secondary side on the mounting surface and temporarily fix it with bolts.

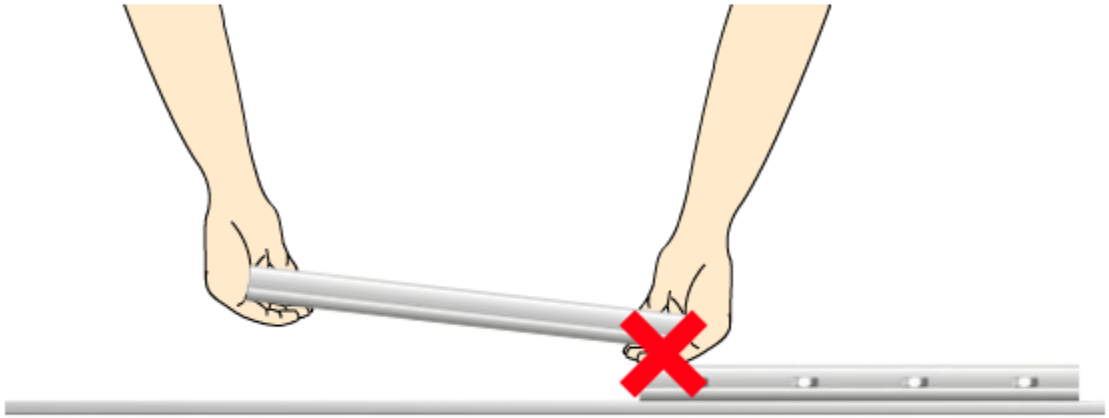
3) Push the temporarily-fixed secondary side against the mounting-standard secondary side.

4) Securely fix the temporarily-fixed secondary side with bolts.

3.4.1 Installing the Secondary Side (Magnet)

For the installation of the secondary sides, pay attention to the following points.

- The permanent magnets on the secondary side make the magnetic substance generate attraction force. Be careful not to get your hand stuck.
- When installing the secondary side, use nonmagnetic tools.
- When installing an additional secondary side block after installing one, place the additional block away from the one that has already been installed, and then slide the secondary side block to a specified position. Your hand may be caught if you place the secondary side block close to another.



- Keep the cumulative pitch error of the mounting screw holes within ±0.2 mm. When two or more secondary sides are aligned, spaces may present between each secondary side (magnet) block, depending on the mounting method and the number of the secondary-side blocks.

3.4.2 Installing the Primary Side (Coil)

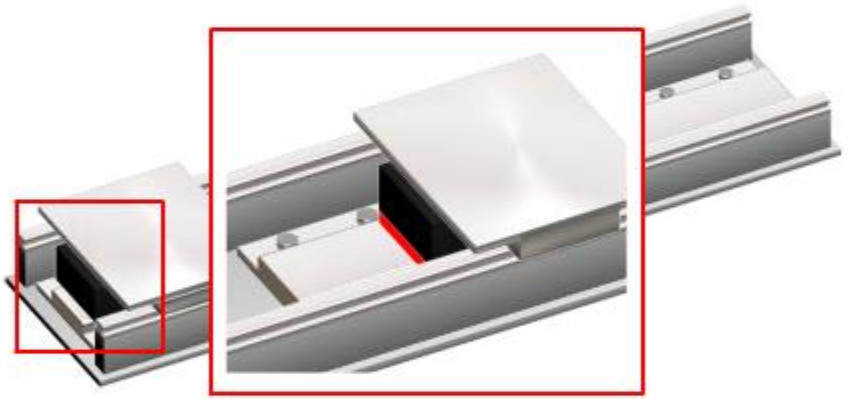
The following shows how to install the primary side.

1) Mount some of the secondary sides.

2) Mount the primary side in a position where the secondary sides are not mounted.

3) Move the primary side over the mounted secondary sides.
Check that the primary side does not contact the secondary sides.

4) Mount the remaining secondary sides.
Check that the primary side does not contact the secondary sides.

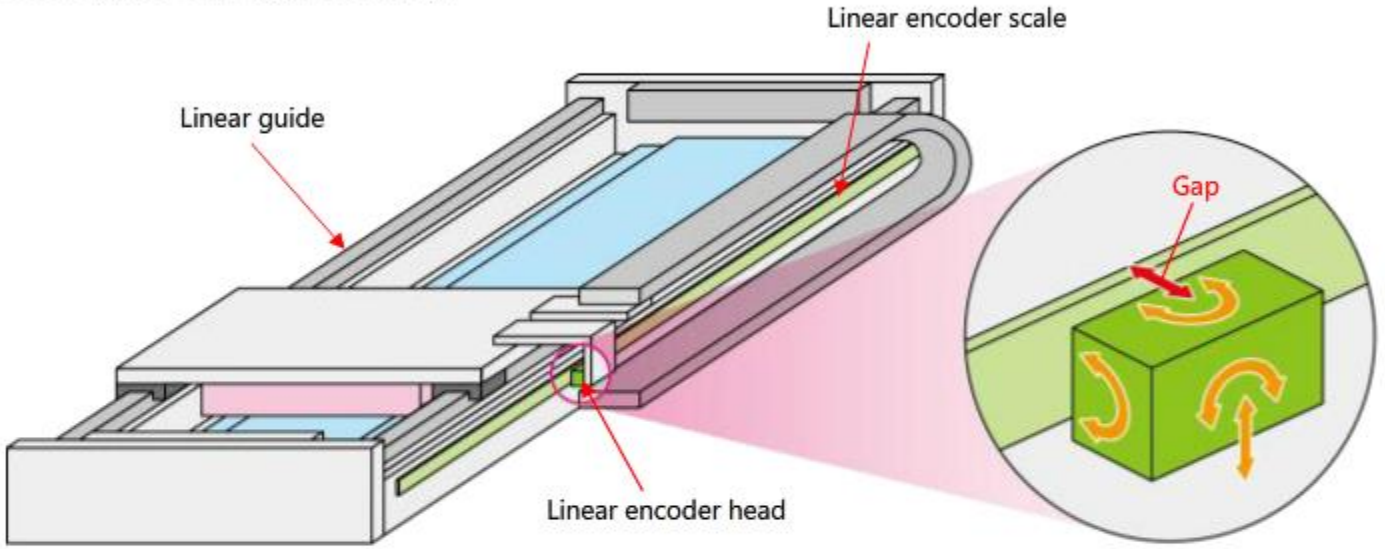


For the installation of the primary sides, pay attention to the following points.

- To avoid the danger caused by attraction force generated between the primary side and the secondary side by the permanent magnet, it is recommended that the primary side be installed in a position where the secondary sides are not installed.
- When installing the primary side over the secondary side is unavoidable, use material handling equipment such as a crane that is fully competent to sustain the load of attraction force, etc.
- When sliding the primary side to move over the secondary side after setting, pay full attention to the attraction force generated.

3.4.3 Installing a Linear Encoder

Install a linear encoder.
Compared to linear servo motors, more careful measures against oil and dust must be taken for linear encoders.
Install the linear guide with high accuracy.



If the linear encoder is improperly installed, an alarm or a position mismatch may occur.
In this case, refer to the following general checking points for linear encoders to confirm the installation.
For detailed precautions, follow the precautions on each manufacturer's specifications and installations of linear encoders.

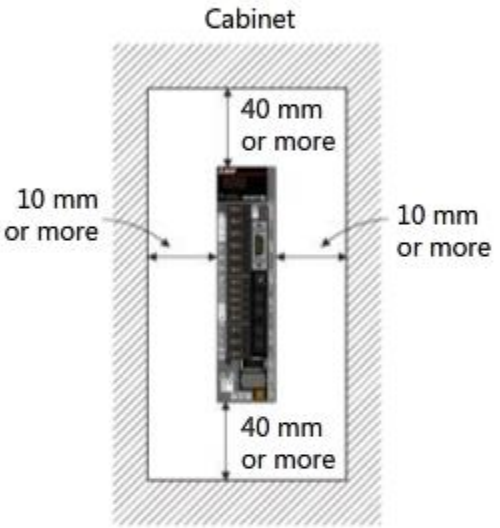
- Check that the gap between the head and scale is proper.
- Check the scale head for rolling and yawing (looseness of scale head section).
- Check the scale surface for contamination and scratches.
- Check that the vibration and temperature are within the specified range.
- Check that the speed is within the permissible range without overshooting.

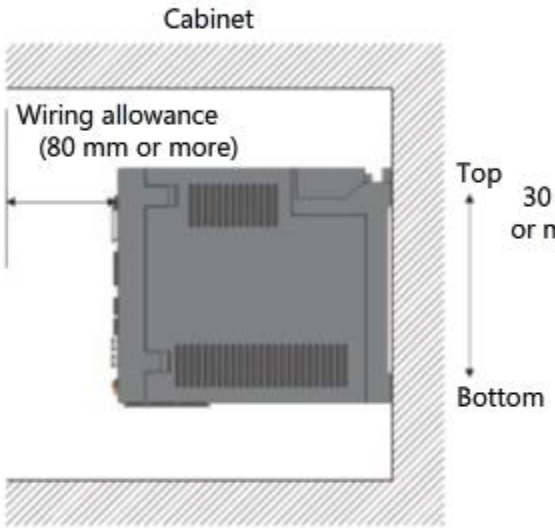
3.5 Installing and Grounding Servo Amplifiers

This section describes the installation and grounding of a servo amplifier.

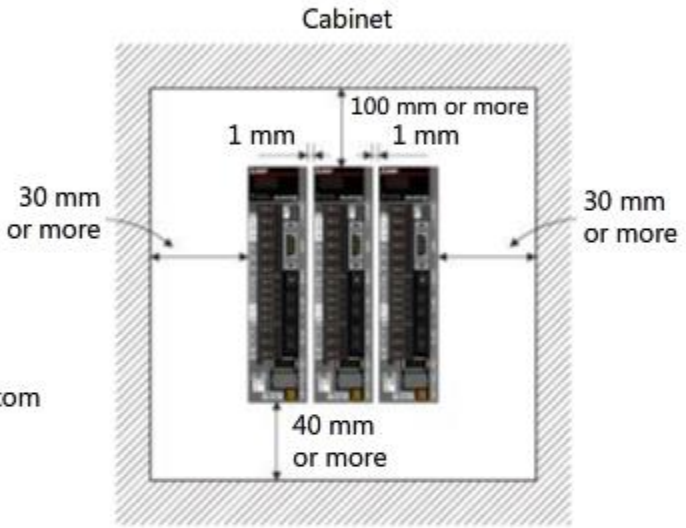
■ Installing servo amplifiers

• Installing one servo amplifier





• Installing two or more servo amplifiers



■ Grounding servo amplifiers

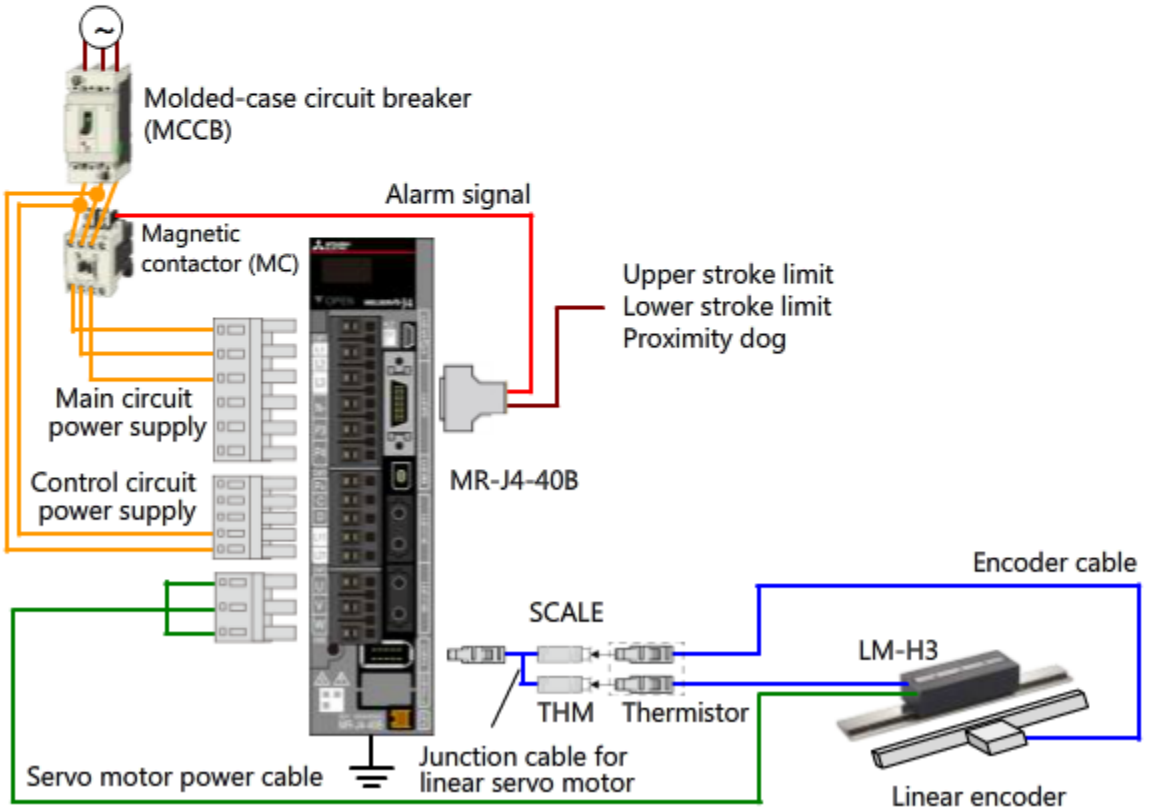
- To prevent an electric shock and reduce noise, ground servo amplifiers and servo motors securely.
- To prevent an electric shock, always connect the protective earth terminal of a servo amplifier to the protective earth of the cabinet.

For details, refer to the "Servo MELSERVO Basics (MR-J4)" course.

3.6 Wiring Servo Amplifiers and Linear Servo Motors

Connect power supplies to the main circuit power supply and the control circuit power supply of a servo amplifier.
Always use a molded-case circuit breaker (MCCB) for the input of the power supplies.
Be sure to install a magnetic contactor between the main circuit power supply and L1/L2/L3 terminals. Create a circuit that turns off the magnetic contactor and then the main circuit power supply when an alarm signal or a forced stop input signal turns off.
Use a junction cable for linear servo motor to connect an encoder cable and thermistor to the servo amplifier.
Wire a servo motor power cable so that the servo amplifier power outputs (U, V, and W) match in phase with the linear servo motor power inputs (U, V, and W).

The following figure shows wiring of the MR-J4-40B and a linear servo motor as an example.

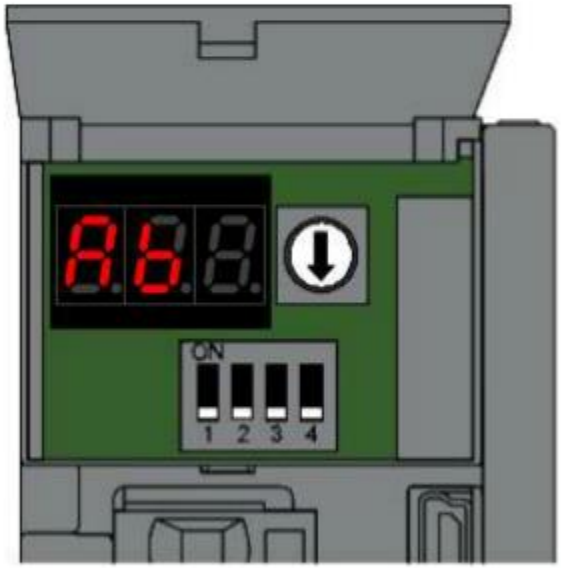


3.7 Turning On Power Supplies

Turn on the control circuit power supply and the main circuit power supply of the servo amplifier.
"Ab" (waiting for the servo system controller to power on) is displayed in the display of the servo amplifier.
No servo system controller is connected in this sample system. Thus, configure required settings and start up the system with the "Ab" state.
When "Ab" is not displayed and an alarm occurs, investigate the alarm cause and remove it.

Power on the servo amplifier.

"Ab" is displayed in the display.



3.8 Summary of This Chapter

In this chapter, you have learned:

- Names and Functions of Parts in a Linear Servo Motor
- Handling of Linear Servo Motors
- Linear Slider
- Installing Linear Servo Motorsς
- Installing and Grounding Servo Amplifiers
- Wiring Servo Amplifiers and Linear Servo Motors
- Turning On Power Supplies

Important points

Handling of Linear Servo Motors	• The secondary side of the linear servo motor contains a strong permanent magnet, so a magnetic attraction force (the force by which a magnet attracts magnetic bodies) is generated toward magnetic bodies such as iron. • One who uses a medical device such as a pacemaker must keep away from the product and equipment. • Do not wear metals such as watches, pierced earrings, necklaces, etc. • Use nonmagnetic tools. • Do not put magnetic cards, watches, portable phones, etc. close to the motor. • Do not put a shock or stress on the molded parts of the product. • Display "Caution! Strong Magnet" or the like and take action by giving cautions to the surrounding, etc.
Installing Linear Servo Motors	• The permanent magnets on the secondary side make the magnetic substance generate attraction force. Be careful not to get your hand stuck. • When installing the secondary side, use nonmagnetic tools. • When installing an additional secondary side block after installing one, place the additional block away from the one that has already been installed, and then slide the secondary side block to a specified position. Your hand may be caught if you place the secondary side block close to another.

3.8 Summary of This Chapter

	• Keep the cumulative pitch error of the mounting screw holes within ±0.2 mm. When two or more secondary sides are aligned, spaces may present between each secondary side (magnet) block, depending on the mounting method and the number of the secondary-side blocks. • To avoid the danger caused by attraction force generated between the primary side and the secondary side by the permanent magnet, it is recommended that the primary side be installed in a position where the secondary sides are not installed. • When installing the primary side over the secondary side is unavoidable, use material handling equipment such as a crane that is fully competent to sustain the load of attraction force, etc. • When sliding the primary side to move over the secondary side after setting, pay full attention to the attraction force generated. • Compared to linear servo motors, more careful measures against oil and dust must be taken for linear encoders.
Wiring the Power Supplies of Servo Amplifiers and Linear Servo Motors	• Connect power supplies to the main circuit power supply and the control circuit power supply of a servo amplifier. • Always use a molded-case circuit breaker (MCCB) for the input of the power supplies

Chapter 4 Setup of Linear Servo Motors

This chapter describes the parameter setting of a servo amplifier using MR Configurator2.
(Setting of servo motor series and servo motor types, linear encoder pole selection, and resolution setting)

Chapter 1 - Learning about Linear Servo Motors

Chapter 2 - Sample System and Capacity Selection

Chapter 3 - Installation and Wiring

Chapter 4 - Setup of Linear Servo Motors

- 4.1 Setup Software MR Configurator2
- 4.2 Creating a New Project (Operation Mode Selection)
- 4.3 Connecting a Servo Amplifier and a Personal Computer
- 4.4 Setting the Servo Motor Series and Servo Motor Type
- 4.5 Selecting the Pole of a Linear Encoder
- 4.6 Setting the Linear Encoder Resolution
- 4.7 Writing Parameters
- 4.8 Summary of This Chapter

Chapter 5 - Magnetic Pole Detection

Chapter 6 - Positioning Operation

4.1 Setup Software MR Configurator2

This section introduces the functions and applications of the setup software "MR Configurator2 (SW1DNC-MRC2-E)". MR Configurator2 facilitates adjustment, monitor display, diagnosis, writing/reading of parameters, and test operations using a personal computer.

■ Startup
Setting various parameters required to operate a servo system, writing them to a servo amplifier, monitoring operation conditions in a graph or others can be performed.

■ Adjustment
By performing the one-touch tuning, all gain values are automatically adjusted and the performance of the servo system is maximized.

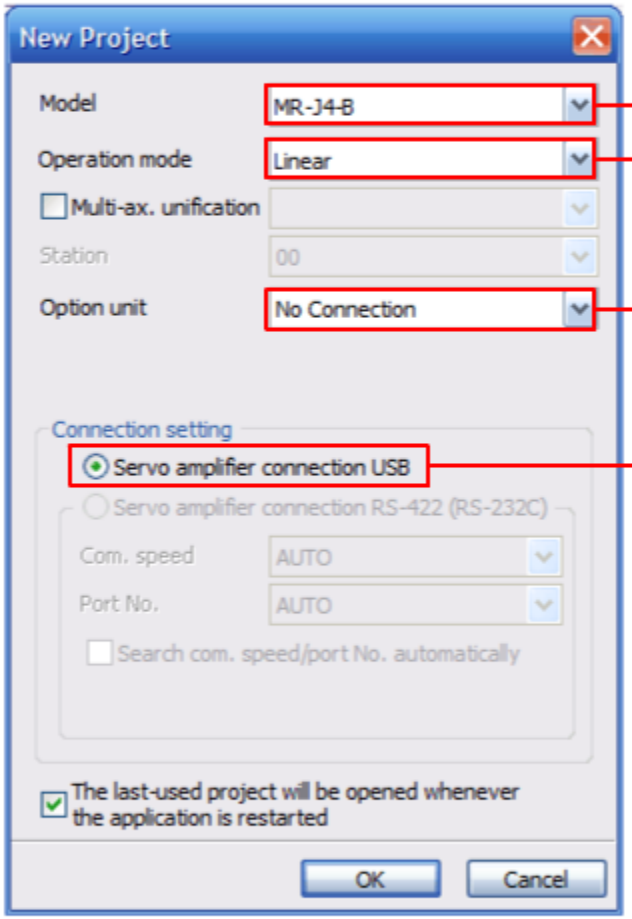
■ Maintenance
The status of the servo system or malfunction causes can be investigated and the lifetime of parts is displayed clearly.

For the basic method for using MR Configurator2, refer to the "Servo MELSERVO Basics (MR-J4)" course.

You can download the trial version and updated version of MR Configurator2 from the Mitsubishi Electric FA Website.

4.2 Creating a New Project (Operation Mode Selection)

Start MR Configurator2 and select [Project] → [New].
The New Project dialog box appears. Select "Linear" for Operation mode.

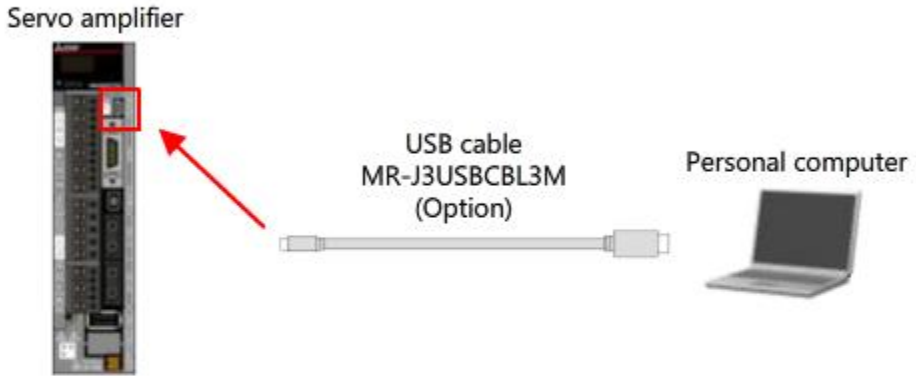


Setting item	Description	Setting in this course
Model setting	Select the model of the servo amplifier to be connected.	MR-J4-B
Operation mode	Select an operation mode.	Linear
Option unit	Select an option unit.	No Connection
Connection setting	Select the communication target.	Servo amplifier connection USB

4.3 Connecting a Servo Amplifier and a Personal Computer

Connect a servo amplifier and a personal computer with a USB cable.
Use USB cable "MR-J3USBCBL3M" (length: 3 m).

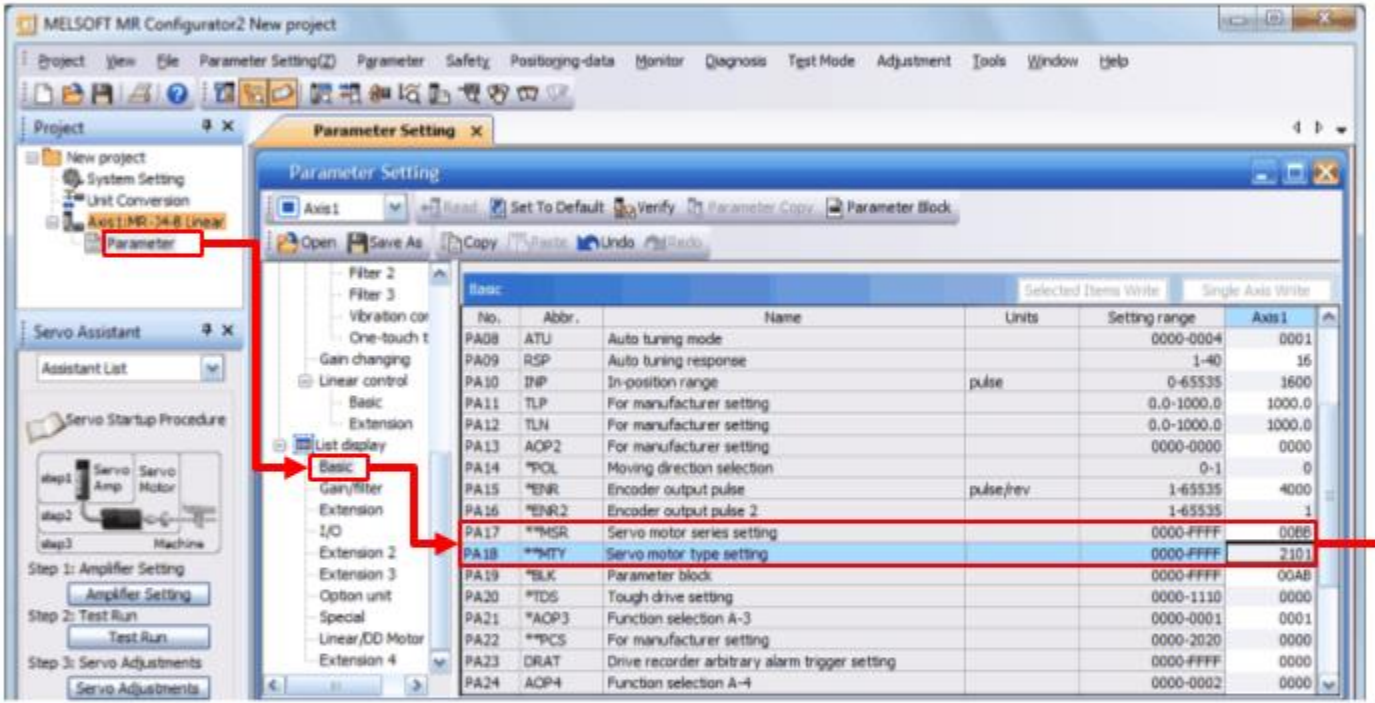
Connection with a servo amplifier



When the message screen shown on the right appears, check "Change to "MR-J4-B Linear"" and click OK.
If you select "Not changed" and click "OK", the parameters will not be rewritten. .
(This message does not appear in offline.)

4.4 Setting the Servo Motor Series and Servo Motor Type

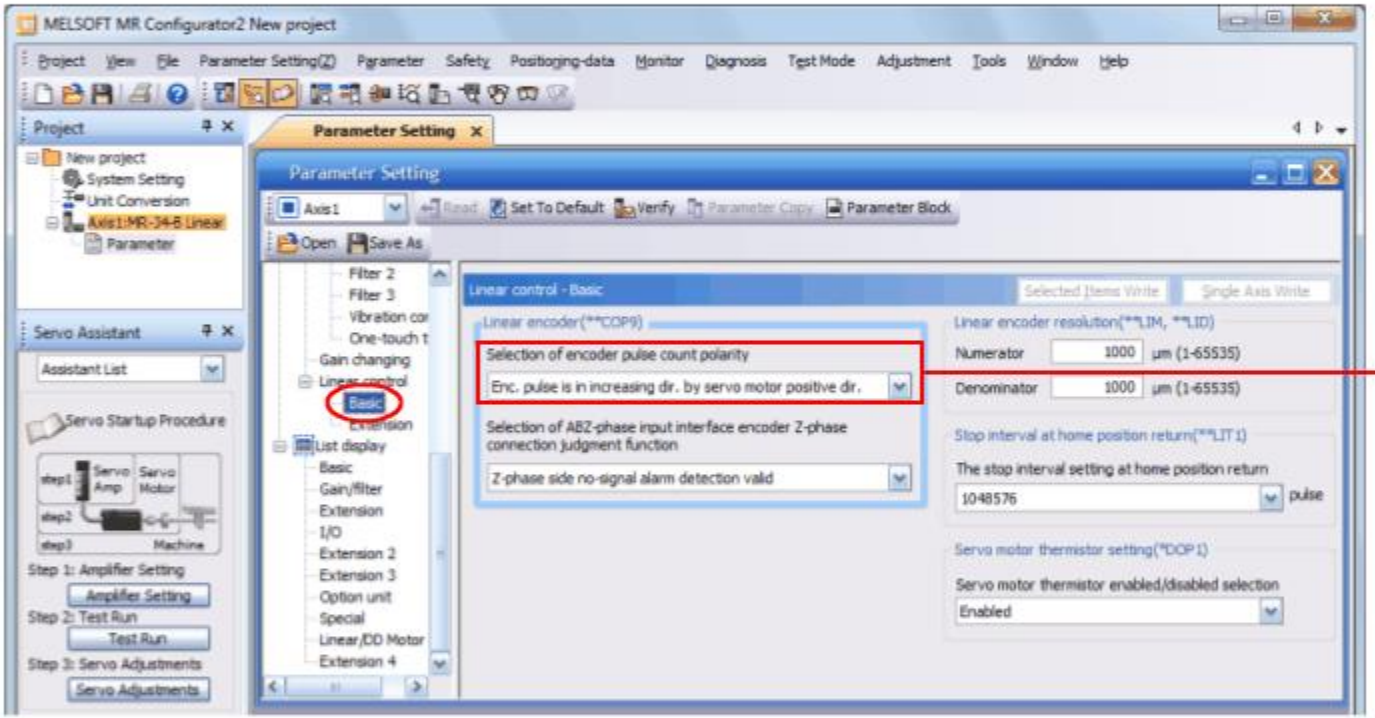
Set the servo motor series and servo motor type from Basic in List display of the parameter setting.
For the setting values, refer to the table in the following link destination.
Parameter setting value <PDF>



No.	Parameter	Description	Initial value	Setting for sample system
PA17	Servo motor series	Set the servo motor series.	0000	00BB
PA18	Servo motor type	Set the servo motor type.	0000	2101

4.5 Selecting the Pole of a Linear Encoder

Select the pole of a linear encoder so that the linear encoder feedback value increases when a linear servo motor is moved in the positive direction.
Set the pole of the linear encoder in "Selection of encoder pulse count polarity" of Basic in Linear control of the parameter setting.



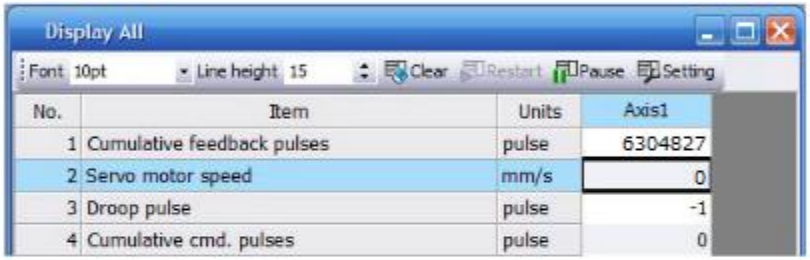
Parameter	Description	Initial value
Selection of encoder pulse count polarity	Set the pole of the linear encoder.	Enc. pulse is in increasing dir. by servo motor positive dir.

The setting method is described on the next page.

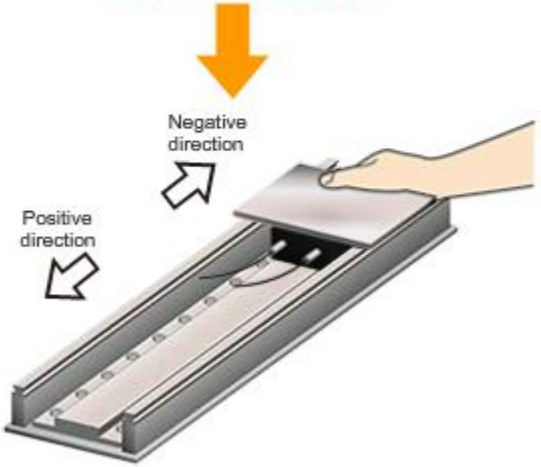
4.5.1 Checking the direction of a linear servo motor

Check the positive direction of the linear servo motor.
In the positive direction of the LM-H3 series, there are a power cable and a thermistor cable of the primary side.
Manually move the linear servo motor in the positive direction in the servo-off status, and check the motor speed (positive/negative) in the monitor screen of MR Configurator2.

Check the servo-off status with the LED display (Ab) of the servo amplifier.

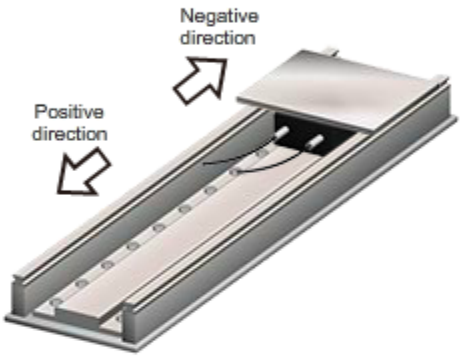


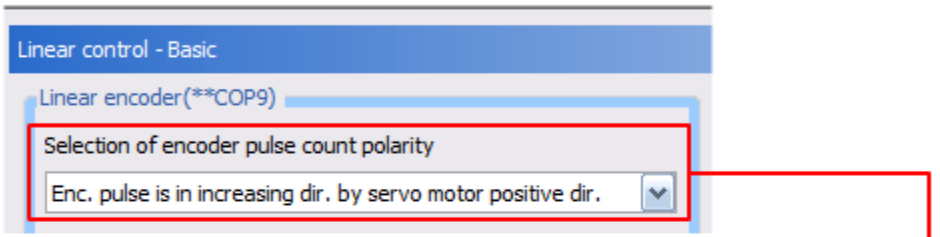
No.	Item	Units	Axis1
1	Cumulative feedback pulses	pulse	6304827
2	Servo motor speed	mm/s	0
3	Droop pulse	pulse	-1
4	Cumulative cmd. pulses	pulse	0



4.5.2 Checking the direction of a linear servo encoder

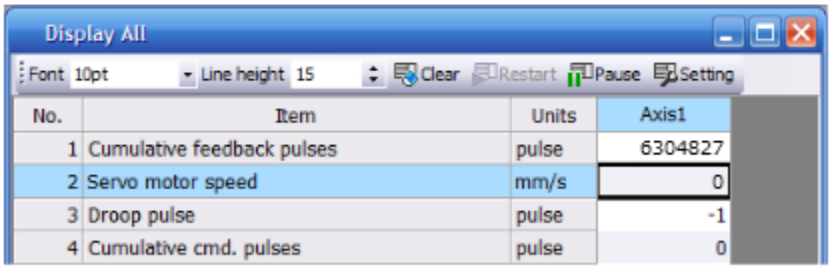
Check the direction of the linear encoder.
When the linear servo motor is manually moved in the positive direction in the servo-off status, the servo motor speed is changed to be positive or negative depending on the value of Selection of encoder pulse count polarity in the parameter setting.





Parameter	Setting value for sample system
Selection of encoder pulse count polarity	Enc. pulse is in increasing dir. by servo motor positive dir.

* Power off and on the servo amplifier to enable the Selection of encoder pulse count polarity after setting.



No.	Item	Units	Axis1
1	Cumulative feedback pulses	pulse	6304827
2	Servo motor speed	mm/s	0
3	Droop pulse	pulse	-1
4	Cumulative cmd. pulses	pulse	0

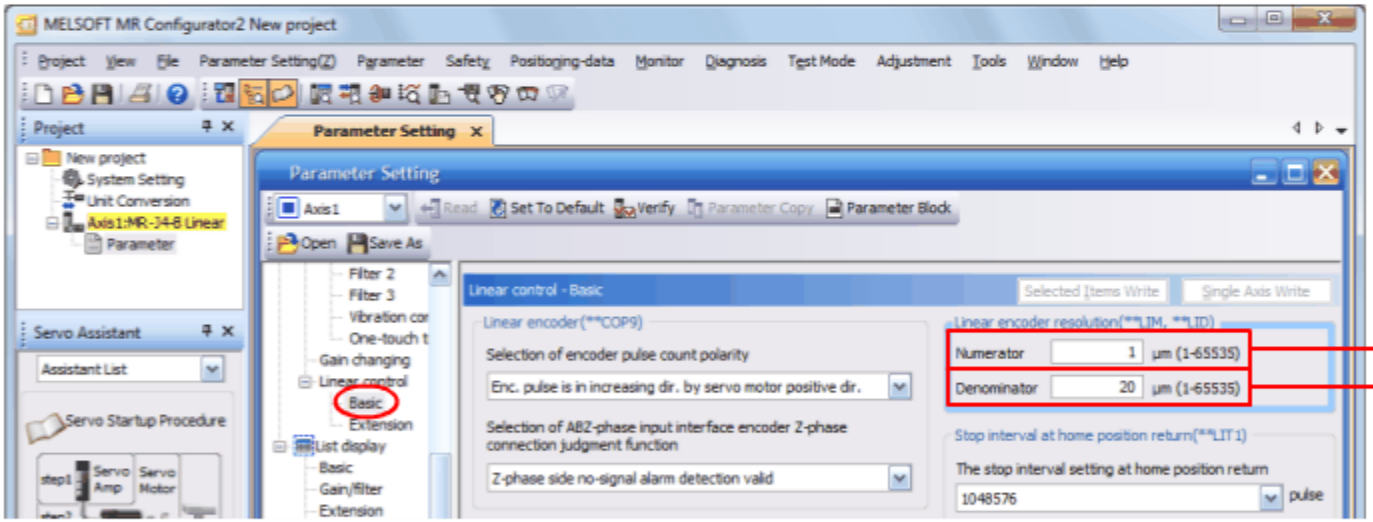
4.6 Setting the Linear Encoder Resolution

Set the linear encoder resolution depending on the linear encoder to be used.
Set the linear encoder resolution from Basic in Linear control of the parameter setting.

$$\frac{\text{[Linear encoder resolution - Numerator]}}{\text{[Linear encoder resolution - Denominator]}} = \text{Linear encoder resolution [μm]}$$

When the linear encoder resolution is 0.05 μm (sample system)

$$\text{Linear encoder resolution} = 0.05\ \mu m = \frac{1}{20}$$

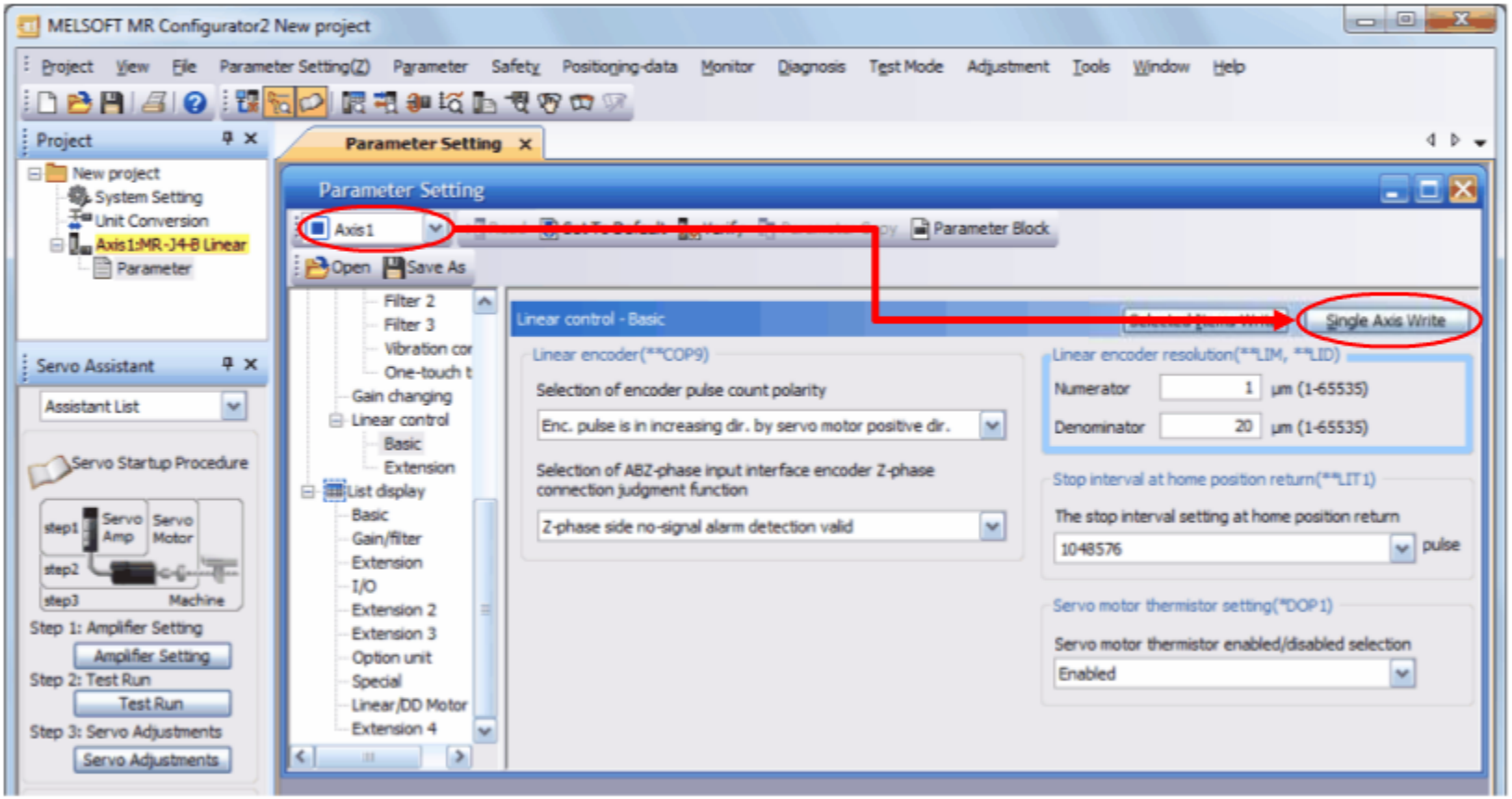


Parameter	Description	Initial value	Setting value for sample system
Numerator	Set the numerator of the linear encoder resolution.	1000	1
Denominator	Set the denominator of the linear encoder resolution.	1000	20

After the parameter setting, cycling the power of the servo amplifier will reflect the setting.

4.7 Writing Parameters

When any change is made to the parameter setting, always write the parameters to the servo amplifier.
To write parameters, select the axis to which the parameters are written and click the "Single Axis Write" button.



4.8 Summary of This Chapter

In this chapter, you have learned:

- Setup Software MR Configurator2
- Creating a New Project (Operation Mode Selection)
- Connecting a Servo Amplifier and a Personal Computer
- Setting the Servo Motor Series and Servo Motor Type
- Selecting the Pole of a Linear Encoder
- Setting the Linear Encoder Resolution
- Writing Parameters

Important points

Setup Software MR Configurator2	• MR Configurator2 facilitates adjustment, monitor display, diagnosis, writing/reading of parameters, and test operations using a personal computer.
Creating a New Project (Operation Mode Selection)	• To use a linear servo motor, select "Linear" for the operation mode in the New Project dialog box of MR Configurator2.
Connecting a Servo Amplifier and a Personal Computer	• When the operation mode change screen appears with the USB cable connection, check "Change to "MR-J4-B Linear"" and click OK.
Setting the Servo Motor Series and Servo Motor Type	• Set specific parameters depending on the combination of the servo motor series and servo motor type.
Selecting the Pole of a Linear Encoder	• Select the pole of a linear encoder so that the linear encoder feedback value increases when a linear servo motor is moved in the positive direction. Manually move the linear servo motor in the positive direction in the servo-off status, check the motor speed (positive/negative) in the monitor screen of MR Configurator2, and configure the setting of Selection of encoder pulse count polarity to change the servo motor speed to be positive.
Setting the Linear Encoder Resolution	• Set the linear encoder resolution depending on the denominator and numerator values.

Chapter 5 Magnetic Pole Detection

This chapter describes the magnetic pole detection (necessity of initial magnetic pole detection), how to perform the magnetic pole detection, and the precautions on the magnetic pole detection.

Chapter 1 - Learning about Linear Servo Motors
Chapter 2 - Sample System and Capacity Selection
Chapter 3 - Installation and Wiring
Chapter 4 - Setup of Linear Servo Motors
Chapter 5 - Magnetic Pole Detection

5.1 Introduction to Magnetic Pole Detection
5.2 Preparation for Magnetic Pole Detection
5.3 Magnetic Pole Detection Method
5.4 Magnetic Pole Detection
5.5 Magnetic Pole Detection Voltage Level Setting
5.6 Magnetic Pole Detection in an Absolute Position System
5.7 Magnetic Pole Detection in Tandem Configuration
5.8 Precautions for Magnetic Pole Detection
5.9 Summary of This Chapter

Chapter 6 - Positioning Operation

5.1 Introduction to Magnetic Pole Detection

A linear servo motor requires a flow of current that depends on the relative positions between the secondary side magnet and primary side coil.
Therefore, when a motor is installed or power is turned on, an operation that detects the relative positions between the magnet and winding wire, so-called initial magnetic pole detection, is required. The start timing of the magnetic pole detection depends on the type of the linear encoder used.

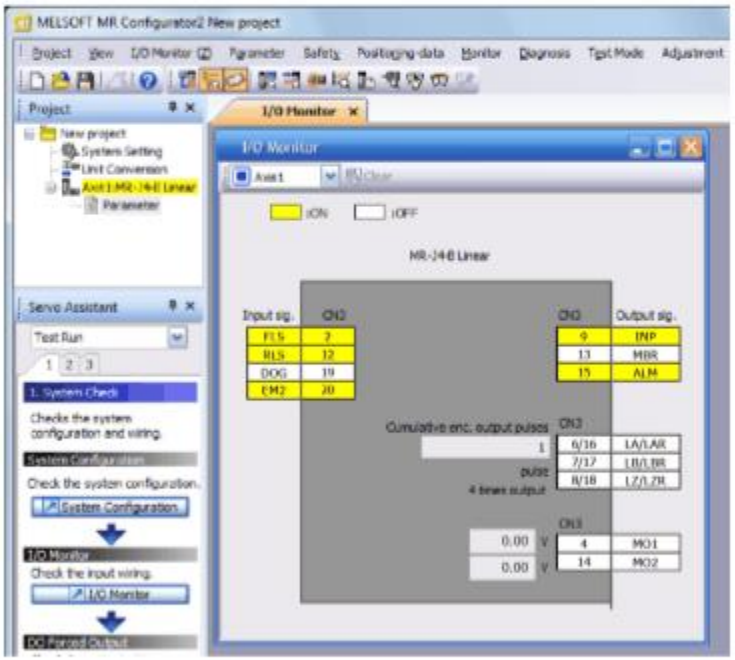
Linear encoder type	Magnetic pole detection
Absolute position type	Requires magnetic pole detection at system setup. (at the first startup of the system)
Incremental type	Requires magnetic pole detection each time when the power is turned on.

The sample system is an incremental system equipped with an incremental-type linear encoder.
This chapter describes the magnetic pole detection mainly in the incremental system.

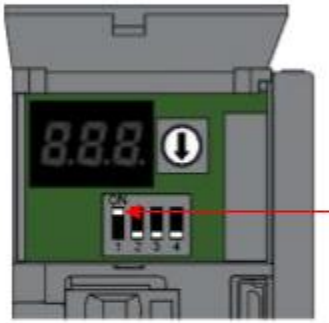
5.2 Preparation for Magnetic Pole Detection

Before starting the magnetic pole detection, prepare the following.

■ **Check that FLS, RLS, and EM2 are on.**
Check that FLS (Upper stroke limit), RLS (Lower stroke limit), and EM2 (Forced stop 2) are on by checking the I/O monitor of MR Configurator2.



■ **Change the mode to the test operation mode.**
Change the mode to the test operation mode following the steps below.
1) Power off the servo amplifier.
2) Set the test operation select switch (SW2-1) to "ON (up)".
3) Power on the servo amplifier.



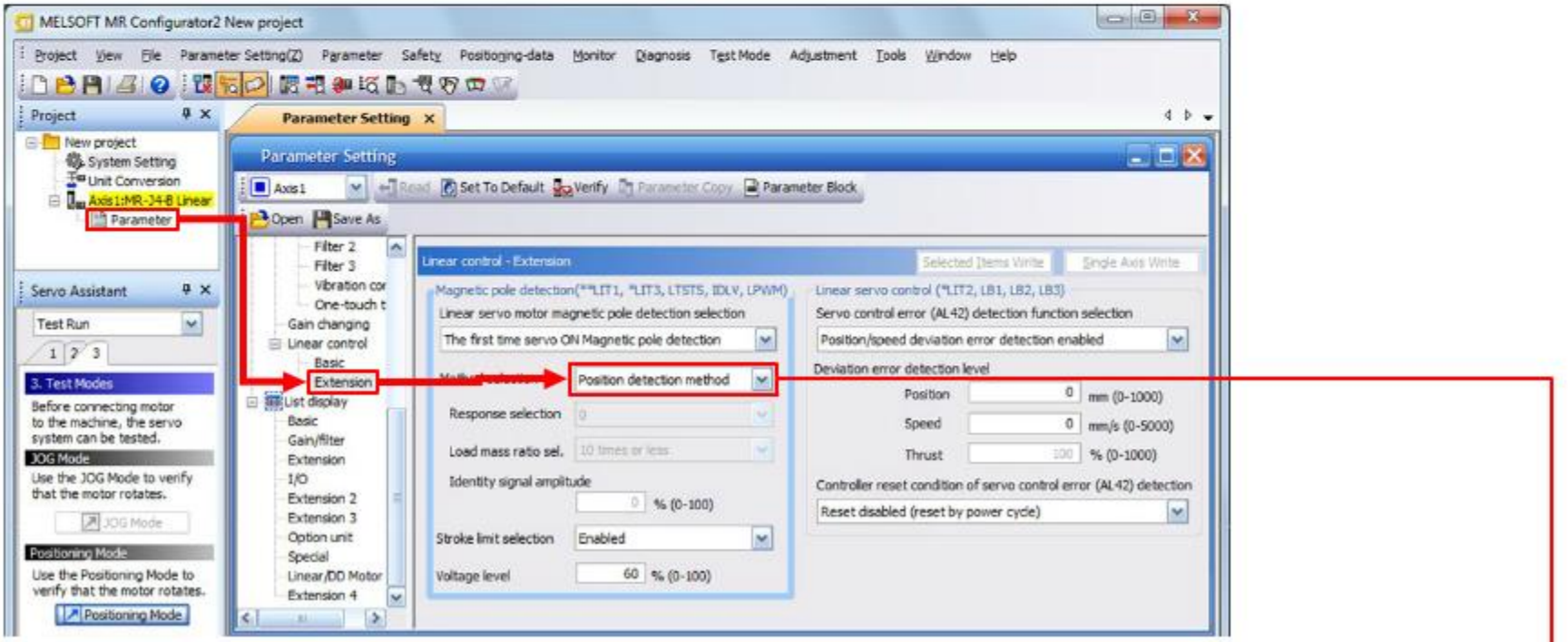
For details, refer to the "Servo MELSERVO Basics (MR-J4)" course.

5.3 Magnetic Pole Detection Method

The following two magnetic pole detection methods are provided: "Position detection method" and "Minute position detection method".

Magnetic pole detection	Advantage	Disadvantage
Position detection method	· The magnetic pole detection has a high degree of accuracy. · The adjustment procedure at the magnetic pole detection is simple.	· The travel distance at the magnetic pole detection is large. · For equipment with small friction, an initial magnetic pole detection error may occur.
Minute position detection method	· The travel distance at the magnetic pole detection is small. · Even for equipment with small friction, the magnetic pole detection is available.	· The adjustment procedure at the magnetic pole detection is complex. · If a disturbance occurs during the magnetic pole detection, [AL. 27 Initial magnetic pole detection error] may occur.

Set a magnetic pole detection method in the "Linear control-Extension" window.
In the sample system, the magnetic pole detection is performed with the position detection method (initial value).



5.3 Magnetic Pole Detection Method

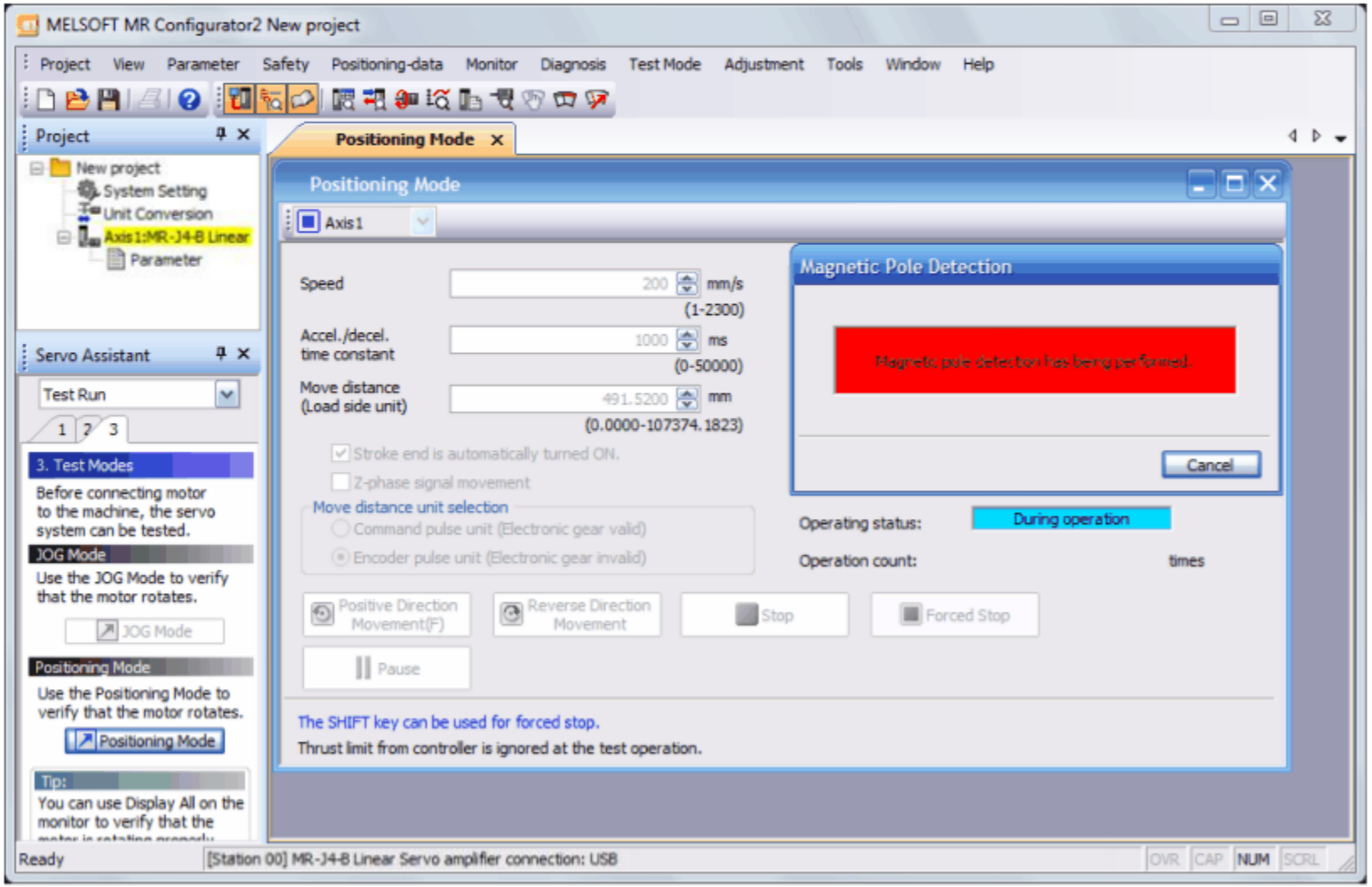
Parameter	Description	Initial value	Setting for sample system
Method selection	Set a magnetic pole detection method.	Position detection method	Position detection method

From the next page, the magnetic pole detection with the position detection method (initial value) is explained.

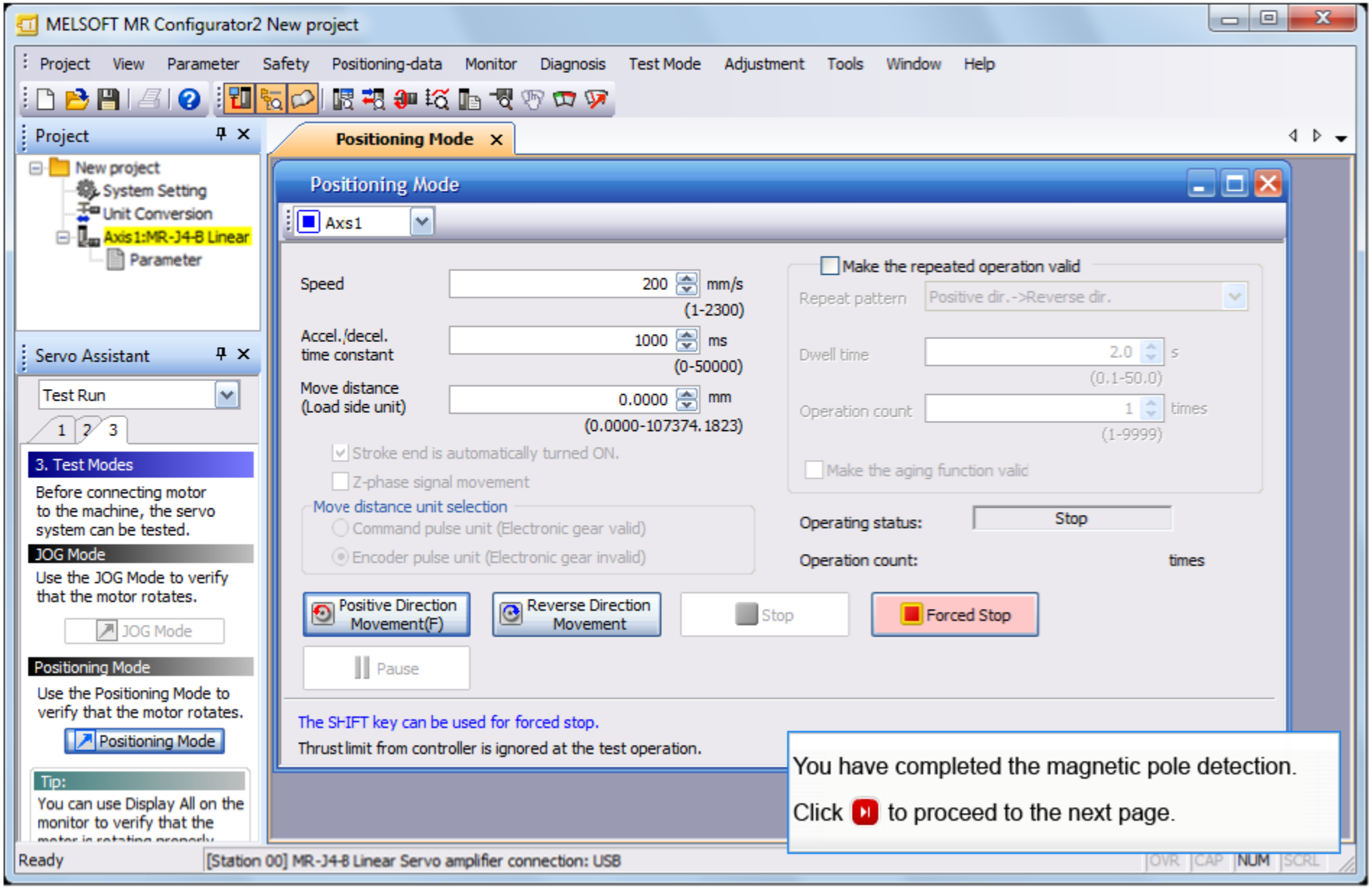
5.4 Magnetic Pole Detection

Perform the magnetic pole detection using the test operation mode (positioning operation) of MR Configurator2.
Set the travel distance to "0", and execute a "forward direction operation" or "reverse direction operation".

On the next page, simulate a magnetic pole detection operation using actual windows.

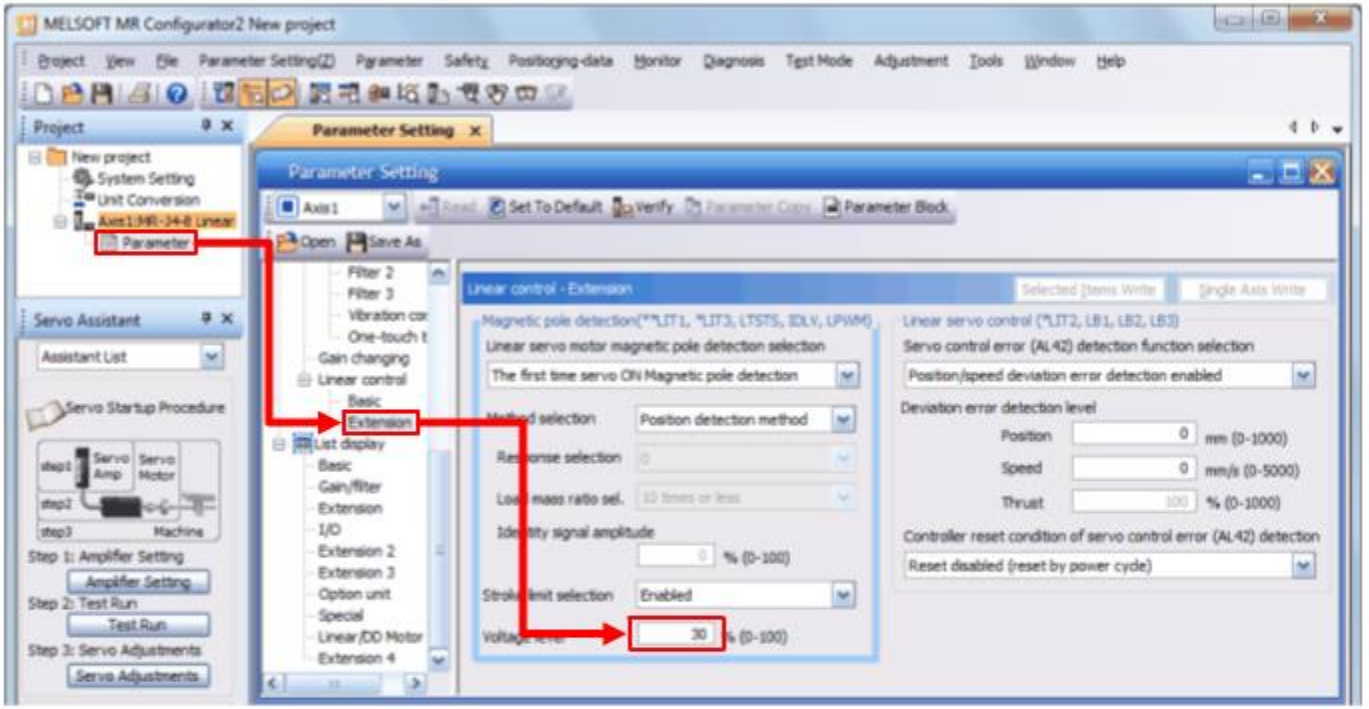


5.4 Magnetic Pole Detection



5.5 Magnetic Pole Detection Voltage Level Setting

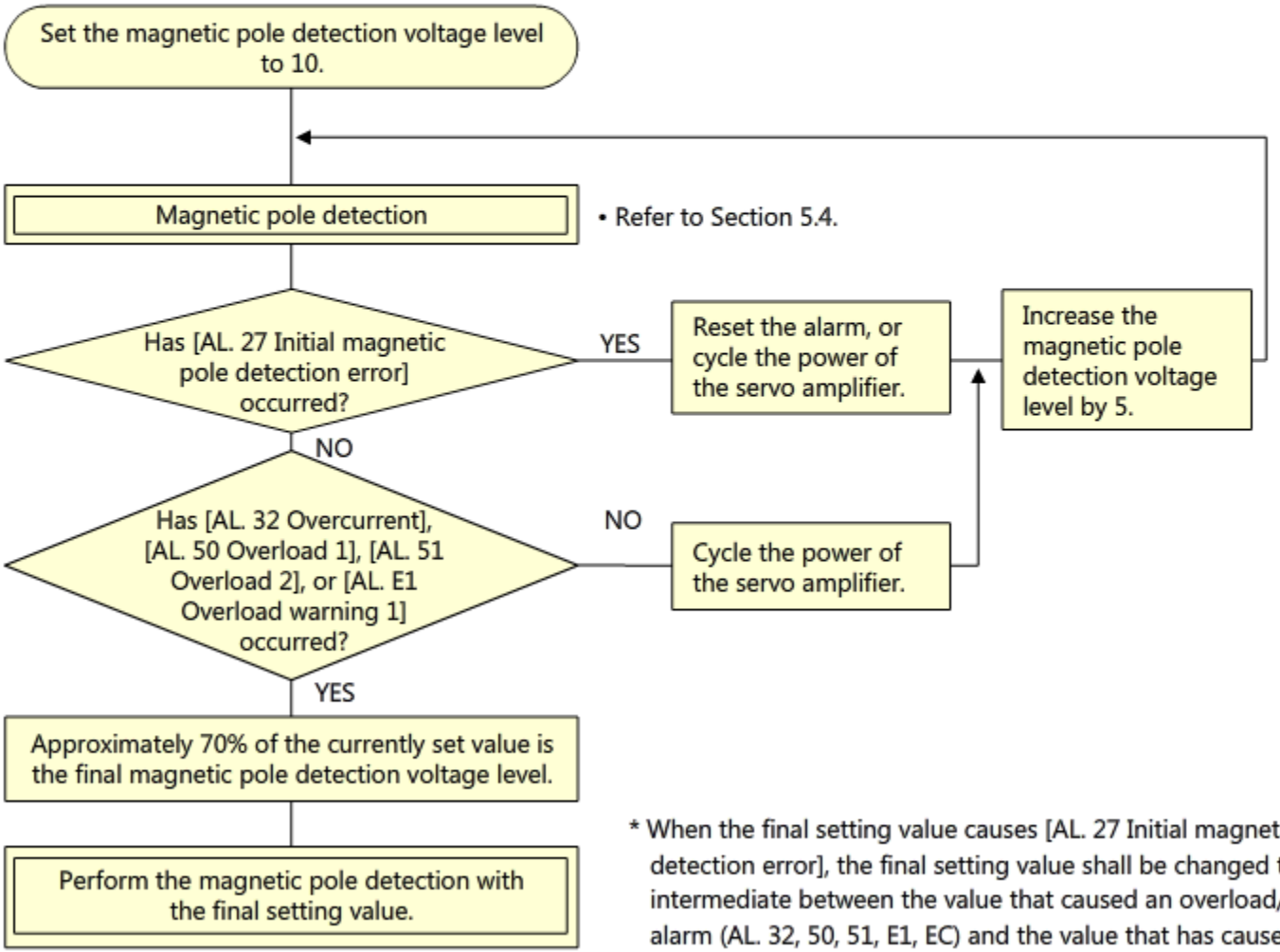
For the magnetic pole detection with the position detection method, a magnetic pole detection voltage level needs to be set to increase accuracy.
By using this setting value for the next and subsequent magnetic pole detection operations, stabilized magnetic pole detection operations can be performed.



Servo amplifier status	Voltage level setting (guide value) Small ← Medium → Large (10 or less (Initial value) 50 or more)	
Thrust at operation	Small	Large
Overload/overcurrent alarm (AL. 32, 50, 51, E1, EC)	Seldom occurs	Frequently occurs
Magnetic pole detection alarm (AL. 27)	Frequently occurs	Seldom occurs
Magnetic pole detection accuracy	Low	High

5.5.1 Setting Procedure

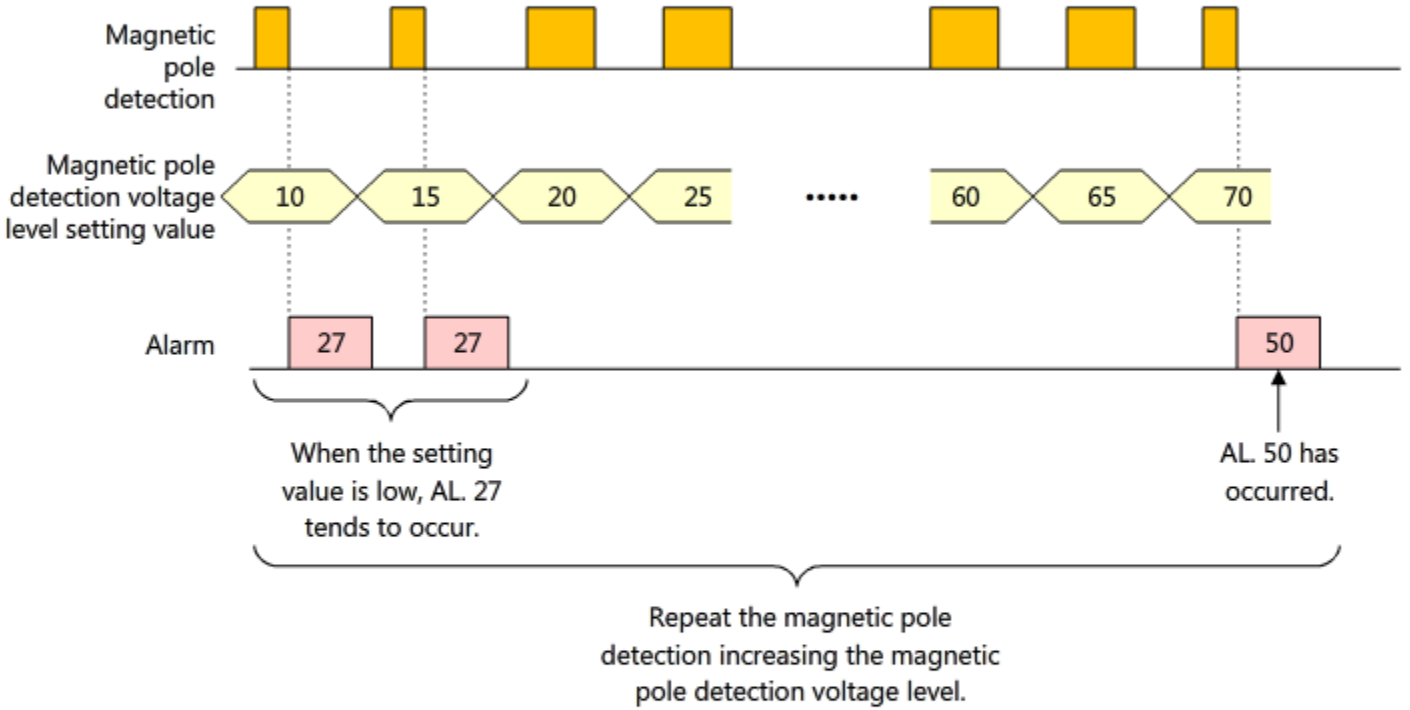
First, set the magnetic pole detection voltage level to 10, and perform the magnetic pole detection.
Increase the magnetic pole detection voltage level by 5 in performing the magnetic pole detection, until an overload/overcurrent alarm (AL. 32, 50, 51, E1, EC) occurs. Approximately 70% of the value that causes an alarm is the final magnetic pole detection voltage level.



* When the final setting value causes [AL. 27 Initial magnetic pole detection error], the final setting value shall be changed to the value intermediate between the value that caused an overload/overcurrent alarm (AL. 32, 50, 51, E1, EC) and the value that has caused [AL. 27 Initial magnetic pole detection error].

5.5.2 Setting example

The following figure shows a setting example of the magnetic pole detection voltage level.

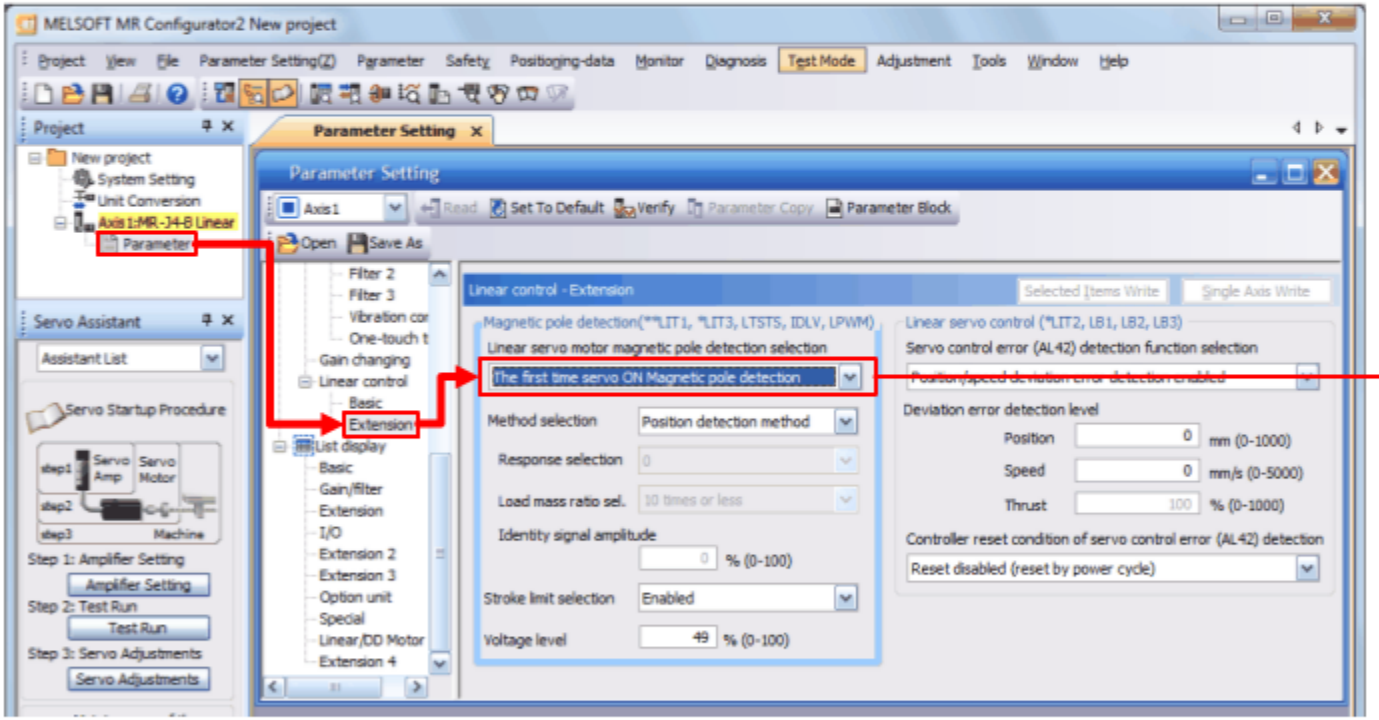


The final magnetic pole detection voltage level is 70 × 0.7 = "49".

Voltage level	49	% (0-100)

5.6 Magnetic Pole Detection in an Absolute Position System

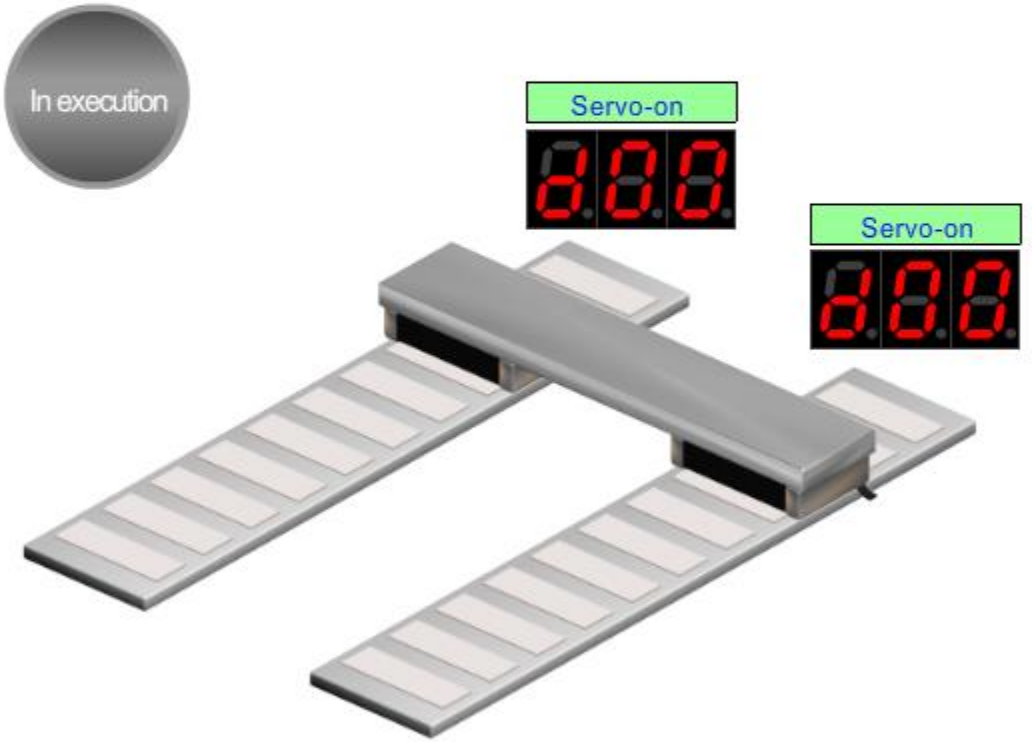
For absolute position system that uses an absolute position linear encoder, perform the magnetic pole detection every time you assemble equipment or replace a motor or liner encoder.
When performing the magnetic pole detection, select "Magnetic pole detection at first servo-on" for Linear servo ON Magnetic pole detection selection. Set "The first time servo ON Magnetic pole detection" for the Linear servo motor magnetic pole detection selection to perform the magnetic pole detection. When the magnetic pole detection is successfully complete, select "Magnetic pole detection disabled" if the magnetic detection is not necessary at every power-on.
(For incremental system, magnetic pole detection is required at every power-on.)



Parameter	Description	Initial value
Linear servo ON Magnetic pole detection selection	Select the type of the linear servo motor magnetic pole detection.	Magnetic pole detection at first servo-on

5.7 Magnetic Pole Detection in Tandem Configuration

When multiple axes are connected to a machine, such as in a tandem configuration, and the magnetic pole detection is performed on multiple axes simultaneously, the magnetic pole detection may not be successfully completed. Always perform the magnetic pole detection on one axis at a time. At this time, change the state of the other axes to servo-off.



5.8 Precautions for Magnetic Pole Detection

Note the following points when performing the magnetic pole detection.

- Note that the magnetic pole detection automatically starts simultaneously with turning on of the servo-on command.
- Establish the machine configuration that uses FLS (Upper stroke limit) and RLS (Lower stroke limit). Otherwise, a collision may damage the machine.
- When the magnetic pole detection is started, the moving direction (positive or negative) of the linear servo motor is unpredictable.
- Depending on the setting of the magnetic pole detection voltage level, an overload, overcurrent, or magnetic pole detection alarm may occur.
- When performing a positioning operation from a controller, use the sequence that outputs a positioning command after checking the normal completion of the magnetic pole detection and the servo-on status. If a positioning command is output before RD (Ready) turns on, the command may not be accepted or a servo alarm may occur.
- When an absolute position linear encoder is used and a gap is generated in the relative positions between the linear encoder and linear servo motor, perform the magnetic pole detection again.
- The accuracy of the magnetic pole detection will improve with no load.
- When a linear encoder has been incorrectly installed, or the linear encoder resolution setting or the magnetic pole detection voltage level is incorrect, a servo alarm may occur.
- For the machine that generates friction of 30% or more of the continuous thrust, the linear servo motor may not operate properly after the magnetic pole detection.
- For the machine whose unbalanced thrust on the horizontal shaft becomes 20% or more of the continuous thrust, the linear servo motor may not operate properly after the magnetic pole detection.
- For the machine whose multiple axes are connected like a tandem configuration, when you try to perform the magnetic pole detection simultaneously to multiple axes, the magnetic pole detection may not be executed. Always perform the magnetic pole detection on one axis at a time. At this time, change the state of the other axes to servo-off.

5.9 Summary of This Chapter

In this chapter, you have learned:

- Introduction to Magnetic Pole Detection
- Preparation for Magnetic Pole Detection
- Magnetic Pole Detection Method
- Magnetic Pole Detection
- Magnetic Pole Detection Voltage Level Setting
- Magnetic Pole Detection in an Absolute Position System
- Magnetic Pole Detection in Tandem Configuration
- Precautions for Magnetic Pole Detection

Important points

Introduction to Magnetic Pole Detection	• A linear servo motor requires a flow of current that depends on the relative positions between the secondary side magnet and primary side coil. Therefore, when a motor is installed or power is turned on, an operation that detects the relative positions between the magnet and winding wire, so-called initial magnetic pole detection, is required.
Preparation for Magnetic Pole Detection	• Before starting the magnetic pole detection, prepare the following. Check that FLS, RLS, and EM2 are on. Change the mode to the test operation mode.
Magnetic Pole Detection Method	• The following two magnetic pole detection methods are provided: "Position detection method" and "Minute position detection method".
Magnetic Pole Detection	• Perform the magnetic pole detection using the test operation mode (positioning operation) of MR Configurator2. • Set the travel distance to "0", and execute a "forward direction operation" or "reverse direction operation".
Magnetic Pole Detection Voltage Level Setting	• For the magnetic pole detection with the position detection method, a magnetic pole detection voltage level needs to be set to increase accuracy.
Magnetic Pole Detection in an Absolute Position System	• For absolute position system that uses an absolute position linear encoder, select "Magnetic pole detection at first servo-on" for Linear servo ON Magnetic pole detection selection.
Magnetic Pole Detection in Tandem Configuration	• When multiple axes are connected to a machine, such as in a tandem configuration, and the magnetic pole detection is performed on multiple axes simultaneously, the magnetic pole detection may not be successfully completed. Always perform the magnetic pole detection on one axis at a time. At this time, change the state of the other axes to servo-off.
Precautions for Magnetic Pole Detection	• Note that the magnetic pole detection automatically starts simultaneously with turning on of the servo-on command.

Chapter 6 Positioning Operation

This chapter describes the positioning operation in the test operation mode using MR Configurator2, connection of controllers, settings (axis numbers, system setting, and positioning control parameters), powering on of the power supply, and home position return.

Chapter 1 - Learning about Linear Servo Motors
Chapter 2 - Sample System and Capacity Selection
Chapter 3 - Installation and Wiring
Chapter 4 - Setup of Linear Servo Motors
Chapter 5 - Magnetic Pole Detection
Chapter 6 - Positioning Operation

6.1 Test Operations Using MR Configurator2
6.2 Preparation for Test Operation Mode (Positioning Operation)
6.3 Performing Operations in Test Operation Mode (Positioning Operation)
6.4 Connection with Controller
6.5 Axis Number Settings
6.6 Controller Settings
6.7 Power-on
6.8 Home Position Return
6.9 Positioning Operation Using Controller
6.10 Summary of This Chapter

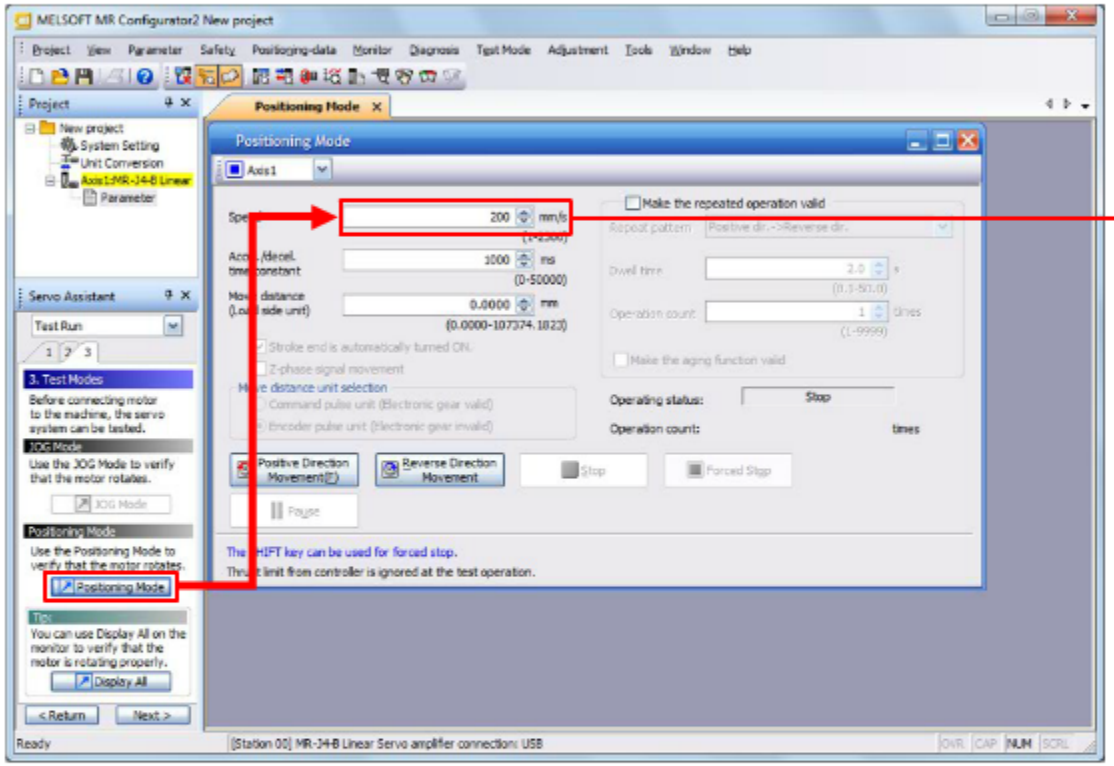
6.1 Test Operations Using MR Configurator2

This section introduces the test operation mode that is available in MR Configurator2.
In this course, "Positioning operation" is performed for checking operations.

Mode name	Function
DO (output signal) forced output	Output signals can be forcibly turned on/off independently of the linear servo motor status. This function can be used to check signal wiring.
Positioning Operation	The linear servo motor moves a specified travel distance at any speed and stops. This function can be used to check the operations and stopping accuracy of the positioning control.

6.2 Preparation for Test Operation Mode (Positioning Operation)

Configure some settings to prepare for the operations in the test operation mode (positioning operation).
For the sample system, set the speed to 200 mm/s.

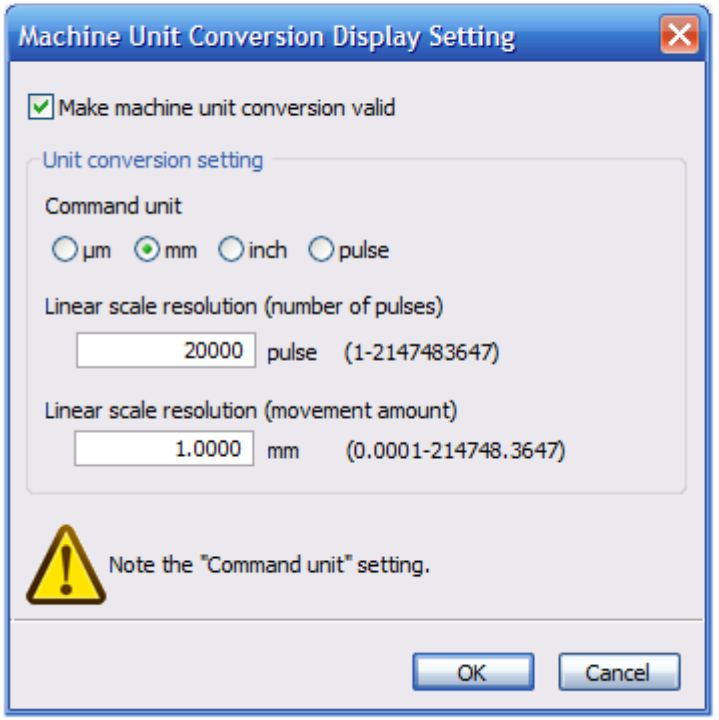


Parameter	Description	Initial value	Setting
Speed	Set the linear servo motor speed.	10	200

You can change the unit of the travel distance in the machine unit conversion setting.
Select [Tools] - [Machine Unit Conversion Display Setting] to configure the machine unit conversion setting.

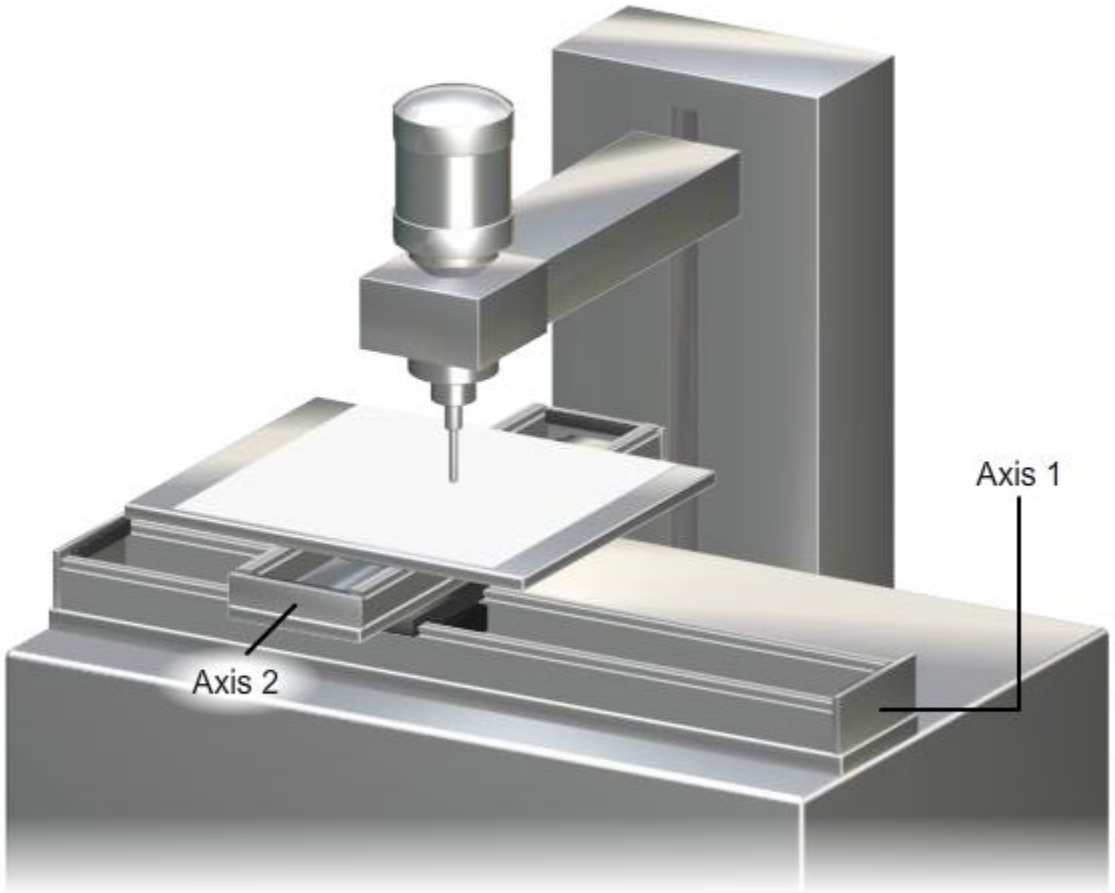
6.2 Preparation for Test Operation Mode (Positioning Operation)

You can change the unit of the travel distance in the machine unit conversion setting.
Select [Tools] - [Machine Unit Conversion Display Setting] to configure the machine unit conversion setting.
From the next page, the test operation mode (positioning operation) with the following settings is explained.



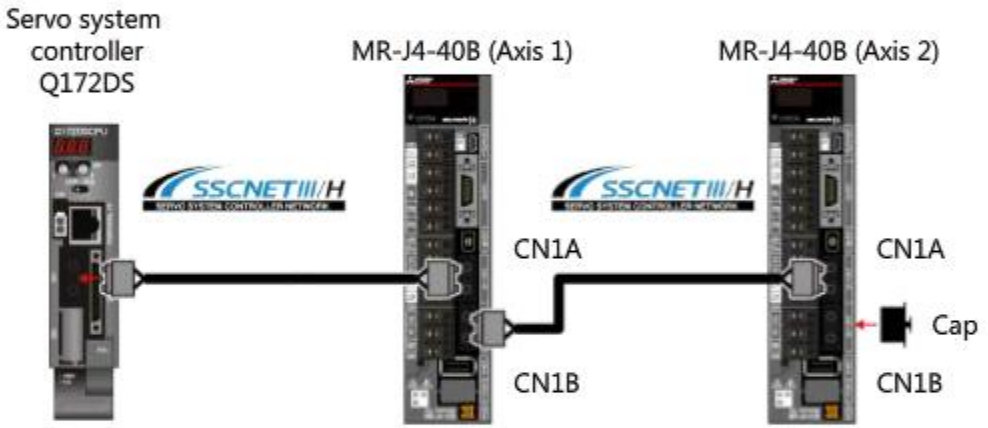
6.3 Performing Operations in Test Operation Mode (Positioning Operation)

Perform operations in the test operation mode (positioning operation).
The sample system operates as follows with the execution of "Positive direction travel" and "Negative direction travel".



6.4 Connection with Controller

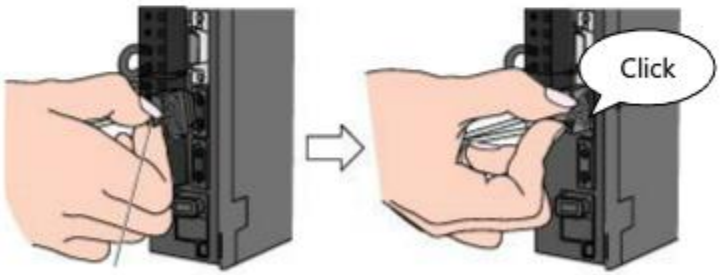
Connect the servo amplifier with a controller.
The MR-J4-B servo amplifier has an SSCNET Ⅲ/H interface.
Using the optical communication method, SSCNET Ⅲ/H achieves high noise tolerance and high-speed , full-duplex communication.
Use a dedicated cable to connect the servo amplifier with the controller. The cable with connectors allows easy connection and disconnection.



Note the following points when using SSCNET Ⅲ cables.

- If any power such as a great shock or lateral pressure is applied to the cable, or the cable is pulled, suddenly bent, or twisted, inside parts are distorted or damaged, and optical transmission will not be available.
- As the optical fibers are made of synthetic resin, it will be thermally deformed if exposed to a fire or high temperature.
- If the end face of an optical cord tip is dirty, optical transmission is interrupted and it may cause malfunctions.
- Do not look directly at the light output from the connector or the end of the cable.
- For your safety and protection of the connector, put a supplied cap in the unused connector (CN1B) on the final-axis servo amplifier.

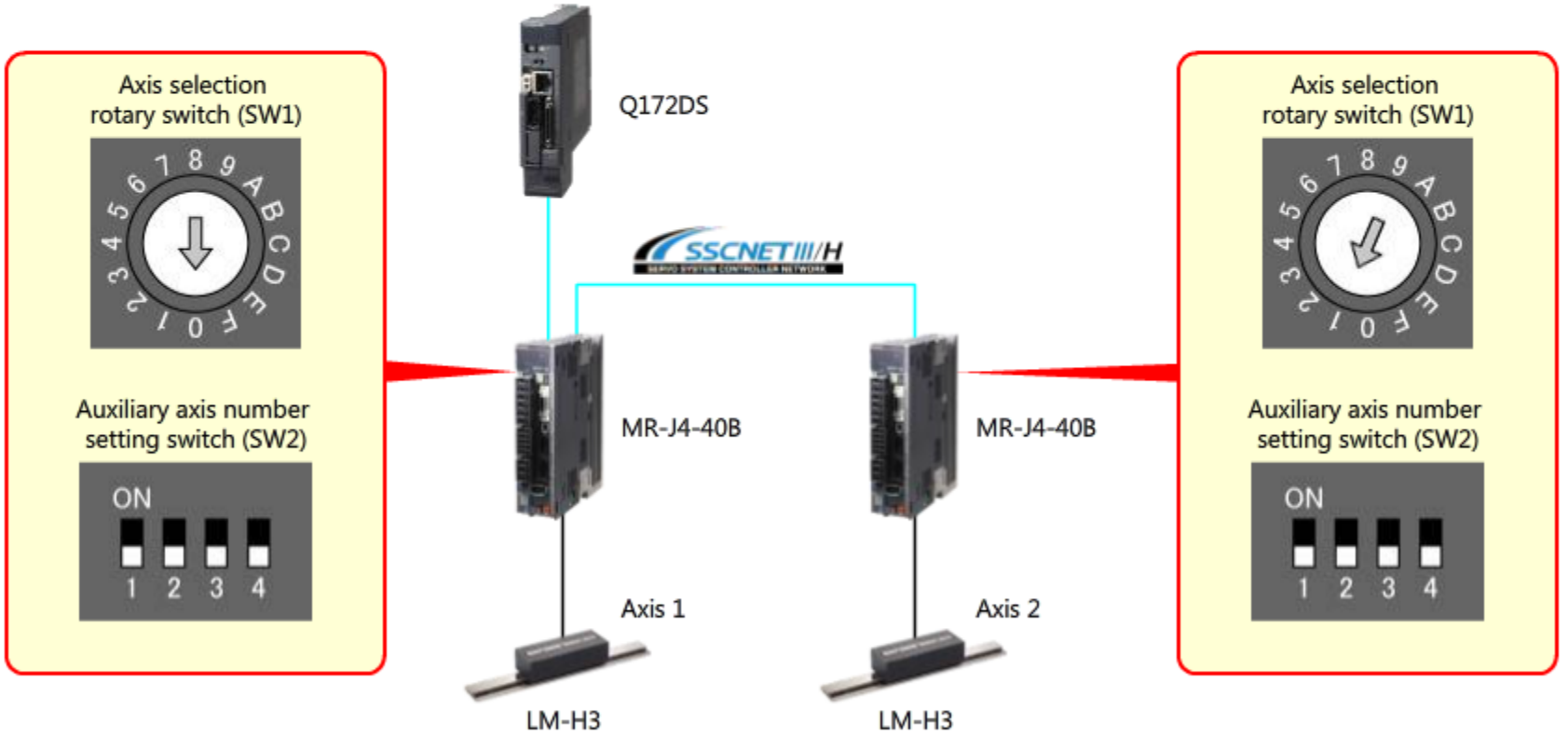
■ How to connect



6.5 Axis Number Settings

Set a control axis number to the servo amplifier.
A control axis number is assigned to each servo amplifier to identify control axes. Up to 16 axis numbers can be set regardless of the order of connection.
Note that the operation may not be performed properly if the set control axis numbers overlap in one servo system.

Set a control axis number to a servo amplifier using both of the axis selection rotary switch (SW1) and the auxiliary axis number setting switch (SW2) in the front cover on the servo amplifier.

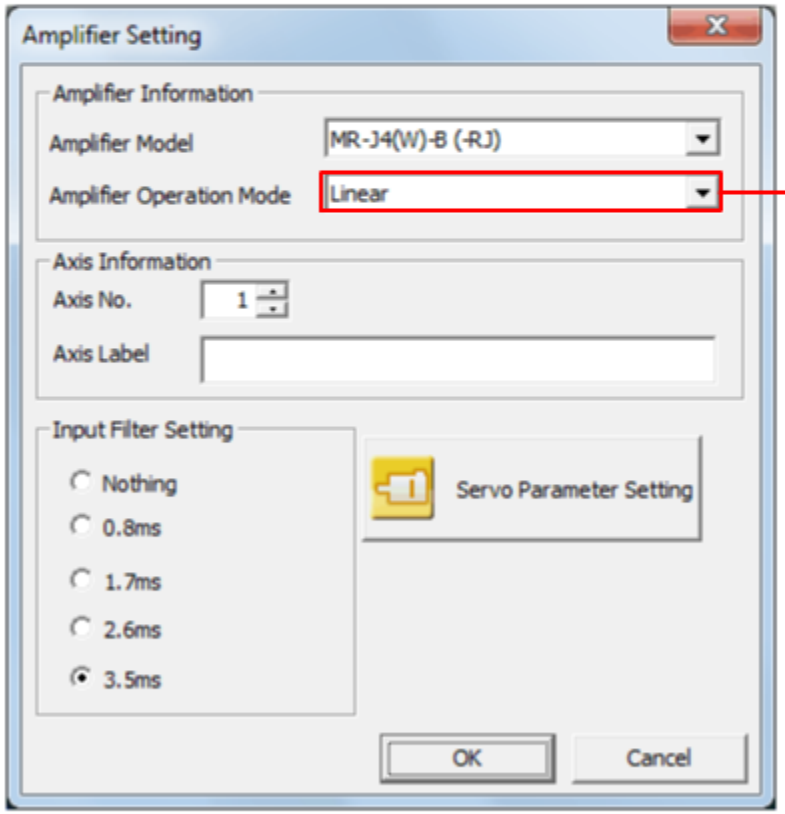


6.6 Controller Settings

This section describes the controller settings to control a linear servo motor. This section describes only the settings different from those for rotary servo motors.

6.6.1 System settings

The following shows the system setting item.



Setting item	Description	Setting
Operation mode	Select an operation mode.	Linear

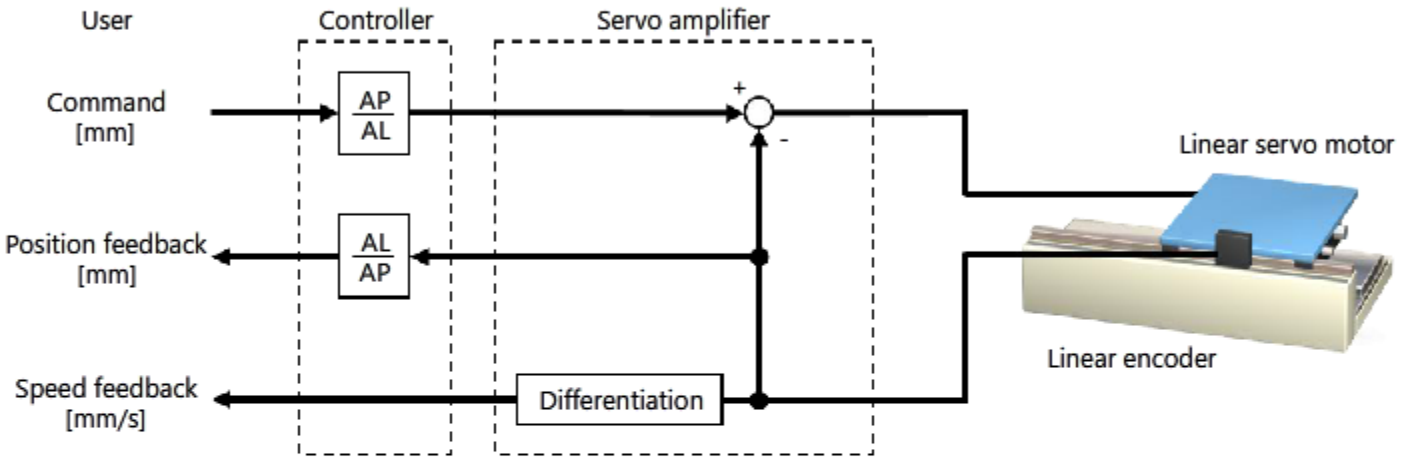
6.6.2 Servo parameters

Set the following values for the servo parameters. (For how to set the values, refer to Chapter 4 and 5.)

Setting item	Description	Setting
Servo motor series setting	Set the servo motor series.	00BB
Servo motor type setting	Set the servo motor type.	2101
Encoder pulse count polarity selection	Set the pole of the linear encoder.	Encoder pulse in the servo motor positive direction
Linear encoder resolution - Numerator	Set the numerator of the linear encoder resolution.	1
Linear encoder resolution - Denominator	Set the denominator of the linear encoder resolution.	20
Magnetic pole detection method selection	Set a magnetic pole detection method.	Position detection method
Magnetic pole detection voltage level	Set a magnetic pole detection voltage level.	49

6.6.3 Positioning Control Parameters

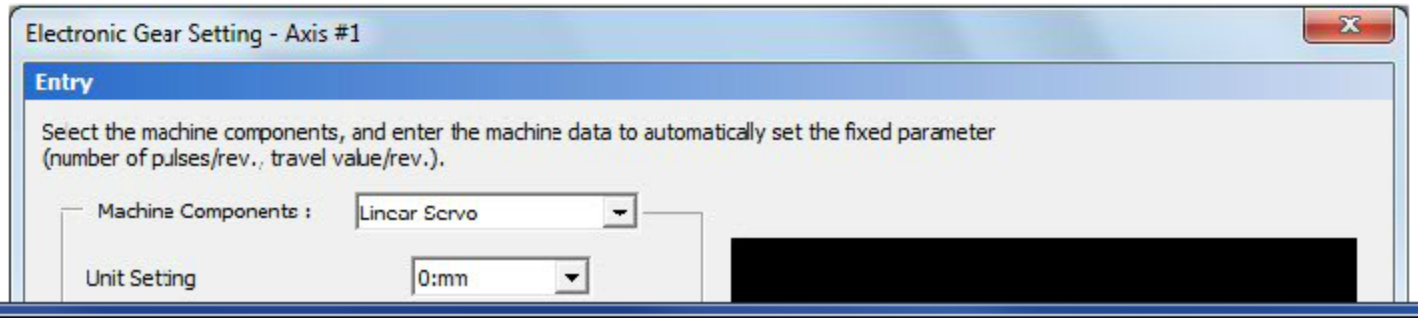
The unit of a linear encoder is "mm".
Match the unit of the controller command resolution with that of the linear encoder.
The following figure shows the relation between the number of pulses (AP) and travel distance (AL) of the linear encoder.



When the linear encoder resolution is 0.05 μm, calculate the number of pulses (AP) and travel distance (AL) as follows.

$$\frac{\text{Number of pulses (AP) [pulse]}}{\text{Travel distance (AL) [μm]}} = \frac{1}{0.05} = \frac{20}{1}$$

Using MELSOFT MT Works2, you can easily set required parameters just by inputting machine components (such as scale resolution).



6.6.3 Positioning Control Parameters

Entry

Seect the machine components, and enter the machine data to automatically set the fixed parameter (number of pulses/rev., travel value/rev.).

Machine Components : Linear Servo

Unit Setting: 0:mm

Scale Resolution: 0.0500 [μm]

Input

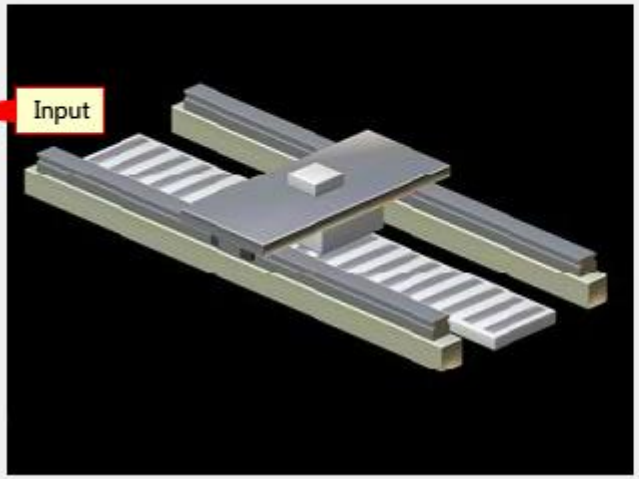
Reduction Gear Ratio (NL/NM) = /

Calculate reduction ratio by teeth or diameters

Reduction Ratio Setting

Encoder Resolution

Setting Range



Calculate Electronic Gear

Clicking this button calculates the number of pulses and travel distance to be set to parameters.

Calculation Result

- Fixed Parameter

Unit Setting	0:mm
Number of Pulses/Rev.	1000 PLS
Travel Value/Rev.	50.0 μm

20/1

Travel Value per Pulse

As a result of calculation, no error occurs in the travel value.

Applying the calculation result: above,

you want to perform is about 0.0 [μm] the error for the travel value 0.0 [μm]

Error Calculation

Click OK to reflect to the fixed parameter.

OK

Clicking the OK button reflects the calculation results into the parameters.

6.7 Power-on

Power on the controller.
The controller and the servo amplifier start the SSCNET Ⅲ/H communication and the initialization communication.
When the initialization communication is successfully completed, "b#" (ready-off, servo-off status) is displayed.

In a system that uses an incremental linear encoder, the magnetic pole detection is automatically performed at the first servo-on after power-on. Therefore, when performing a positioning operation, always establish a sequence that checks the servo-on status as the interlock condition of the positioning command.

6.8 Home Position Return

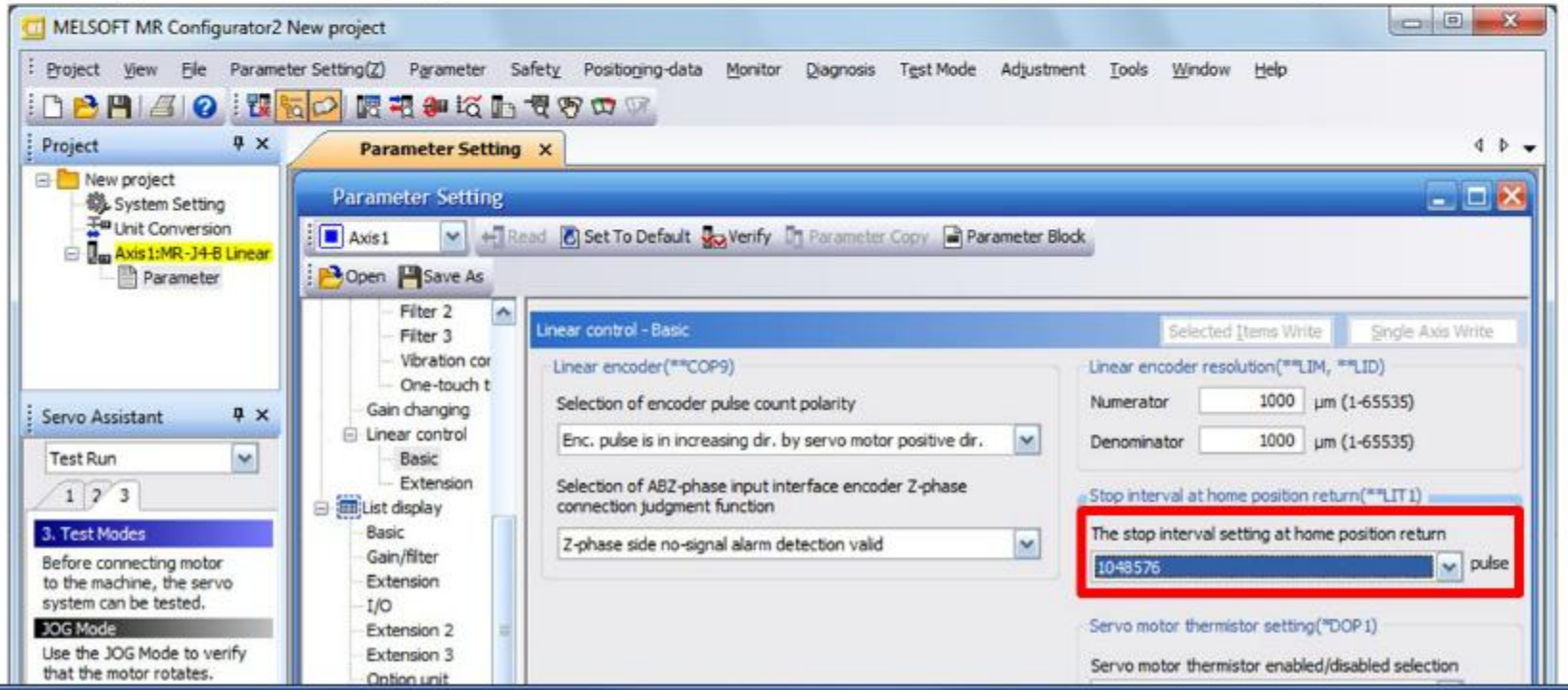
The home position return operation establishes the home position of the machine. Once the home position is established, subsequent positioning control operations are performed based on the home position.

The home position of the linear servo motor is the position per the set stop interval at the home position return, based on the linear encoder home position.

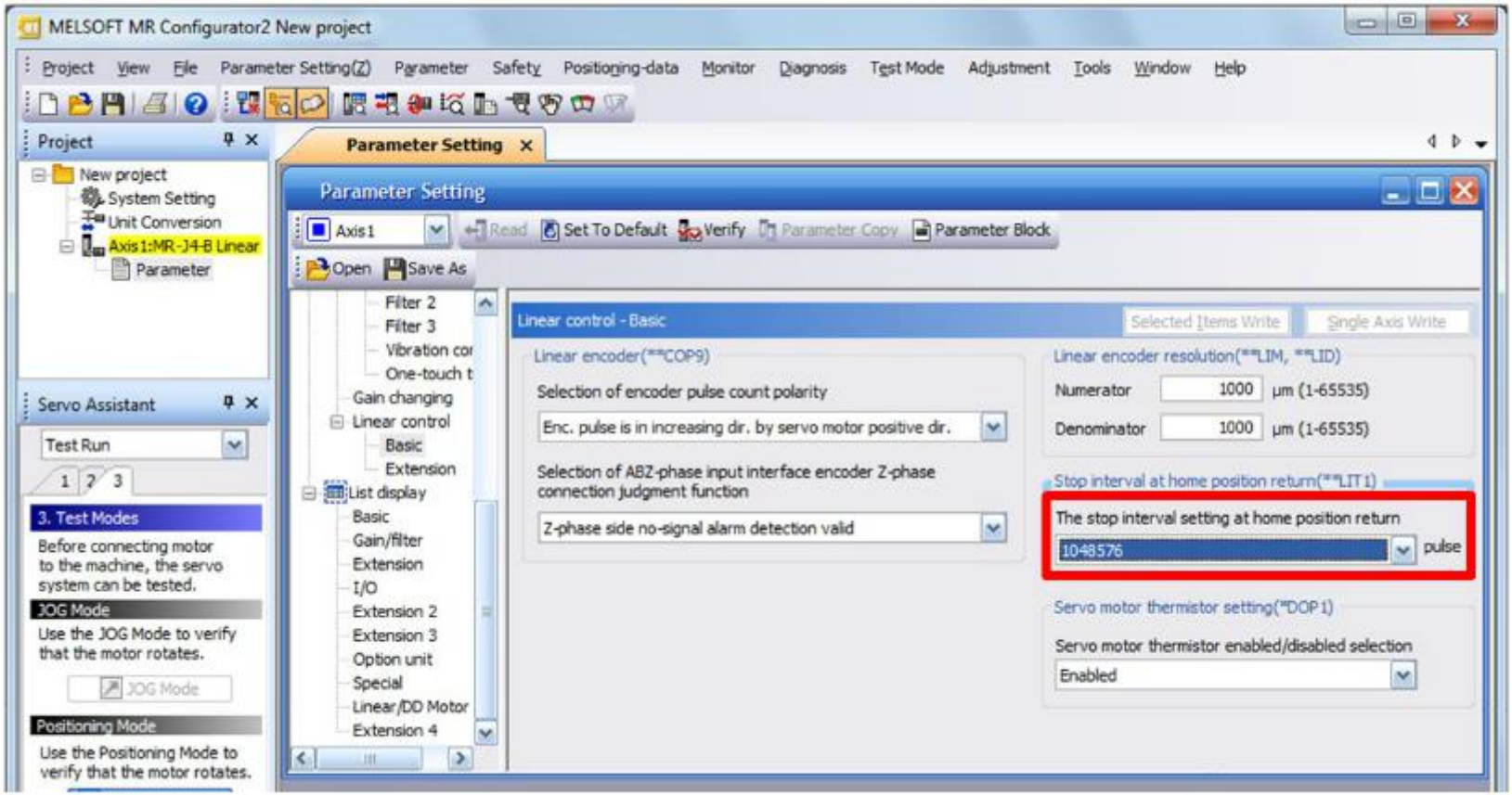
The linear encoder home position at the home position return varies depending on the type of the linear encoder used.

Linear encoder type	Linear encoder home position at home position return
Incremental linear encoder	Linear encoder home position passed through first after a home position return start (reference mark)
Absolute position linear encoder	Linear encoder home position (Absolute position data = 0)

Set the stop interval at the home position return in the "Linear control-Basic" window of MR Configurator2.



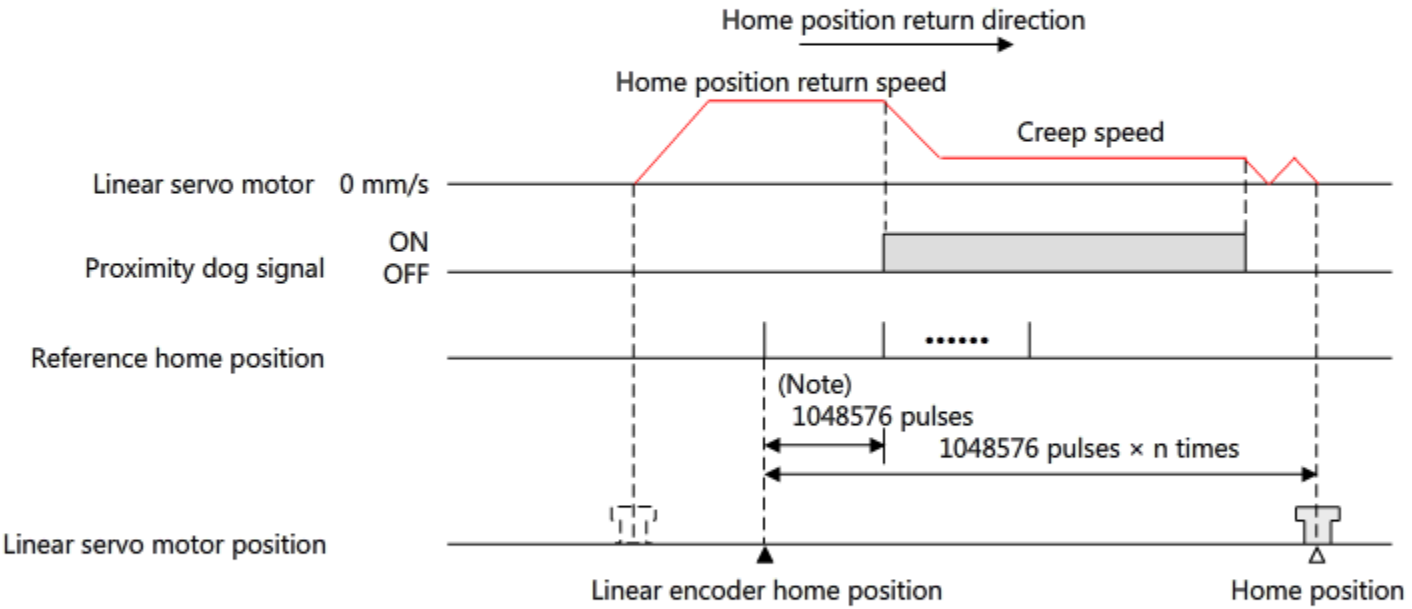
6.8 Home Position Return



6.8.1 Home position return using an incremental linear encoder

The following figure shows an operation example of the proximity dog type home position return of when the stop interval is set to 1048576 pulses (initial value).

With reference to the linear encoder home position passed through first after a home position return start, the home position will be the nearest reference home position after proximity dog off (the position that is 1048576 pulses × n times away from the linear encoder home position).

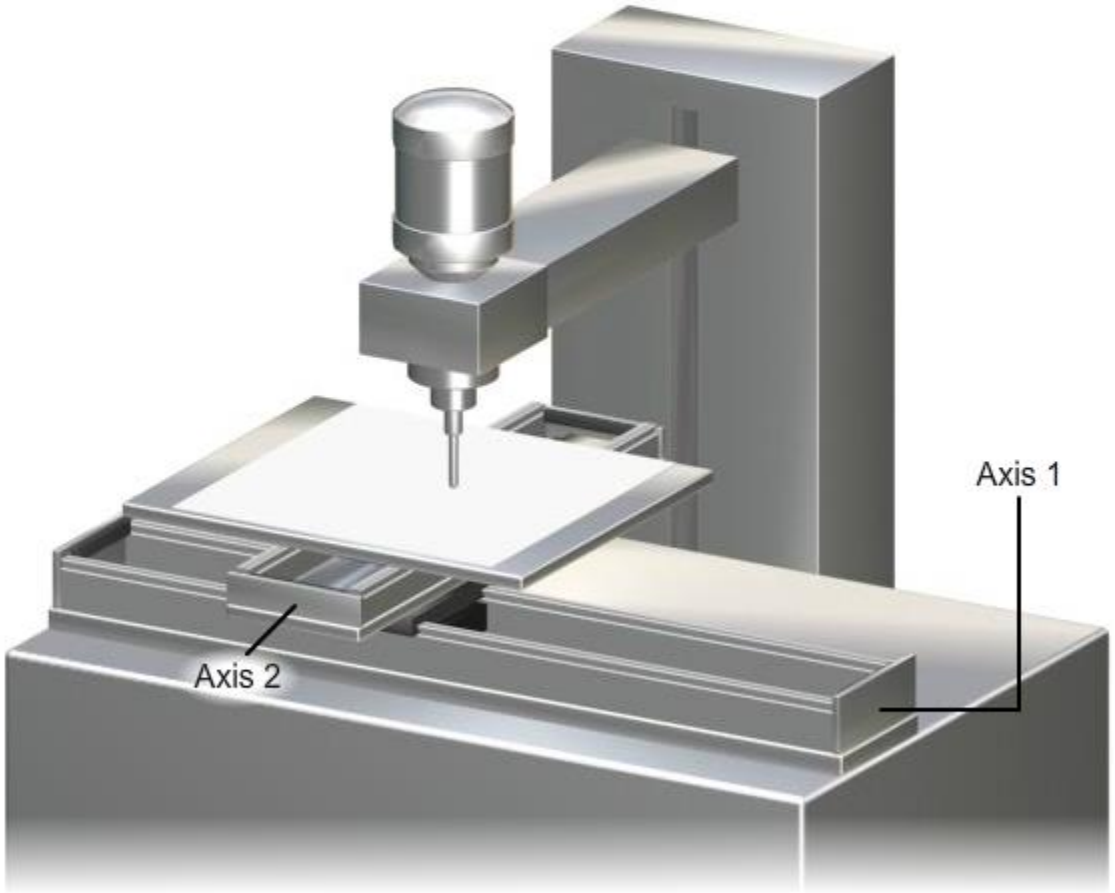


Set just one linear encoder home position in the full stroke, and make sure that the position is always passed through after a home position return start.
If no linear encoder home position exist in the home position return direction, a home position return error occurs on the controller.

6.9 Positioning Operation Using Controller

The following shows the positioning operation of the sample system.
For details on the programs for positioning operations and others, refer to the following courses.

- When a motion CPU is the servo system controller: "MOTION CONTROLLER Basics (Real Mode:SFC)" course
- When a simple motion module is the servo system controller: "SIMPLE MOTION Module" course



6.10 Summary of This Chapter

In this chapter, you have learned:

- Test Operations Using MR Configurator2
- Preparation for Test Operation Mode (Positioning Operation)
- Performing Operations in Test Operation Mode (Positioning Operation)
- Connection with Controller
- Axis Number Settings
- Controller Settings
- Power-on
- Home Position Return
- Positioning Operation Using Controller

Important points

Test Operations Using MR Configurator2	• The following test operation modes are provided in MR Configurator2: "DO (output signal) forced output" and "Positioning operation".
Connection with Controller	• Note the following points when using SSCNET III cables. • If any power such as a great shock or lateral pressure is applied to the cable, or the cable is pulled, suddenly bent, or twisted, inside parts are distorted or damaged, and optical transmission will not be available. • As the optical fibers are made of synthetic resin, it will be thermally deformed if exposed to a fire or high temperature. • If the end face of an optical cord tip is dirty, optical transmission is interrupted and it may cause malfunctions. • Do not look directly at the light output from the connector or the end of the cable. • For your safety and protection of the connector, put a supplied cap in the unused connector (CN1B) on the final-axis servo amplifier.
Axis Number Settings	• A control axis number is assigned to each servo amplifier to identify control axes. Up to 16 axis numbers can be set regardless of the order of connection. • Note that the operation may not be performed properly if the set control axis numbers overlap in one servo system.

6.10 Summary of This Chapter

Controller Settings	• To enable the set parameters, cycle the power of the servo amplifier after writing the parameters from the controller to the servo amplifier. • The number of pulses (AP) and travel distance (AL) of the linear encoder is calculated as follows. $\frac{\text{Number of pulses (AP) [pulse]}}{\text{Travel distance (AL) [μm]}} = \frac{1}{\text{Linear encoder resolution [μm]}}$
Power-on	• When the initialization communication is successfully completed after the servo amplifier is powered on, "b#" (ready-off, servo-off status) is displayed. • In a system that uses an incremental linear encoder, the magnetic pole detection is automatically performed at the first servo-on after power-on. Therefore, when performing a positioning operation, always establish a sequence that checks the servo-on status as the interlock condition of the positioning command.
Home Position Return	• The home position return operation establishes the home position of the machine. Once the home position is established, subsequent positioning control operations are performed based on the home position.

Test Final Test

Now that you have completed all of the lessons of the MELSERVO Basics (Linear servo motor) Course, you are ready to take the final test.
If you are unclear on any of the topics covered, please take this opportunity to review those topics.
There are a total of 5 questions (18 items) in this Final Test.
You can take the final test as many times as you like.

How to score the test

After selecting the answer, make sure to click the **Answer** button. Your answer will be lost if you proceed without clicking the Answer button. (Regarded as unanswered question.)

Score results

The number of correct answers, the number of questions, the percentage of correct answers, and the pass/fail result will appear on the score page.

Correct answers : 5

Total questions : 5

Percentage : 100%

To pass the test, you have to answer **60%** of the questions correct.

Proceed Review

- Click the **Proceed** button to exit the test.
- Click the **Review** button to review the test. (Correct answer check)
- Click the **Retry** button to retake the test again.

Test — Final Test 1

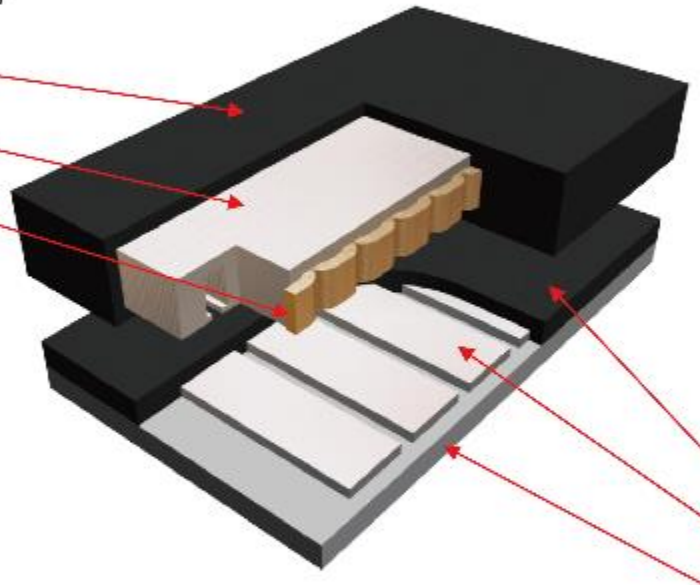
Select the names of linear servo motor components from the term box.

Primary side

Q1 [ ]

Q2 [ ]

Q3 [ ]



Secondary side

Molded resin or stainless cover

Q4 [ ]

Q5 [ ]

Term box

1. Molded resin
2. Permanent magnet
3. Mounting part (yoke)
4. Motor coil
5. Laminated core

Answer | Back

Test Final Test 2

Select the precautions inapplicable to the use of linear servo motors.

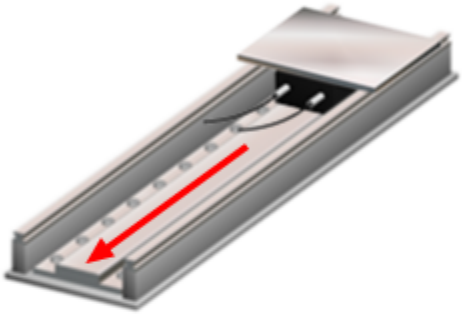
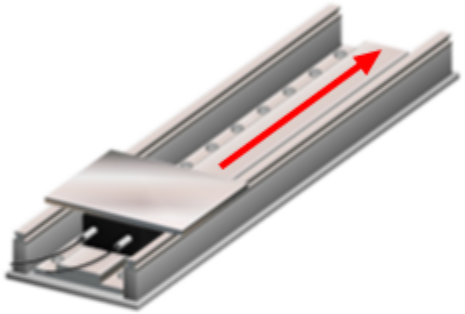
Q1

- One who uses a medical device such as a pacemaker must keep away from the product and equipment.
- Do not wear metals such as watches, pierced earrings, necklaces, etc.
- Use iron tools.
- Do not put magnetic cards, watches, portable phones, etc. close to the motor.
- Do not apply a shock or stress on the molded parts of the product.
- Display the message "Caution! Strong Magnet" or the like and take actions by giving cautions to the surrounding, etc.

Answer Back

Test Final Test 3

The following table shows the combinations of the movement of a linear servo motor and the linear encoder pulse count polarity selection in MR Configurator2.
Select Positive or Negative, the corresponding direction of the motor speed to be monitored in MR Configurator2, in each box.

Movement of linear servo motor	 (LM-H3 series motor, positive direction)		 (LM-H3 series motor, negative direction)	
Linear encoder pulse count polarity selection in MR Configurator2	Encoder pulse increasing direction in the servo motor positive direction	Encoder pulse decreasing direction in the servo motor positive direction	Encoder pulse increasing direction in the servo motor positive direction	Encoder pulse decreasing direction in the servo motor positive direction
Positive or Negative, the direction of the motor speed monitored in MR Configurator2	Q1	Q2	Q3	Q4

Answer Back

Test Final Test 4

The following sentences describe the preparation for the magnetic pole detection using MR Configurator2.
Select ON or OFF in each box to complete the sentences.

- **Check FLS, RLS, and EM2.**
  Check that FLS (Upper stroke limit), RLS (Lower stroke limit), and EM2 (Forced stop 2) are [▼] (Q1) by checking the I/O monitor of MR Configurator2.

- **Change the mode to the test operation mode.**
  Change the mode to the test operation mode following the steps below.

  1) Power [▼] (Q2) the servo amplifier.

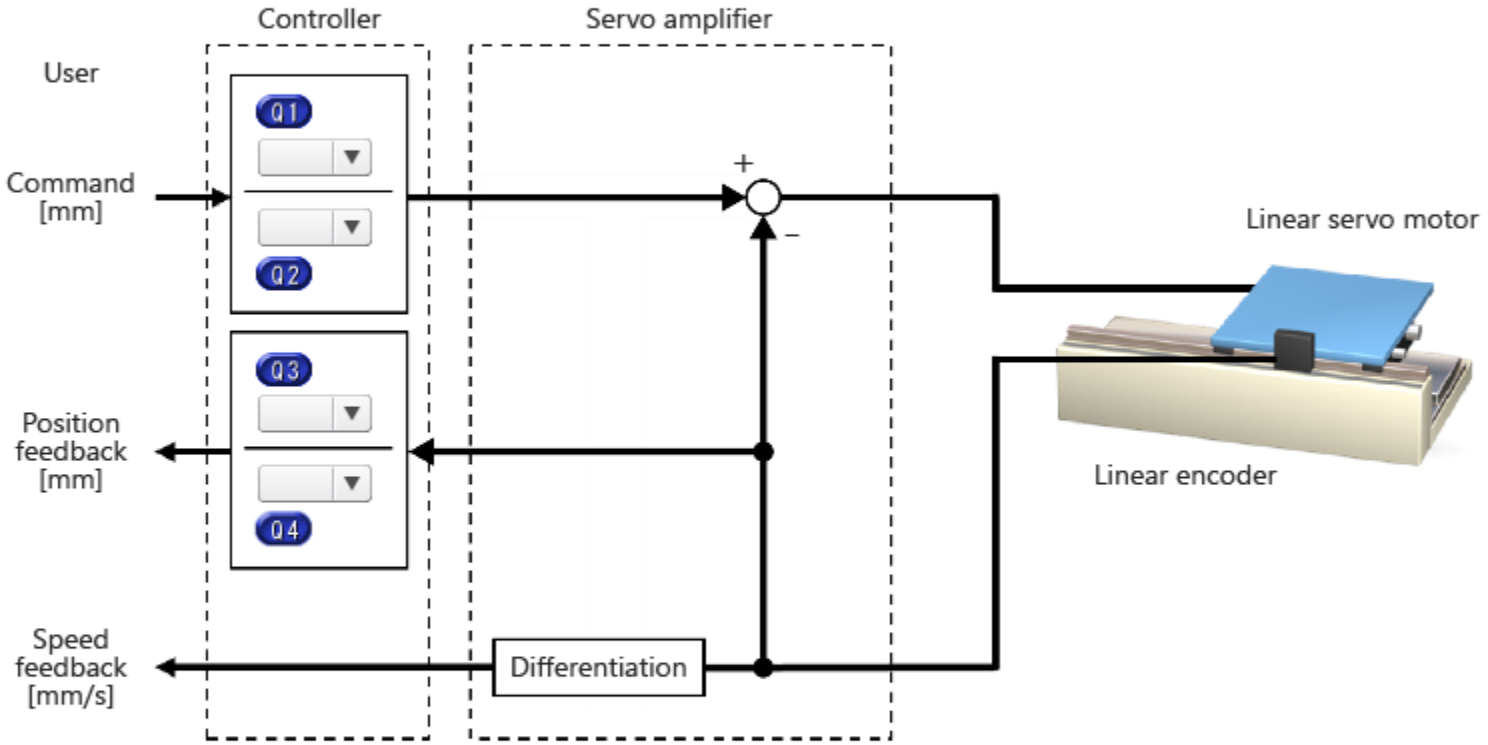
  2) Set the test operation select switch (SW2-1) to " [▼] (Q3) (up)".

  3) Power [▼] (Q4) the servo amplifier.

Answer Back

Test Final Test 5

The following figure shows the relation between the number of pulses and travel distance of a linear encoder.
Select AP (number of pulses) or AL (travel distance) in each box.



Answer Back

Test Score

You have completed the Final Test. You results area as follows.
To end the Final Test, proceed to the next page.

Correct answers : 0

Total questions : 5

Percentage : 0%

Proceed | Review | Retry

You failed the test.

You have completed the MELSERVO Basics (Linear servo motor) Course.

Thank you for taking this course.

We hope you enjoyed the lessons and the information you acquired in this course will be useful in the future.

You can review the course as many times as you want.

Review Close