Motorized Actuators

Linear Guide Types of Motorized Linear Slides and Motorized Cylinders

The linear guides used on motorized linear slides and motorized cylinders are made by THK.
The table below lists the products of linear guides used by each series.

Series	Product	Linear Guide Type
EZSII Series	**EZS3**	SRS12WM
	EZS4	SRS15WM
	EZS6	SRS15WM×2 Blocks

Maintenance of Motorized Linear Slides and Motorized Cylinders

The lubrication system QZ and LM guide ball retainer significantly extend the maintenance intervals.
Oriental Motor's motorized linear slides and motorized cylinders require greasing as part of their maintenance.

We have evaluated and confirmed that up to the expected service life for each series, our products should be problem-free, even if they are not maintained with grease and are operated at the maximum load and maximum speed.
However, periodic maintenance is still required according to the operating conditions and operating environment.
For check list and actions, refer to the following table.

Item	Check list	Action
Linear Slide Ball Screw Shaft	Attachment of dust or other foreign object?	If there are any foreign objects, remove them.
	Has the grease lost its luster? Has the amount of grease decreased?*	Clean the screw shaft using a soft cloth and then apply grease to the nut raceway grooves.
Linear Slide Guide Rail	Attachment of dust or other foreign object?	If there are any foreign objects, remove them.
	Has the grease lost its luster? Has the amount of grease decreased?*	Clean the ball raceway grooves on both sides of the guide rail using a soft cloth and then apply grease to the ball raceway grooves.
Cylinder Rod	Attachment of dust or other foreign object?	If there are any foreign objects, remove them.
	Has the grease lost its luster? Has the amount of grease decreased?*	Clean the rod using a soft cloth and then apply grease to the rod.

*Even if the color of the grease has changed to brown, good lubrication is maintained as long as the traveling surface appears shiny.

List of greases used on each model is shown below.

Series	Linear Slide Ball Screw	Linear Slide Linear Guide	Cylinder Rod
EZSII Series	AFF (Manufactured by THK)	AFF (Manufactured by THK)	–
EZSII Series for Cleanroom Use	AFE-CA (Manufactured by THK)	AFF (Manufactured by THK)	–
EZCII Series	–	–	Marutemp SRL (Manufactured by Kyodo Yushi)

Table Deflection of Motorized Linear Slides

Assume a moment acting upon a linear slide table which is supported by a linear guide.
The action of moment causes balls in the linear guide to deflect. As a result, the load is displaced.
Shown below are the actual displacements that were measured when a load moment was caused to act upon a linear slide.

Measurement Conditions

A 100 mm overhung plate was fixed on a linear slide table and dynamic permissible moments (M_P, M_Y, M_R) were caused to act upon the linear slide table in respective directions. The displacement of the tip was measured under these conditions.

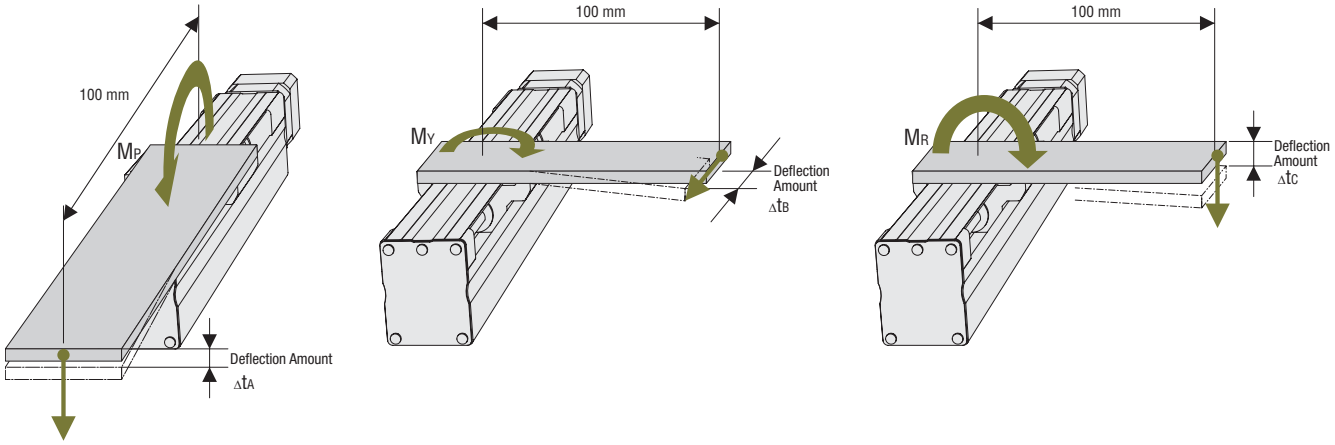


Table Deflection of Each Series under Moment

Unit [mm]

Series	Product	Δt_A	Δt_B	Δt_C
EZSII Series	**EZS3**	0.11	0.14	0.14
	EZS4	0.09	0.12	0.17
	EZS6	0.10	0.19	0.04

● Ignore the deflection of the 100 mm plate.

Repetitive Positioning Accuracy of Compact Linear Actuators

To meet the specifications for repetitive positioning accuracy, take note of the following points:

① Sufficient rigidity for peripheral equipment

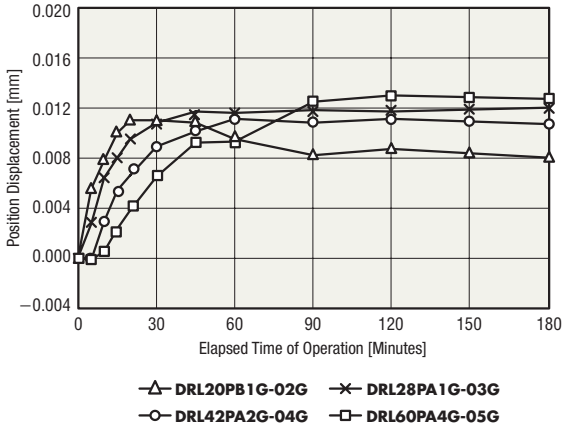
- For the linear guide and other mechanical components used, select those that have enough rigidity to withstand the load mass and external forces.
- If these components lack rigidity, they may not meet specifications due to deflection or other unwanted behaviors. The installation brackets used to install the actuator and metal fittings for connecting the load should also have enough rigidity to withstand the load mass and external forces. If they lack rigidity, the specifications may not be met due to deflection or other unwanted behaviors.

② Sensor

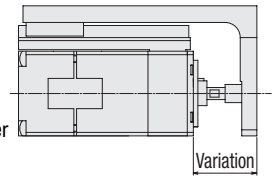
- For the home sensor, use a highly accurate type (photomicro sensor, etc.). Return-to-home accuracy is not included in repetitive positioning accuracy.

③ Temperature rise in the actuator

- The actuator may generate significant heat depending on the driving conditions. As a result, the built-in ball screw may extend and cause displacement, as shown to the figure below (reference values). To minimize the effects of temperature on repetitive positioning accuracy, adjust the input current value of the actuator and design the peripheral equipment by considering heat radiation.

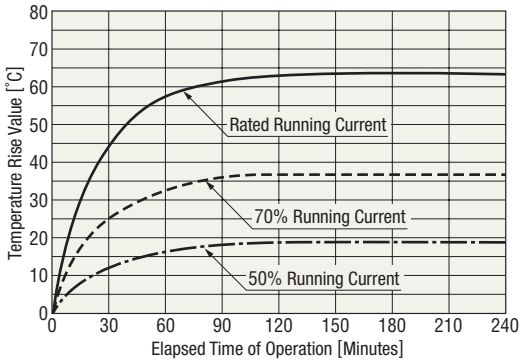


Condition
Current Cutback: : OFF
Operating Duty : 80%
Measurement Method : By laser displacement meter



<Reference>
Adjusting the input current of the actuator changes the rise in actuator temperature. This method is effective when there is sufficient allowance in starting characteristics and holding force.

DRL42 Relationship between Running Current and Temperature Rise



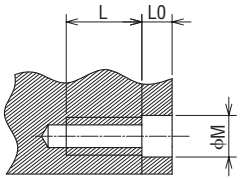
Readjusting the operating duty also influences the temperature rise.
(In the above figure, the running duty is 75%.)

Installation of Compact Linear Actuators

Installation Methods

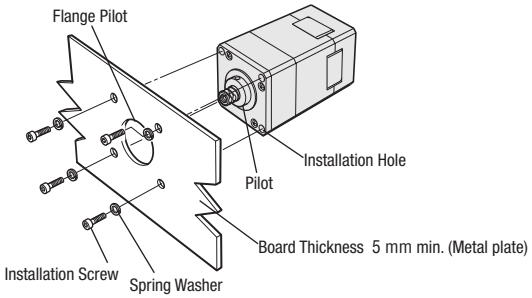
1. Insert the pilot located on the actuator installation surface into the installation plate's counterbore hole or the flange pilot.
2. Install the actuator to an installation plate or equipment using installation holes of the actuator (①), or using an installation plate (②) (sold separately).

Configurations of Installation Hole (Unit mm)



Product Name	Nominal Diameter of Screw	Tightening torque N·m	Installation Hole Dimensions (mm)		
			ϕM	L0	L (Effective screw depth)
DRL20	M2	0.4	2.3	2	5
DRS28/DRL28	M2.5	0.6	3	2	6
DRS42	M4	1.8	4.5	2	8
DRL42	M4	1.8	–	–	8
DRS60	M5	5.0	5.5	4	8
DRL60	M5	5.0	5.5	4	10

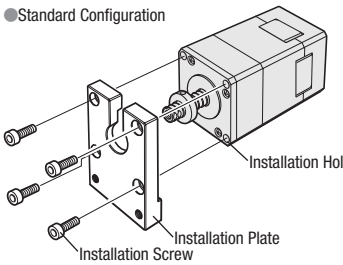
① Using Installation Holes of an Actuator



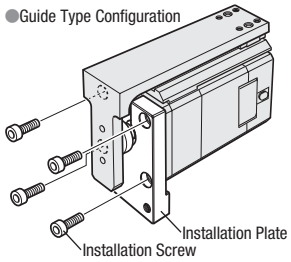
(The figure shows installation for **DRL** Series standard type.)

② Using a Installation Plate (Sold separately)

Standard Configuration

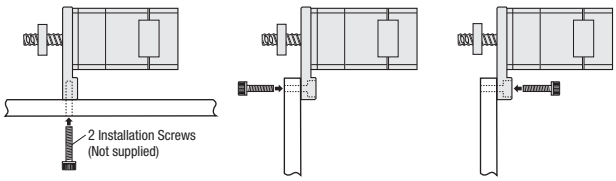


Guide Type Configuration



(**Accessories** → Page F-192)

There are 3 fixing methods for installing an actuator to equipment.



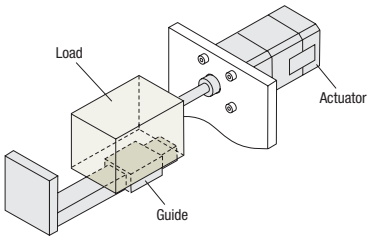
Installation Conditions

Install the actuator in locations that meet the following conditions. Use in a location that does not satisfy these conditions could damage the products.

- Inside an enclosure installed indoors (with ventilation holes provided)
- Operating Ambient Temperature: 0 to +40°C (non-freezing)
- Operating Ambient Humidity: 85% or less (Non-condensing)
- Not exposed to an explosive atmosphere, toxic gases (sulfidizing gas, etc.) or liquids
- Not exposed to direct sunlight.
- Not exposed to significant amounts of dust or iron powder
- Do not expose to water (rain, water droplets), oil (oil droplets) or other liquids
- Not exposed to air having high salt content
- Not exposed to continuous vibration or excessive shock
- Not subjected to significant electromagnetic noise caused by welders, power equipment, etc.
- Not exposed to radioactive materials, magnetic field or vacuum conditions

Anti-Spin Mechanism

The moving part of the standard configuration actuator does not have an anti-spin mechanism. Always provide an external anti-spin mechanism, such as a guide for positioning operations. In addition, make sure the load is supported with a linear-guide, etc.

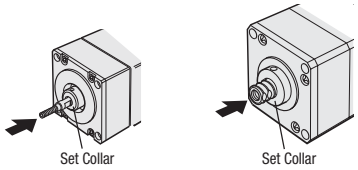


Load Installation Methods

[Standard Configuration]

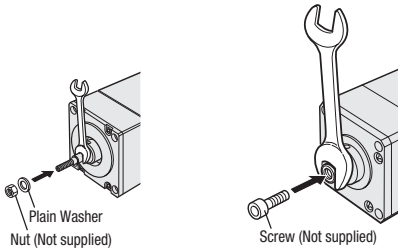
1. Retract the screw shaft until it stops at the set collar.

DRS28, **DRL20**, **DRL28** **DRS42**, **DRL42**, **DRS60**, **DRL60**



2. Holding the flat section of the screw shaft with a wrench, fix the load with a screw (or nut, in the case of the **DRS28**, **DRL20**, **DRL28**).

DRS28, **DRL20**, **DRL28** **DRS42**, **DRL42**, **DRS60**, **DRL60**

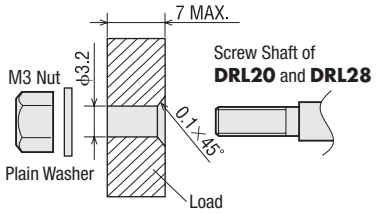


Product Name	Nominal Diameter of Screw/Nut	Tightening torque N·m
DRL20	M3 Nut	0.6
DRS28/DRL28	M3 Nut	0.6
DRS42/DRL42	M4 Screw	1.8
DRS60/DRL60	M8 Screw	5.0

- Use of a thread-locking fluid is recommended.

Note

- When placing the load on the standard configuration of the **DRL20** or **DRL28**, chamfer the load installation holes to 0.1. If the end face of the screw shaft is chamfered excessively, the screw shaft may tilt and cause the actuator to malfunction or reduce the actuator life.

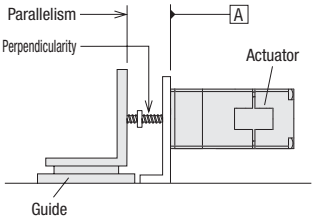


Installation Accuracy

When connecting the load, the accuracy shown in the figure below is required. Machine and assemble the installation parts to or above this accuracy. Poor installation accuracy may result in a malfunction or shortened service life.

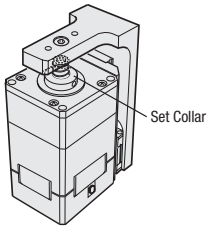
Perpendicularity
DRL20: ⊥ ϕ0.02 A
DRL28: ⊥ ϕ0.03 A
DRL42, **DRL60**: ⊥ ϕ0.05 A

Parallelism
DRL20: // 0.02 A
DRL28: // 0.03 A
DRL42, **DRL60**: // 0.05 A



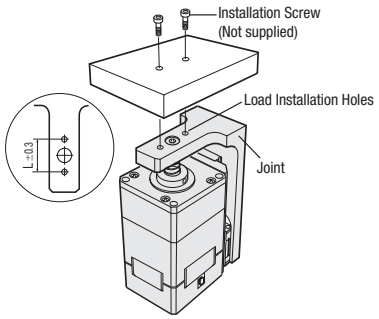
[Guide Type Configuration]

1. Retract the screw shaft until it stops at the set collar.



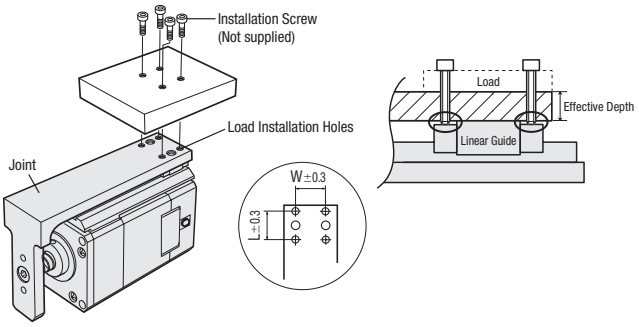
2. Fix the load with a screw.

- When Using Load-Installation Holes on the Screw Shaft Side
  Install the load using installation screws on the load-installation holes of the joint.



Product Name	Nominal Diameter of Screw	Tightening Torque N·m	Effective Screw Depth mm	L mm
DRL20	M2	0.4	4	15
DRL28	M2.5	0.6	5	16
DRL42	M4	1.0	7.5	20
DRL60	M5	2.0	11.5	30

- When Using Load-Installation Holes on the Linear Guide Side
  Install the load using installation screws on the load-installation holes of the joint. Use screws whose length does not exceed the effective depth in the linear guide.



Product Name	Nominal Diameter of Screw	Tightening Torque N·m	Effective Screw Depth mm	L mm	W mm
DRL20	M2	0.4	4	18	12
DRL28	M2.5	0.6	3.5	14	12
DRL42	M4	1.0	5.5	24	19
DRL60	M5	2.0	5.5	22	28

Note

- When installing a load to the guide type configuration, do not disconnect the ball screw from the joint. This may cause an offset when assembling, resulting in malfunction.
- Do not apply an overhung load to the joint of the guide type configuration. Also, do not apply a load moment to the joint of the guide type configuration of the **DRL20** and **DRL28**. Doing so may result in a malfunction or shortened service life of actuator.
- Remove the load from the actuator before transporting the equipment. Failure to do so may result in equipment damage.

Maintenance of Grease

If grease on the screw shaft and linear guide of the compact linear actuator has become dirty, wipe it off with waste cloth and then apply new grease. Check the grease once after the first week of operation. After that, check it approximately once a month.
The grease used for the maintenance of the product is shown below.

Series	Ball Screw	Linear Guide
DRL Series (Rolled/Ground ball screw types)	AFC (Manufactured by THK)	Marutemp PS No.2 (Manufactured by Kyodo Yushi)

Glossary

Motorized Linear Slides and Cylinders

Positioning Time Coefficient

The positioning time required at the maximum speed corresponding to the applicable stroke is calculated by multiplying the positioning time coefficient with the positioning time needed when the motorized actuator is operated at the maximum specification. The longer the stroke, the lower is the maximum drivable speed to prevent the ball screw from reaching a critical speed. (For the positioning time coefficient of each product, refer to "Positioning distance - Positioning time.")

Operating Duty

The ratio of the time it takes the motorized actuator to perform one operation vs. the time during which it is stopped (=operating ratio of the motor).
Oriental Motor's motorized actuators should be used at an operating duty of 50% or less. If the operation duty exceeds 50%, the motor surface temperature may rise to 100˚C or more, which will reduce the motor life.
When the ambient temperature of the product is at +40˚C or below, the motor surface temperature should not exceed 100˚C as long as the operating duty remains 50% or below.
If the operation duty will exceed 50%, take appropriate measures to keep the motor surface temperature under 100˚C.

Overhung Load

Overhung load is the load applied vertically to the traveling direction of cylinder output shaft (rod). Note that a permissible value is determined for each product and the overhung load cannot be applied to some products.

Acceleration, Acceleration/Deceleration Rate

The acceleration rate indicates the variation in speed per unit time.
The acceleration rate is expressed in "m/s^2" when the SI international system of units is followed, or in the gravitational unit of "G" based on gravitational acceleration. The conversion formula is as follows:

1 G ≒ 9.807 m/s^2

The acceleration rate is indicated as the acceleration/deceleration rate when using Oriental Motor's controllers (except for linear motion controllers).
The acceleration/deceleration rate is expressed in ms/kHz.
The conversion formula is as follows:

$$\text{Acceleration/deceleration rate [ms/kHz]} = \frac{\text{Resolution [mm]} \times 10^3}{\text{Acceleration [m/s}^2\text{]}}$$

Repetitive positioning accuracy

This is a value for constant temperature and constant load conditions indicating the variation error of accuracy of the stop position that generates when positioning is performed repeatedly to the same positioning point in the same direction.

Grease

This refers to the class of lubricants applied to lubricate the movement of guides and moving parts of the ball screw.
Grease forms an oil film on metal surface to reduce wear and friction, thereby prolonging the life and preventing rust. Linear slides require periodic maintenance (greasing) according to their use conditions.

Maximum Speed

The longer the stroke, the lower the maximum speed. It is because the ball screws become unable to move when they rotate at the resonance point (critical speed) and the resonance occurs due to the natural frequency of the screw shaft. Confirm the maximum speed of desired stroke with the linear slide/cylinder specifications. The critical speed is related to the ball screw length and screw diameter. The ball screw diameter of each series is shown below.

Series	Product	Ball Screw Diameter mm
EZSII Series **EZCII** Series	**EZS3/EZS4/EZC4/EZA4**	ϕ8
	EZS6/EZC6/EZA6	ϕ12

Maximum Load Moment (Pitching direction, yawing direction, rolling direction)

The life of each motorized actuator is defined as a corresponding travel distance, which is affected by the moment that can be tolerated by the motorized actuator. The maximum load moment indicates the maximum value of moment with which the linear slide can reach its specified life.

Lubrication System QZ (Manufactured by THK)

This is a lubrication system that supplies an appropriate amount of lubricant to the raceways of the ball screw. An oil film is maintained between the rolling element and raceways, which extends the maintenance interval considerably.

Maintenance-Free for Long-Term Performance

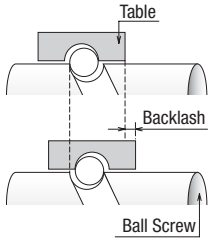
Here, "maintenance" specifically refers to the maintenance of grease.
The maintenance interval can be extended considerably through the use of a lubrication system QZ.

Installation Reference Surface

Reference surfaces used for installing are provided on the body of the linear slide. These reference surfaces are used to install the linear slide in the same position after removal for maintenance, etc.

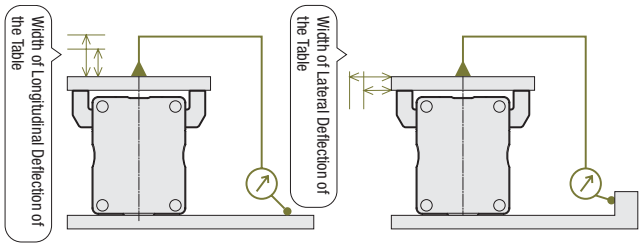
Backlash

This refers to the play along the ball within the raceways of the ball screw and screw nut.



Traveling Parallelism

The **EZSII** Series achieves high traveling parallelism because the linear guide can be used directly as the installation surface (within 0.03 mm).
The band of fluctuation in the distance between the table and reference plane is equivalent to the table travels with the linear slide installed on the reference plane as shown.

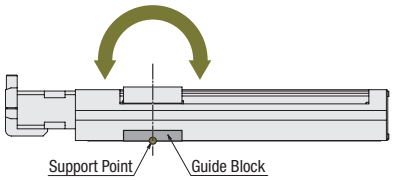


"QZ" is a registered trademark of the THK Co., Ltd.

Load Moment

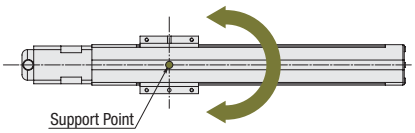
When the load acting upon the table extends beyond the table in the longitudinal, lateral or vertical direction, the linear slide receives a torsional force. This torsional force is referred to as "load moment." As shown in the illustrations below, moments can be applied in three directions: pitching (M_P), yawing (M_Y) and rolling (M_R). In a condition where moment is not applied in two of these three directions, the permissible moment applied only in one direction is defined as the maximum value of moment.
Permissible values of the moments in respective directions are specified for each product.

Pitching Direction (M_P)



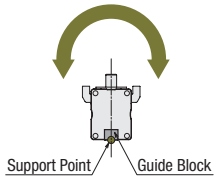
(Linear slide bottom face, center of table)

Yawing Direction (M_Y)



(Center of table)

Rolling Direction (M_R)



(Linear slide bottom face, center of table)

Ball Retainer (Manufactured by THK)

A Ball Retainer holds individual balls in a manner preventing contact between adjacent balls and thereby allowing smooth rotation of balls. The LM Guide adopting a Ball Retainer is structured so that the balls move along a circular path while being held by the Ball Retainer.
This structure provides the following benefits:

① The balls do not make contact with each other. Consequently, the grease has more holding force, resulting in a longer service life and longer maintenance-free period. Also, less dust is produced because dispersal of grease is kept to a minimum.
② The balls do not collide with one another. This enables them to move smoothly and produce less noise.
③ The balls do not make contact with each other and therefore less heat is generated, making this structure ideal for high speed operation.

"Ball Retainer" and "LM Guide" are registered trademarks of THK.

Lost Motion

The difference between positions achieved by repeated positioning operations to the same positioning point performed in the positive and negative directions.
The lost motion of each series is shown in the table below.

Series	Lost motion mm
EZSII Series	0.1
EZCII Series	0.15

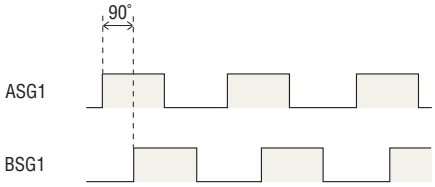
Controller

A-Phase/B-Phase Output

While the linear slide table or cylinder rod is moving, A-phase and B-phase pulses are output continuously.

- A Phase: The table or rod position can be monitored by counting the number of output pulses.
- B Phase: The B-phase output has a 90˚ phase difference compared with the A-phase output.

The traveling direction of the table or rod can be identified from the B-phase output level at the rising edge of the A-phase output pulse.



DIR.-A Pulse (2-Pulse) Input Signal Model

ASG1 Output: Pulses corresponding to the actuator operation are output.
BSG1 Output: This output is used to identify the traveling direction of the table or rod. There is a 90˚ phase difference compared with the ASG1 output. The traveling direction of the table or rod can be identified from the B-phase (BSG1) output level at the leading edge of the A-phase (ASG1) output pulse.

HOMELS (Home Sensor)

This sensor is used to determine the reference point in positioning operation. It is used during return-to-home operation in 3-sensor mode.

I/O Power Supply

This power supply is needed to use I/O signals such as START input and END output. Always connect an I/O power supply.

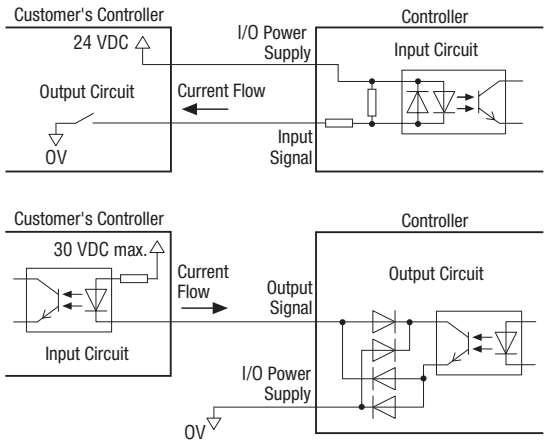
+LS/−LS (Limit sensor)

These are limit sensors in the + and − directions.
These sensors are used to prevent the linear slide table or cylinder rod from exceeding the mechanical limit position.
When a +LS or −LS sensor signal is detected, the operation will stop and an alarm will be generated. During return-to-home operation in 2-sensor mode, the position at which a +LS or −LS sensor is detected can be used as the home.

Sink Logic (NPN specification)

When the output circuit turns ON, current flows into the output circuit.

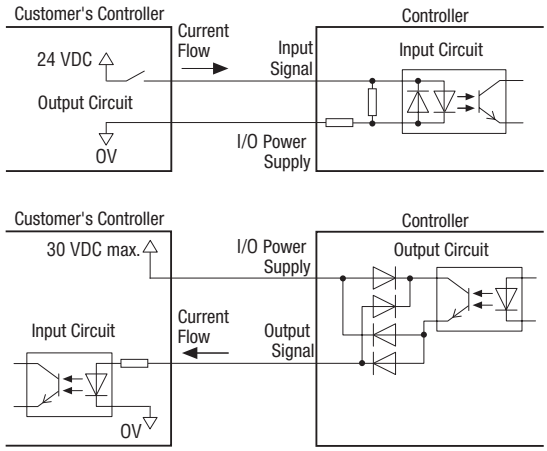
(Example) Controller Connection Examples
(For **EZSII**/**EZSII** for Cleanroom/**EZCII** Series)



Source Logic (PNP specification)

When the output circuit turns ON, current flows out of the output circuit.

(Example) Controller Connection Examples
(For **EZSII**/**EZSII** for Cleanroom/**EZCII** Series)



Depending on the wiring, both NPN and PNP specifications are available for the I/O specifications of linear motion controller **EZSII** Series/**EZSII** Series for Cleanroom Use/**EZCII** Series.

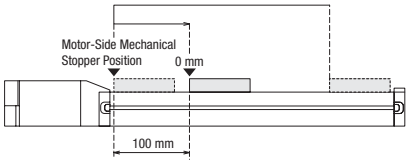
Positioning Completion Area

This is a band around the command position specified in the positioning, within which the positioning is deemed completed. When the linear slide table or cylinder rod enters this positioning completion area (specified in mm), the END output (positioning completion output) will turn ON.

Home Offset

A home offset is used to define the home position (current position = 0 mm) at a position a certain distance away from the position detected in return-to-home operation (mechanical stopper position, ±LS or HOMELS position). When setting a home offset, the actuator will complete return-to-home operation and then automatically move to the home offset position before stopping.
This setting is useful when you wish to set the home position at a position away from a mechanical stopper position or when a sensor cannot be installed in the position you wish to set as the home position.

(Example): Home offset = 100 mm, Return-to-home operation=Push-motion operation



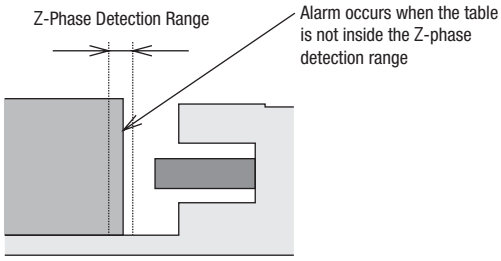
A position 100 mm away from the motor side mechanical stopper position is set as the home position.

Return-To-Home Operation

This is an operation to confirm the home (current position = 0 mm) for positioning operation. Return-to-home operation is performed in one of the following three modes:

- Push-motion: A return-to-home operation based on the position where the table or rod contacts the mechanical stopper of motorized actuator. Since no sensor is used, it is called "sensorless return-to-home operation."
  The maximum speed of the push-motion return-to-home operation is as follows.
  12 mm Lead :100 mm/s
  6 mm Lead :50 mm/s
  3 mm Lead :50 mm/s
- 2-Sensor Mode: A return-to-home operation that uses sensors. The position at which a +LS or −LS sensor signal is detected is set as the home position. Which sensor is used as the home is set with the controller.
- 3-Sensor Mode: Three sensors, namely +LS, −LS and HOMELS are used. In this return-to-home operation, the position at which a HOMELS sensor signal is detected is set as the home.

The return-to-home operation with higher reliability is possible by checking with Z-phase signal when the sensorless return-to-home operation is completed.
The function can be operated by enabling the "Highly accurate return-to-home". At the return-to-home operation, check if the Z-phase is output at the home position when returning the actuator by the fixed amount after the table or rod contacts. When a foreign particle is caught in or the Z-phase cannot be detected, the return-to-home operation is judged as failure (alarm). (Initial value of Z-phase range: Motor rotation angle 7.2° the value can be changed.)

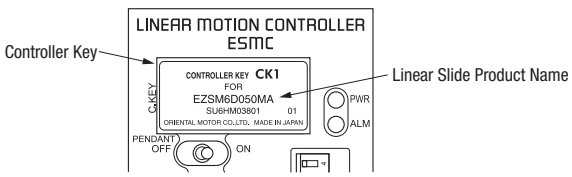


Controller Key

Use this on **EZSII**/**EZSII** for Cleanroom/**EZCII** Series linear motion controller. The controller key stores parameters related to linear slide control.
The following parameters are automatically set in accordance with the specifications of the linear slide/controller combination.

- I/O Parameter: Enable or disable LS detection
- Home Parameter: Return-to-home mode
- Speed Parameters: Starting speed, acceleration, deceleration, common operating speed
- Common Parameter: Upper soft limit
- Internal Settings (Cannot be changed): Resolution, operating speed (maximum value), acceleration/deceleration (maximum value), settings related to motor control

Always check that the linear slide product name shown on the controller key matches the linear slide product name connected. If the names do not match, the linear slide cannot be operated as specified.



Controller Mode, Driver Mode

- Controller Mode: A mode in which data stored in the controller is used to operate the motorized actuator.
- Driver Mode: A mode in which pulse signals output from the user's controller are used to operate the motorized actuator.

Main Power Supply

This power supply is needed to drive the motor. Always connect when using. The required current to be supplied from the the main power supply of linear motion controller **EZSII** Series/**EZSII** Series for Cleanroom Use/**EZCII** Series varies depending on the connected motorized actuators.

Control Power Source

This power supply is needed to use the controller's functions such as data setting and operation execution. Always connect when using.

Sensor Power Supply

This power supply is needed when sensors such as ±LS and HOMELS are connected to the controller. Always connect a sensor power supply when sensors are used.

Soft Limits

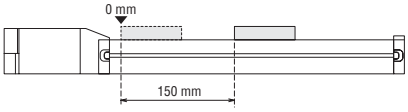
The traveling range corresponding to the stroke is predefined in the controller. The upper limit and lower limit of the traveling range set in the controller are referred to as "+ soft limit" and "− soft limit," respectively. If the linear slide table or cylinder rod is operated to a position beyond a soft limit, the table will stop at the soft limit position and an alarm will be generated.

Preset

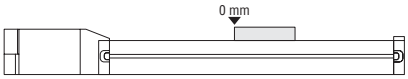
A preset is used to change the predefined current position. You can enter a desired preset position.

(Example) When the preset position = 0 mm

① Stop the linear slide table at the 150 mm position, and then turn the preset input ON.



② In each positioning operation performed after ①, the position of ① is used as the 0 mm position.



Safety and Standards

Emergency Stop

This is a function to stop the machine with a single human action in order to avoid or reduce potential harm to personnel and damage to machines or loads in the process.

In general, an emergency stop circuit is configured by combining mechanical parts such as relays and switches to shut down the power source (or cut off the motor power supply in the case of a linear slide).
Stopping the motor while it is still excited, by the controller's stop function or stopping the motor using a software-operated device such as a programmable controller or computer can cause malfunctions due to a programming error or noise. By cutting off the motor power by non-software means, an emergency stop can be actuated more reliably.
[Refer to EN ISO 13850 for details.]

Risk Assessment

This refers to assessment of potential dangers associated with the machine.
[Refer to EN ISO 12100 for details.]

Estimate risks based on the usage of the machine or potential dangers associated with machine itself, and determine the necessary countermeasures. Use the risk assessment result to select the required emergency stop category, control system performance level and category.

Machines using the same linear slide may have different risk assessment results depending on the design, installation conditions of safety covers over the exterior surface and other conditions of each machine. You must conduct risk assessment of your specific machine to select appropriate categories.

Stop Category

Stop functions to stop a machine are classified into three categories as specified below:

Stop category 0: Stop the machine by directly cutting off the power to the machine's actuator. (In the case of a linear slide, the motor power is cut off.)
Stop category 1: This is a controlled stop where power is supplied to stop the machine's actuator, and then the power is cut off once the actuator has stopped. (This method is used in situations where suddenly cutting off the motor power may cause other dangers.)
Stop category 2: This is a controlled stop where power remains supplied to the machine's actuator. (In the case of a linear slide, the linear slide is stopped while the motor is still excited.)

An emergency stop must conform to the stop category 0 or 1. Which category should be selected is determined based on the risk assessment of user's equipment.
[Refer to EN 60204-1 (IEC 60204-1) for details.]

Category

This is a classification into five levels including Category B and 1 to 4 regarding the ability to maintain safe function in the circuit structure should a safety control system fail.
[Refer to EN ISO 13849-1 for details.]

Performance Level

The performance level is classified using five levels (a to e) regarding safety performance for the control system based on control system category, product reliability and failure detection performance.
[Refer to EN ISO 13849-1 for details.]