Selection Calculations For Linear & Rotary Actuators

Electric Linear Actuators

First determine your series, then select your product.
Select the actuator that you will use based on the following flow charts:

Selection Procedure

An overview of the procedure is explained below.

Check the Required Specifications (Equipment specifications)	● Check the required specification for the electric linear actuator based on the equipment specifications. The general items are explained below. • Frame size • Load mass • Thrust • Table height • Stroke • Pushing force • Speed
▼	
Tentative Selection of Linear & Rotary Actuator	● Check that the positioning time of the tentatively selected product satisfies the requirements. The 2 confirmation methods are shown below: ① Use the "Positioning Distance – Positioning Time" graph. ② Calculate using a formula. (Refer to page H-28.) If the required positioning time is satisfied, check the operating speed and acceleration.
▼	
Selection Calculation	● Take into account the calculated acceleration conditions and check that the dynamic permissible moment applied to the electric linear actuators is within the specified values. Refer to page H-19 for the load moment formula.

Sizing and Selection Service

We provide selection services for motor selection from load calculations that requires time and effort.

● Internet

Simple requests for motors can be made using the selection form on our website.
www.orientalmotor.eu

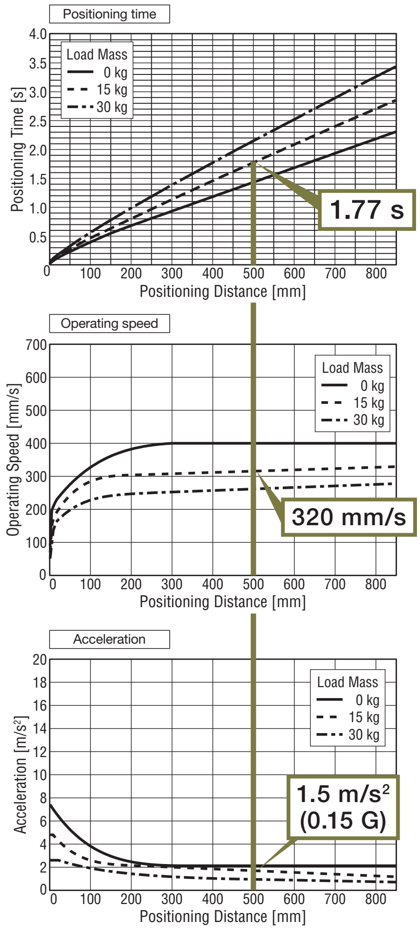
Tentative Selection of Linear Actuators

Confirming Using the Positioning Distance – Positioning Time Graph:

(1) Use the graph to confirm the positioning time necessary for a positioning distance of 500 mm.
(2) If the positioning time requirement is satisfied, check the operating speed and acceleration.
(3) If the positioning time requirement is not satisfied, select a different product.

Product Name : **EAS6**
Lead Screw Pitch : 6 mm
Power Supply Input : Single-Phase 230 VAC

<Example operation>
Drive Direction : Vertical
Load Mass : 15 kg
Positioning Distance : 500 mm
Positioning Time : 1.77 s
Operating Speed : 320 mm/s
Acceleration : 1.5 m/s² (0.15 G)



For Electric Linear Slides

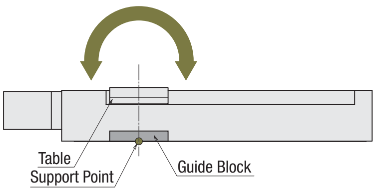
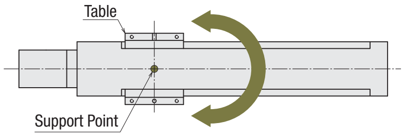
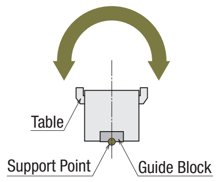
Positioning Time Coefficient

Stroke [mm]	Load Mass					
	Horizontal Direction Installation			Vertical Direction Installation		
	0 kg	30 kg	60 kg	0 kg	15 kg	30 kg
50～550	1.0	1.0	1.0	1.0	1.0	1.0
600	1.1	1.1	1.1	1.1	1.0	1.0
650	1.2	1.2	1.2	1.2	1.0	1.0
700	1.4	1.4	1.3	1.4	1.2	1.0
750	1.6	1.6	1.5	1.6	1.3	1.1
800	1.9	1.8	1.7	1.8	1.5	1.3
850	2.1	2.0	2.0	2.1	1.7	1.4

Approximate the positioning time by multiplying the positioning time derived from the graph by the positioning time coefficient of the stroke.

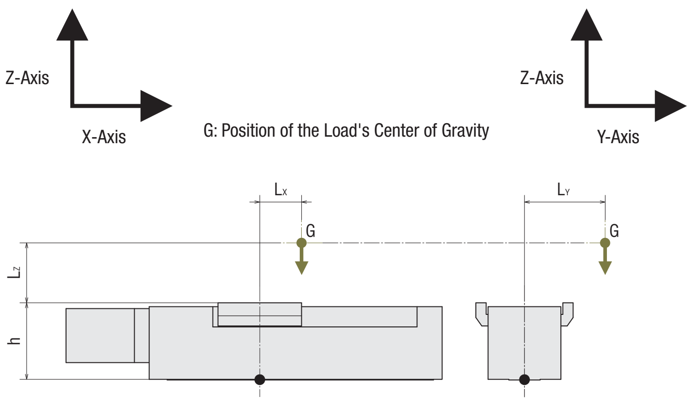
Calculating the Load Moment of Electric Linear Slides

When a load is transported with electric linear slides, the load moment acts on the linear guide if the position of the load's center of gravity is offset from the center of the table. The direction of action applies to 3 directions: pitching (M_P), yawing (M_Y), rolling (M_R), depending on the position of the offset.

Pitching Direction (M_P)	Yawing Direction (M_Y)	Rolling Direction (M_R)
		
(Linear Slide Bottom Face, Center of Table)	(Center of Table)	(Linear Slide Bottom Face, Center of Table)

Even though the selected electric linear slides satisfy the load mass and positioning time requirements, when the center of gravity of the load is overhung from the table's center, the run life may decrease as a result of the load moment. Load moment calculations must be completed and whether the conditions are within specifications values must be checked. The moment applied under static conditions is the static permissible moment. The moment applied under movement is the dynamic permissible moment, and both must be checked.

Calculate the load moment of the electric linear slides based on loads that are applied. Check that the static permissible moment and dynamic permissible moment are within limits and check that strength is sufficient.



m: Load mass (kg)
g: Gravitational acceleration 9.807 (m/s^2)
a: Acceleration (m/s^2)
h: Electric linear slide table height (m)

L_X: Overhung distance in the direction of the x-axis (m)
L_Y: Overhung distance in the direction of the y-axis (m)
L_Z: Overhung distance in the direction of the z-axis (m)

ΔM_P: Load moment in the pitching direction (N·m)
ΔM_Y: Load moment in the yawing direction (N·m)
ΔM_R: Load moment in the rolling direction (N·m)
M_P: Permissible moment in the pitching direction (N·m)
M_Y: Permissible moment in the yawing direction (N·m)
M_R: Permissible moment in the rolling direction (N·m)

● Load Moment Formula:

$$\frac{|\Delta M_P|}{M_P} + \frac{|\Delta M_Y|}{M_Y} + \frac{|\Delta M_R|}{M_R} \leqq 1$$

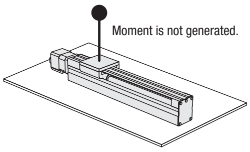
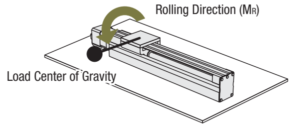
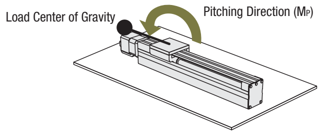
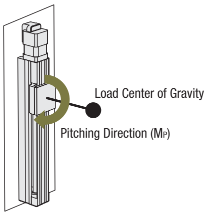
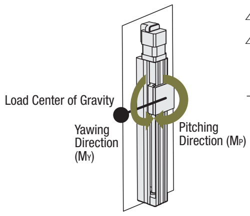
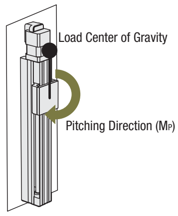
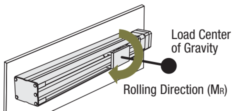
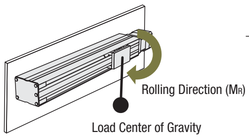
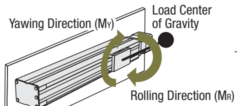
When there are several overhung loads, etc., it is determined by the sum of moments from all loads.

● For Multiple Loads (n)

$$\frac{|\Delta M_{P1} + \Delta M_{P2} + \cdots \Delta M_{Pn}|}{M_P} + \frac{|\Delta M_{Y1} + \Delta M_{Y2} + \cdots \Delta M_{Yn}|}{M_Y} + \frac{|\Delta M_{R1} + \Delta M_{R2} + \cdots \Delta M_{Rn}|}{M_R} \leqq 1$$

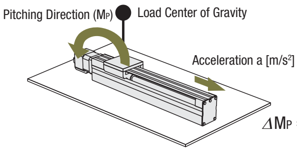
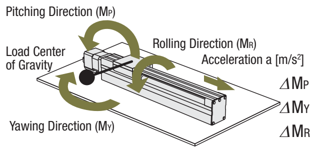
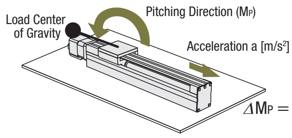
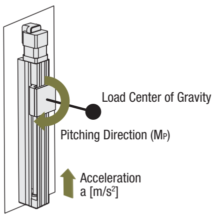
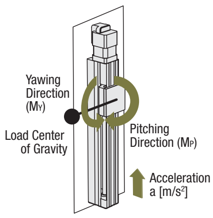
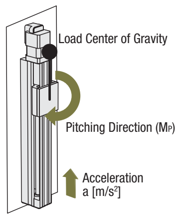
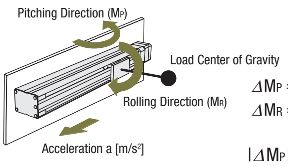
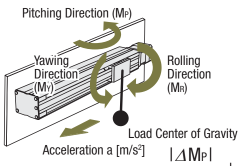
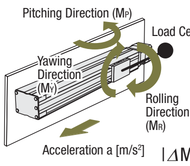
●Concept of Static Moment Application

Check the static moment when the load moment is applied to the stopped electric linear slide and compare it with the static permissible moment or the max. load moment.

	Position of the Load's Center of Gravity ①	Position of the Load's Center of Gravity ②	Position of the Load's Center of Gravity ③
Horizontal		 $\Delta M_R = m \cdot g \cdot L_Y \quad \frac{\lvert\Delta M_R\rvert}{M_R} \leqq 1$	 $\Delta M_P = m \cdot g \cdot L_X \quad \frac{\lvert\Delta M_P\rvert}{M_P} \leqq 1$
Vertical	 $\Delta M_P = m \cdot g \cdot (L_Z + h)$ $\frac{\lvert\Delta M_P\rvert}{M_P} \leqq 1$	 $\Delta M_P = m \cdot g \cdot (L_Z + h)$ $\Delta M_Y = m \cdot g \cdot L_Y$ $\frac{\lvert\Delta M_P\rvert}{M_P} + \frac{\lvert\Delta M_Y\rvert}{M_Y} \leqq 1$	 $\Delta M_P = m \cdot g \cdot (L_Z + h)$ $\frac{\lvert\Delta M_P\rvert}{M_P} \leqq 1$
Wall Mounting	 $\Delta M_R = m \cdot g \cdot (L_Z + h)$ $\frac{\lvert\Delta M_R\rvert}{M_R} \leqq 1$	 $\Delta M_R = m \cdot g \cdot (L_Z + h)$ $\frac{\lvert\Delta M_R\rvert}{M_R} \leqq 1$	 $\Delta M_Y = m \cdot g \cdot L_X$ $\Delta M_R = m \cdot g \cdot (L_Z + h)$ $\frac{\lvert\Delta M_Y\rvert}{M_Y} + \frac{\lvert\Delta M_R\rvert}{M_R} \leqq 1$

●Concept of Dynamic Moment Application

When the load moment is applied during electric linear slide operation, check that the dynamic moment is not exceeded by taking acceleration into account, and compare it with the dynamic permissible moment or the max. load moment.

	Position of the Load's Center of Gravity ①	Position of the Load's Center of Gravity ②	Position of the Load's Center of Gravity ③
Horizontal	 $\Delta M_P = m \cdot a \cdot (L_Z + h)$ $\frac{\lvert\Delta M_P\rvert}{M_P} \leqq 1$	 $\Delta M_P = m \cdot a \cdot (L_Z + h)$ $\Delta M_Y = m \cdot a \cdot L_Y$ $\Delta M_R = m \cdot g \cdot L_Y$ $\frac{\lvert\Delta M_P\rvert}{M_P} + \frac{\lvert\Delta M_Y\rvert}{M_Y} + \frac{\lvert\Delta M_R\rvert}{M_R} \leqq 1$	 $\Delta M_P = m \cdot g \cdot L_X + m \cdot a \cdot (L_Z + h)$ $\frac{\lvert\Delta M_P\rvert}{M_P} \leqq 1$
Vertical	 $\Delta M_P = m \cdot g \cdot (L_Z + h) + m \cdot a \cdot (L_Z + h)$ $\frac{\lvert\Delta M_P\rvert}{M_P} \leqq 1$	 $\Delta M_P = m \cdot g \cdot (L_Z + h) + m \cdot a \cdot (L_Z + h)$ $\Delta M_Y = m \cdot g \cdot L_Y + m \cdot a \cdot L_Y$ $\frac{\lvert\Delta M_P\rvert}{M_P} + \frac{\lvert\Delta M_Y\rvert}{M_Y} \leqq 1$	 $\Delta M_P = m \cdot g \cdot (L_Z + h) + m \cdot a \cdot (L_Z + h)$ $\frac{\lvert\Delta M_P\rvert}{M_P} \leqq 1$
Wall Mounting	 $\Delta M_P = m \cdot a \cdot (L_Z + h)$ $\Delta M_R = m \cdot g \cdot (L_Z + h)$ $\frac{\lvert\Delta M_P\rvert}{M_P} + \frac{\lvert\Delta M_R\rvert}{M_R} \leqq 1$	 $\Delta M_P = m \cdot a \cdot (L_Z + h)$ $\Delta M_Y = m \cdot a \cdot L_Y$ $\Delta M_R = m \cdot g \cdot (L_Z + h)$ $\frac{\lvert\Delta M_P\rvert}{M_P} + \frac{\lvert\Delta M_Y\rvert}{M_Y} + \frac{\lvert\Delta M_R\rvert}{M_R} \leqq 1$	 $\Delta M_P = m \cdot a \cdot (L_Z + h)$ $\Delta M_Y = m \cdot g \cdot L_X$ $\Delta M_R = m \cdot g \cdot (L_Z + h)$ $\frac{\lvert\Delta M_P\rvert}{M_P} + \frac{\lvert\Delta M_Y\rvert}{M_Y} + \frac{\lvert\Delta M_R\rvert}{M_R} \leqq 1$

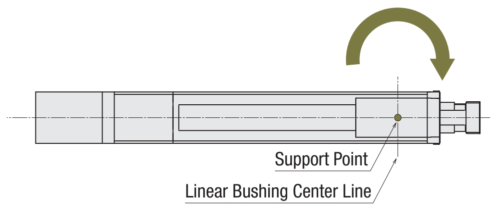
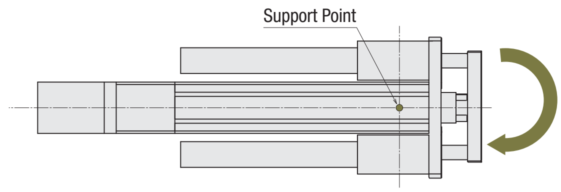
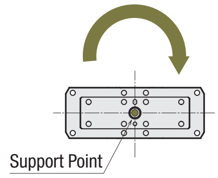
The expected life distance of the linear guide of the electric slide is designed as reference for the expected life of each series.
If the load moment calculates to 1 max., the expected life of the linear guide will be shorter than it would otherwise. Use the formula below to approximate the expected life distance.

$$\text{Expected life distance (km)} = 5000\ \text{km}^{*} \times \left(\frac{1}{\frac{|\Delta M_P|}{M_P} + \frac{|\Delta M_Y|}{M_Y} + \frac{|\Delta M_R|}{M_R}} \right)^3$$

✻The expected life distance of the **EAS2** linear guide is 3000 km.
Refer to "■Service Life of an Electrical Linear Actuator" on page H-35 for the expected life distance of an electric linear slide with bearings and ball screws.

Calculating the Load Moment of Electric Cylinders (Units equipped with shaft guide only)

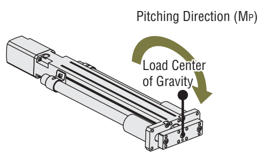
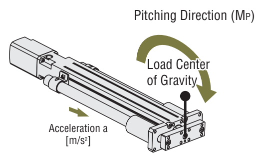
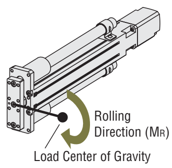
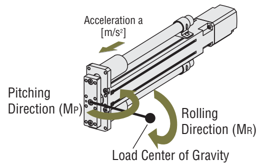
When a load is transported with an electric cylinder (unit equipped with shaft guide only), a load moment affects the shaft guide if the position of the load's center of gravity is offset from the center (support point) of the shaft guide. The direction of action applies to 3 directions: pitching (M_P), yawing (M_Y), and rolling (M_R), depending on the position of the offset.

Pitching Direction (M_P)	Yawing Direction (M_Y)	Rolling Direction (M_R)
		

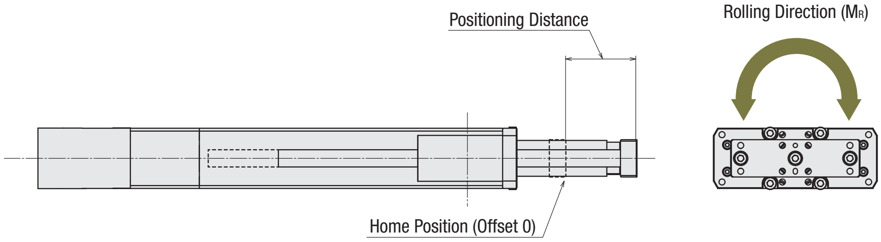
Even when the selected electric cylinders satisfy the load mass and positioning time requirements, if the center of gravity of the load is offset from the center (support point) of the shaft guide, the run life may decrease as a result of the load moment. Load moment calculations must be completed and whether the conditions are within specifications values must be checked. The moment applied under static conditions is the static permissible moment. The moment applied under movement is the dynamic permissible moment, and both must be checked.

●Concept of Load Moment Application (When Used in the Horizontal and Wall Mounting Directions)

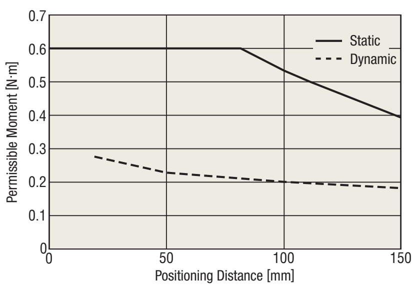
When the load moment is applied while the electric cylinders (units equipped with shaft guide only) are stopped or operated, refer to the characteristics diagram (■Horizontal Transportable Mass) on the page where the electric cylinder specifications are listed.
The characteristics diagram is common to the static moment and the dynamic moment.

	Stopped	Operating
Horizontal		
Wall Mounting		

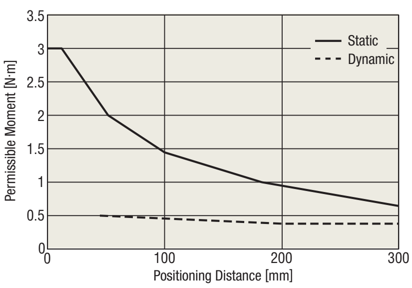
◇Permissible moment in the rolling direction (M_R)



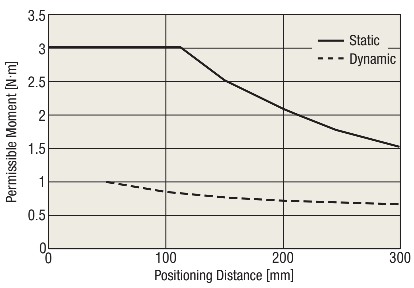
•EAC2W



•EAC4W

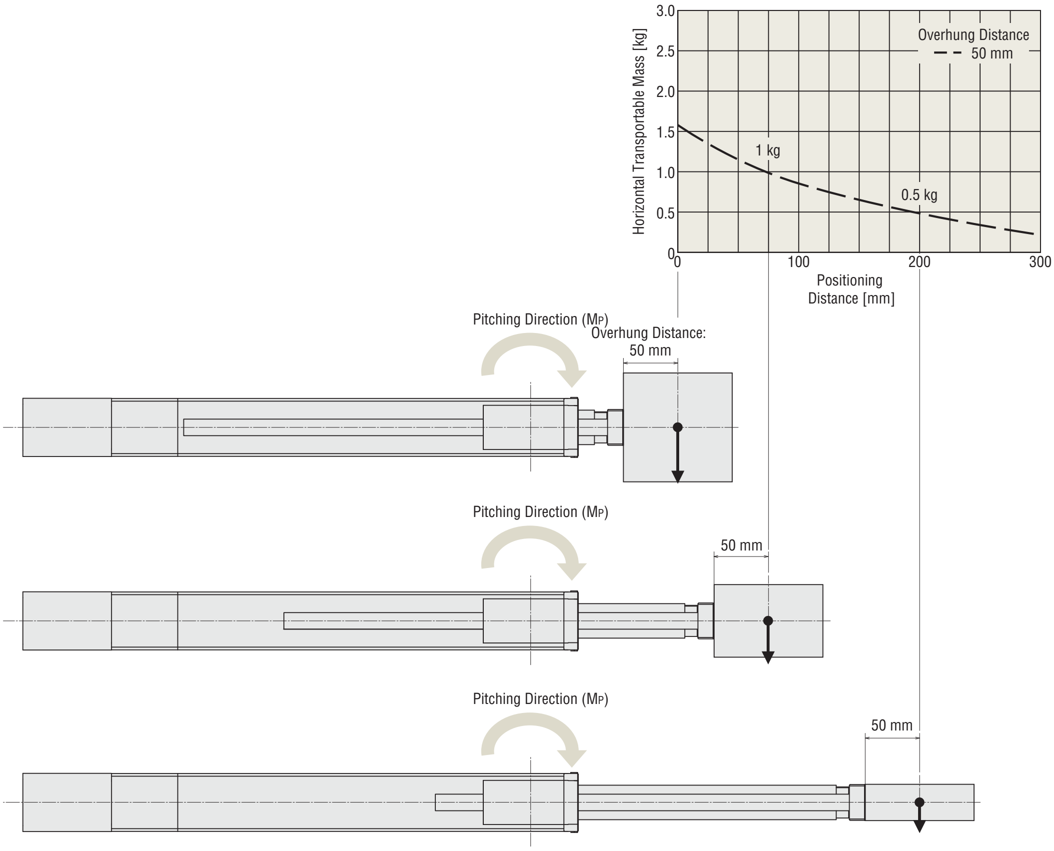


•EAC6W



◇Permissible moment in the pitching direction (M_P)

When installed in the horizontal or wall mounting direction, refer to the calculation results in the characteristics diagram, taking into account the load moment formula.



●Concept of Load Moment Application (When Used Horizontally)

Calculate the load moment of the electric cylinder (unit equipped with shaft guide only) based on loads that are applied. Check that the strength of the static permissible moment and dynamic permissible moment are sufficient.

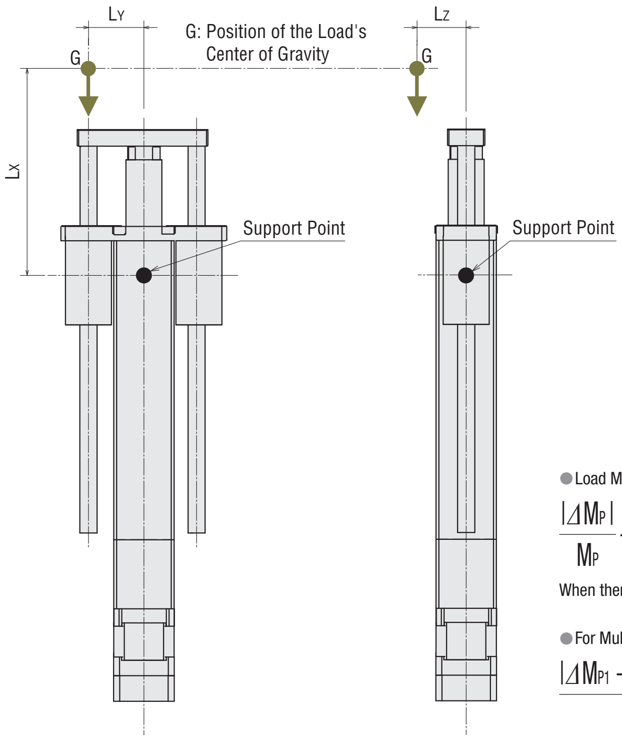
m: Load mass (kg)
g : Gravitational acceleration 9.807 [m/s²]
a : Acceleration [m/s²]

L_X: Overhung distance in the direction of the x-axis (m)
L_Y: Overhung distance in the direction of the y-axis (m)
L_Z: Overhung distance in the direction of the z-axis (m)

ΔM_P: Load moment in the pitching direction (N·m)
ΔM_Y: Load moment in the yawing direction (N·m)
ΔM_R: Load moment in the rolling direction (N·m)

M_P: Permissible moment in the pitching direction (N·m)
M_Y: Permissible moment in the yawing direction (N·m)
M_R: Permissible moment in the rolling direction (N·m)

•Electric Cylinders (Units equipped with shaft guide only)



●Load Moment Formula:

$$\frac{|\Delta M_P|}{M_P} + \frac{|\Delta M_Y|}{M_Y} + \frac{|\Delta M_R|}{M_R} \leqq 1$$

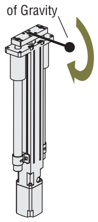
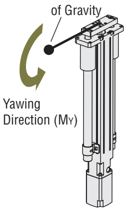
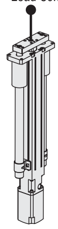
When there are several overhung loads, etc., it is determined by the sum of moments from all loads.

●For Multiple Loads (n)

$$\frac{|\Delta M_{P1} + \Delta M_{P2} + \cdots \Delta M_{Pn}|}{M_P} + \frac{|\Delta M_{Y1} + \Delta M_{Y2} + \cdots \Delta M_{Yn}|}{M_Y} + \frac{|\Delta M_{R1} + \Delta M_{R2} + \cdots \Delta M_{Rn}|}{M_R} \leqq 1$$

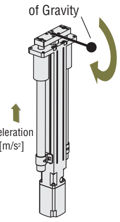
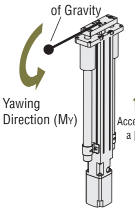
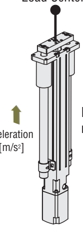
●Concept of Static Moment Application

The following illustration indicates the load moment (ΔM_P, ΔM_Y, ΔM_R) applied when the electric cylinders (units equipped with shaft guide only) are installed vertically and stopped. Use the load moment formula to confirm that the load moment is within the range of the static permissible moment (M_P, M_Y, M_R).

Vertical	 $\Delta M_P = m \cdot g \cdot L_Z$ $\frac{\lvert \Delta M_P \rvert}{M_P} \leqq 1$	 $\Delta M_Y = m \cdot g \cdot L_Y$ $\frac{\lvert \Delta M_Y \rvert}{M_Y} \leqq 1$	

●Concept of Dynamic Moment Application

The following illustration indicates the load moment (ΔM_P, ΔM_Y, ΔM_R) applied when the electric cylinders (units equipped with shaft guide only) are installed vertically and being operated (taking acceleration into account). Use the load moment formula to confirm that the load moment is within the range of the dynamic permissible moment (M_P, M_Y, M_R).

Vertical	 $\Delta M_P = m \cdot g \cdot L_Z + m \cdot a \cdot L_Z$ $\frac{\lvert \Delta M_P \rvert}{M_P} \leqq 1$	 $\Delta M_Y = m \cdot g \cdot L_Y + m \cdot a \cdot L_Y$ $\frac{\lvert \Delta M_Y \rvert}{M_Y} \leqq 1$	

The expected life distance of the shaft guide part of the electric cylinders (units equipped with shaft guide only) were designed as reference for the expected life of each series.
If the load moment calculates to 1 max., the expected life of the linear guide will be shorter than it would otherwise. Use the formula below to approximate the expected life distance.

$$\text{Expected life distance (km)} = 5000\ \text{km}^{*} \times \left(\frac{1}{\frac{\lvert \Delta M_P \rvert}{M_P} + \frac{\lvert \Delta M_Y \rvert}{M_Y} + \frac{\lvert \Delta M_R \rvert}{M_R}} \right)^3$$

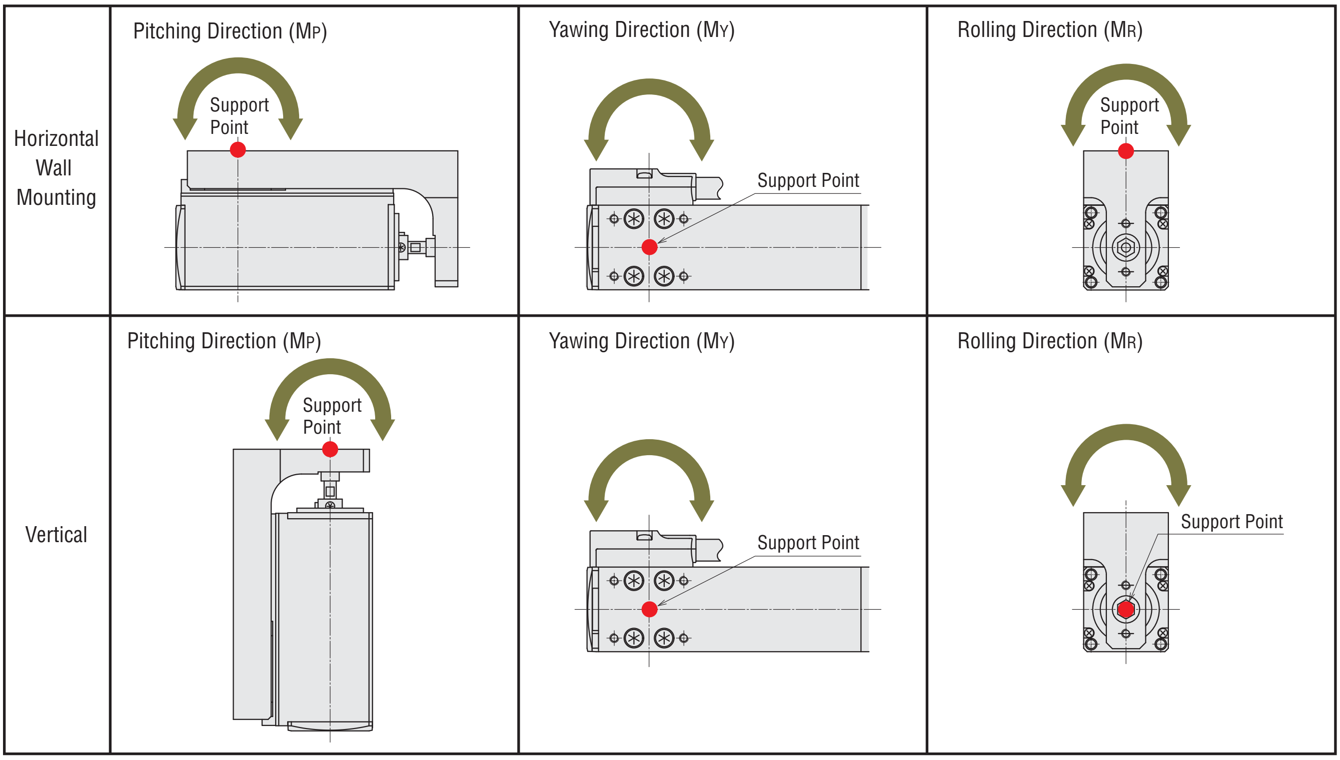
✻The expected life distance of the **EAC2** shaft guide cover is 3000 km.
Refer to "■Service Life of an Electric Linear Actuator" on page H-35 for the expected life distance of an electric linear slide with bearings and ball screws.

Calculating the Load Moment of Compact Linear Actuators

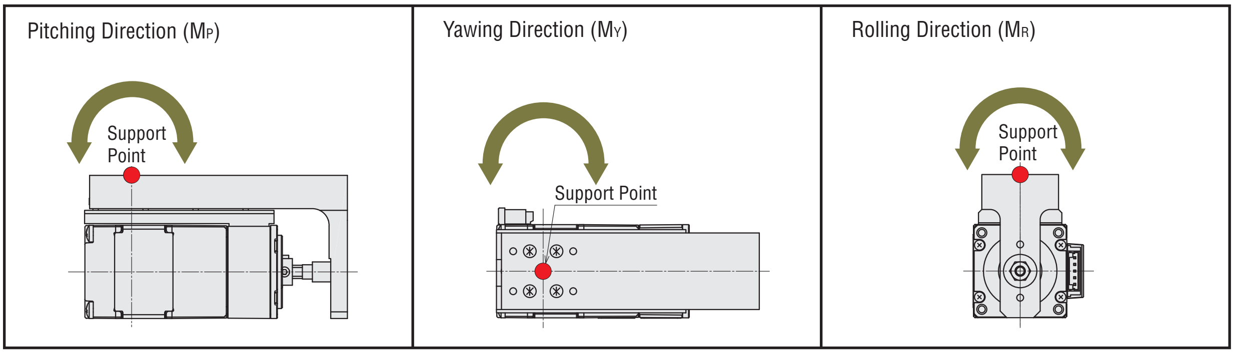
When a load is transported with the following products, a load moment affects the guide (or table) if the position of load's center of gravity is offset from the center of the guide (or table). Force is applied in 3 directions, depending on the direction of the offset: pitching (M_P), yawing (M_Y), and rolling (M_R).

- **DRS2** Series Type with a Guide
- **DRLⅡ** Series Type with a Guide/Table

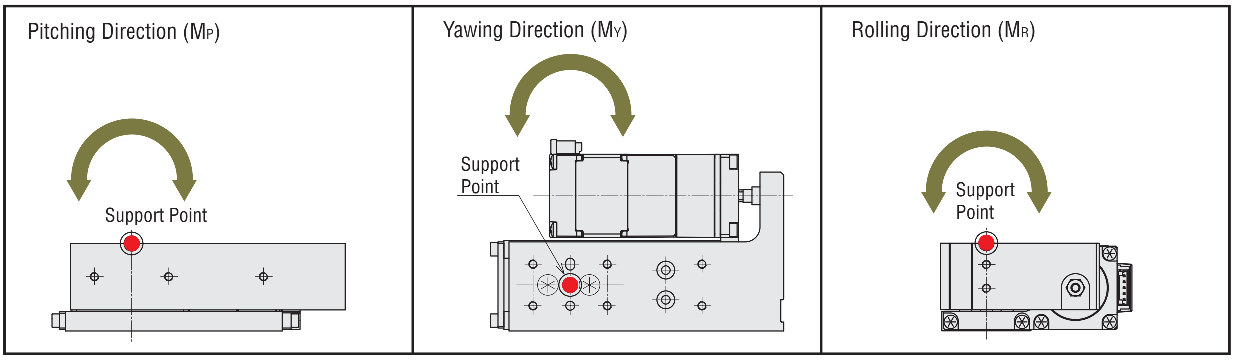
◇**DRS2** Series: Load Moment of Type with a Guide



◇**DRLⅡ** Series: Load Moment of Type with a Guide



◇**DRLⅡ** Series: Load Moment of Type with a Table



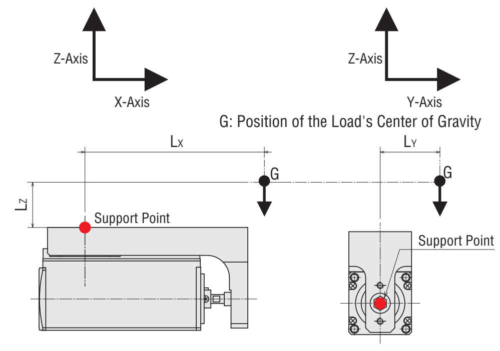
Even when the selected compact linear actuators satisfy the load mass and positioning time requirements, if the center of gravity of the load is offset from the joint's center, the run life may decrease as a result of the load moment. Load moment calculations must be completed and whether the conditions are within specifications values must be checked. The moment applied under static conditions is the static permissible moment. The moment applied under movement is the dynamic permissible moment, and check that both do not exceed the maximum permissible moment.

● When oriented vertically, the joint center for calculating the moment changes.

Calculate the load moment of the compact linear actuators based on loads that are applied. Check that the max. load moment is within the limits and check that strength is sufficient.

◇**DRS2** Series Type with a Guide

Horizontal Wall Mounting



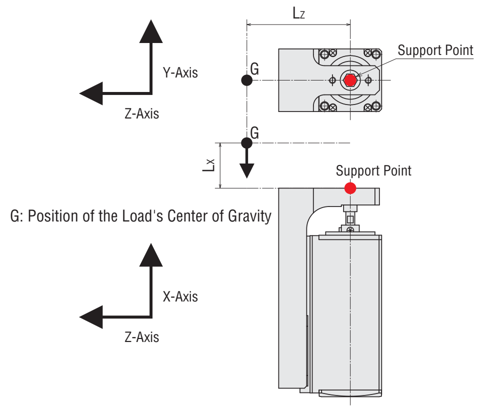
m: Load mass (kg)
g : Gravitational acceleration 9.807 (m/s²)
a : Acceleration (m/s²)

L_X: Overhung distance in the direction of the x-axis (m)
L_Y: Overhung distance in the direction of the y-axis (m)
L_Z: Overhung distance in the direction of the z-axis (m)

$\varDelta M_P$: Load moment in the pitching direction (N·m)
$\varDelta M_Y$: Load moment in the yawing direction (N·m)
$\varDelta M_R$: Load moment in the rolling direction (N·m)

M_P: Permissible moment in the pitching direction (N·m)
M_Y: Permissible moment in the yawing direction (N·m)
M_R: Permissible moment in the rolling direction (N·m)

Vertical



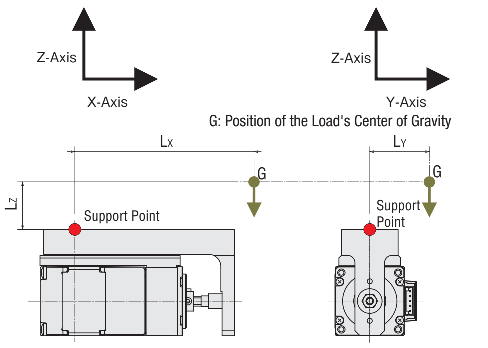
m: Load mass (kg)
g : Gravitational acceleration 9.807 (m/s²)
a : Acceleration (m/s²)

L_X: Overhung distance in the direction of the x-axis (m)
L_Y: Overhung distance in the direction of the y-axis (m)
L_Z: Overhung distance in the direction of the z-axis (m)

$\varDelta M_P$: Load moment in the pitching direction (N·m)
$\varDelta M_Y$: Load moment in the yawing direction (N·m)
$\varDelta M_R$: Load moment in the rolling direction (N·m)

M_P: Permissible moment in the pitching direction (N·m)
M_Y: Permissible moment in the yawing direction (N·m)
M_R: Permissible moment in the rolling direction (N·m)

◇**DRLII** Series Type with a Guide



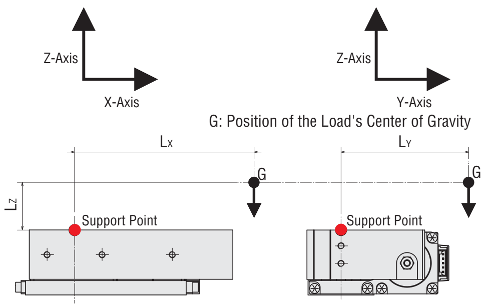
m: Load mass (kg)
g : Gravitational acceleration 9.807 (m/s²)
a : Acceleration (m/s²)

L_X: Overhung distance in the direction of the x-axis (m)
L_Y: Overhung distance in the direction of the y-axis (m)
L_Z: Overhung distance in the direction of the z-axis (m)

$\varDelta M_P$: Load moment in the pitching direction (N·m)
$\varDelta M_Y$: Load moment in the yawing direction (N·m)
$\varDelta M_R$: Load moment in the rolling direction (N·m)

M_P: Permissible moment in the pitching direction (N·m)
M_Y: Permissible moment in the yawing direction (N·m)
M_R: Permissible moment in the rolling direction (N·m)

◇**DRLII** Series Table Type with a Table



m: Load mass (kg)
g : Gravitational acceleration 9.807 (m/s²)
a : Acceleration (m/s²)

L_X: Overhung distance in the direction of the x-axis (m)
L_Y: Overhung distance in the direction of the y-axis (m)
L_Z: Overhung distance in the direction of the z-axis (m)

$\varDelta M_P$: Load moment in the pitching direction (N·m)
$\varDelta M_Y$: Load moment in the yawing direction (N·m)
$\varDelta M_R$: Load moment in the rolling direction (N·m)

M_P: Permissible moment in the pitching direction (N·m)
M_Y: Permissible moment in the yawing direction (N·m)
M_R: Permissible moment in the rolling direction (N·m)

● Load Moment Formula

$$\frac{|\varDelta M_P|}{M_P}+\frac{|\varDelta M_Y|}{M_Y}+\frac{|\varDelta M_R|}{M_R}\leqq 1$$

● For Multiple Loads (n)

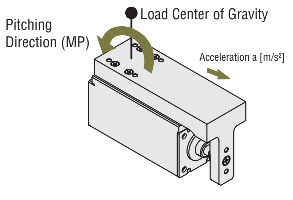
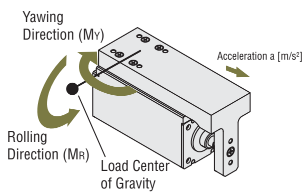
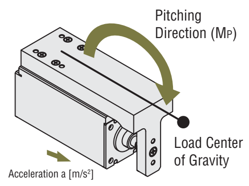
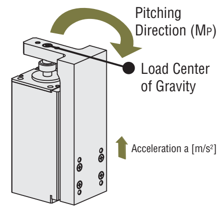
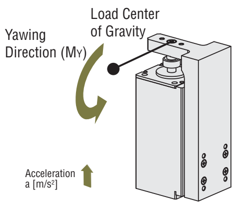
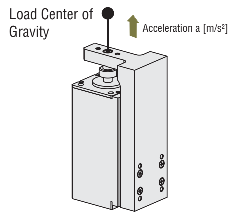
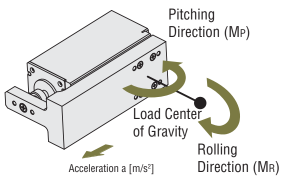
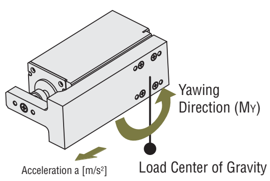
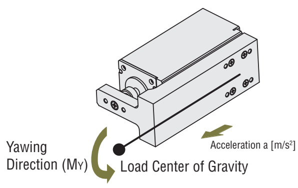
When there are several overhung loads, etc., it is determined by the sum of moments from all loads.

$$\frac{|\varDelta M_{P1}+\varDelta M_{P2}+\cdots\varDelta M_{Pn}|}{M_P}+\frac{|\varDelta M_{Y1}+\varDelta M_{Y2}+\cdots\varDelta M_{Yn}|}{M_Y}+\frac{|\varDelta M_{R1}+\varDelta M_{R2}+\cdots\varDelta M_{Rn}|}{M_R}\leqq 1$$

●Concept of Load Moment Application

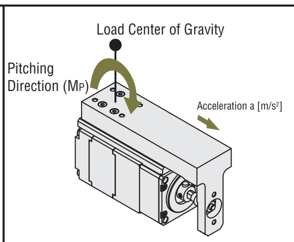
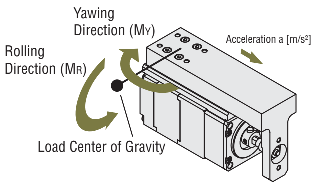
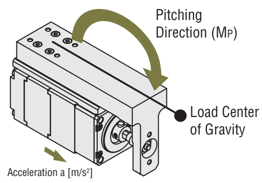
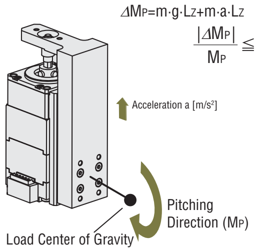
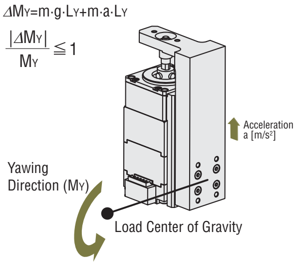
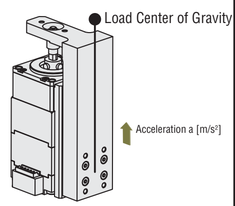
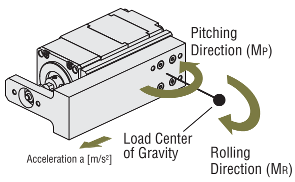
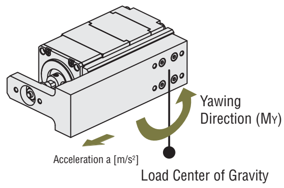
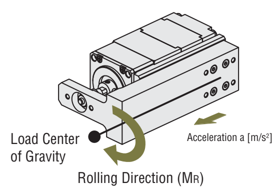
When the load moment is applied during an operation or a stopped state, check the dynamic moment and the static moment by taking acceleration into account, and compare it with the max. load moment.

◇DRS2 Series Type with a Guide

Horizontal	 $\Delta M_P=m\cdot a\cdot L_Z$ $\frac{\lvert\Delta M_P\rvert}{M_P}\leq 1$	 $\Delta M_Y=m\cdot a\cdot L_Y$ $\Delta M_R=m\cdot g\cdot L_Y$ $\frac{\lvert\Delta M_Y\rvert}{M_Y}+\frac{\lvert\Delta M_R\rvert}{M_R}\leq 1$	 $\Delta M_P=m\cdot g\cdot L_X$ $\frac{\lvert\Delta M_P\rvert}{M_P}\leq 1$
Vertical	 $\Delta M_P=m\cdot g\cdot L_Z+m\cdot a\cdot L_Z$ $\frac{\lvert\Delta M_P\rvert}{M_P}\leq 1$	 $\Delta M_Y=m\cdot g\cdot L_Y+m\cdot a\cdot L_Y$ $\frac{\lvert\Delta M_Y\rvert}{M_Y}\leq 1$	 Load moment is not generated.
Wall Mounting	 $\Delta M_P=m\cdot a\cdot L_Z$ $\Delta M_R=m\cdot g\cdot L_Z$ $\frac{\lvert\Delta M_P\rvert}{M_P}+\frac{\lvert\Delta M_R\rvert}{M_R}\leq 1$	 $\Delta M_Y=m\cdot a\cdot L_Y$ $\frac{\lvert\Delta M_Y\rvert}{M_Y}\leq 1$	 $\Delta M_Y=m\cdot g\cdot L_X$ $\frac{\lvert\Delta M_Y\rvert}{M_Y}\leq 1$

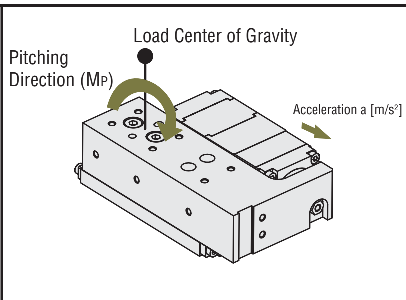
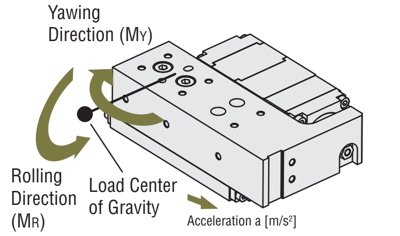
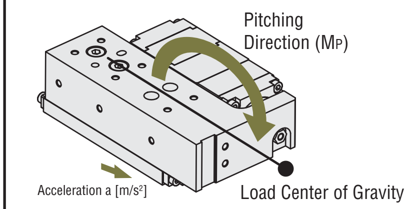
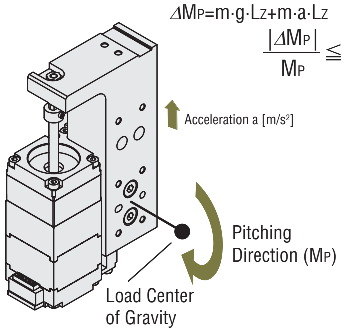
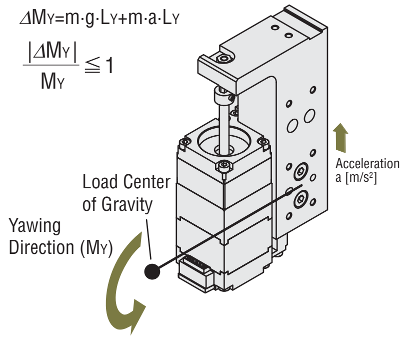
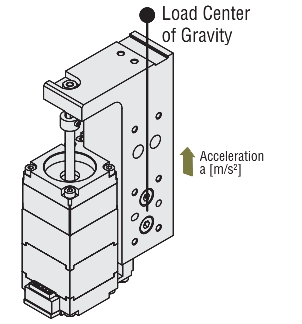
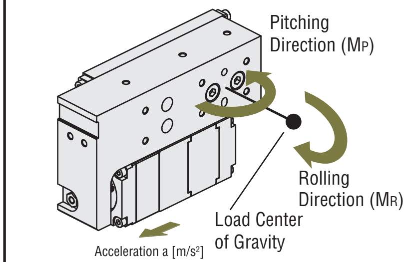
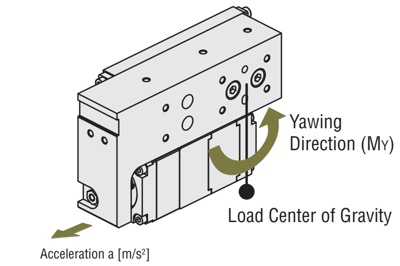
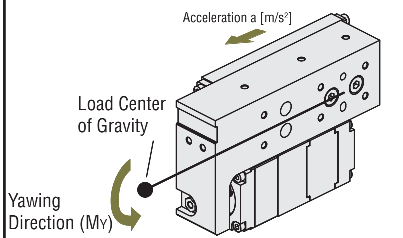
When the load factor of the max. load moment for the calculated load moment is 1 min., it may cause a malfunction or reduce of the expected life.

◇DRLⅡ Series Type with a Guide

Horizontal	 $\Delta M_P=m\cdot a\cdot L_Z$ $\frac{\lvert\Delta M_P\rvert}{M_P}\leq 1$	 $\Delta M_Y=m\cdot a\cdot L_Y$ $\Delta M_R=m\cdot g\cdot L_Y$ $\frac{\lvert\Delta M_Y\rvert}{M_Y}+\frac{\lvert\Delta M_R\rvert}{M_R}\leq 1$	 $\Delta M_P=m\cdot g\cdot L_X$ $\frac{\lvert\Delta M_P\rvert}{M_P}\leq 1$
Vertical	$\Delta M_P=m\cdot g\cdot L_Z+m\cdot a\cdot L_Z$ $\frac{\lvert\Delta M_P\rvert}{M_P}\leq 1$ 	$\Delta M_Y=m\cdot g\cdot L_Y+m\cdot a\cdot L_Y$ $\frac{\lvert\Delta M_Y\rvert}{M_Y}\leq 1$ 	 Load moment is not generated.
Wall Mounting	 $\Delta M_P=m\cdot a\cdot L_Z$ $\Delta M_R=m\cdot g\cdot L_Z$ $\frac{\lvert\Delta M_P\rvert}{M_P}+\frac{\lvert\Delta M_R\rvert}{M_R}\leq 1$	 $\Delta M_Y=m\cdot a\cdot L_Y$ $\frac{\lvert\Delta M_Y\rvert}{M_Y}\leq 1$	 $\Delta M_Y=m\cdot g\cdot L_X$ $\frac{\lvert\Delta M_Y\rvert}{M_Y}\leq 1$

When the load factor of the max. load moment for the calculated load moment is 1 min., it may cause a malfunction or reduce of the expected life.

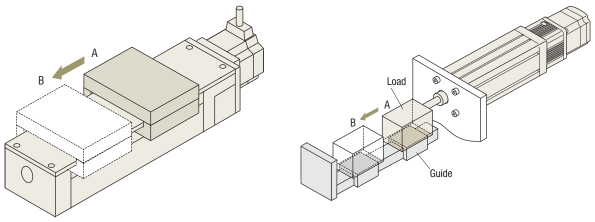
◇**DRLⅡ** Series Table Type with a Table

Horizontal	 $\Delta M_P = m \cdot a \cdot L_Z$ $\quad \frac{\lvert \Delta M_P \rvert}{M_P} \leqq 1$	 $\Delta M_Y = m \cdot a \cdot L_Y$ $\Delta M_R = m \cdot g \cdot L_Y$ $\quad \frac{\lvert \Delta M_Y \rvert}{M_Y} + \frac{\lvert \Delta M_R \rvert}{M_R} \leqq 1$	 $\Delta M_P = m \cdot g \cdot L_X$ $\quad \frac{\lvert \Delta M_P \rvert}{M_P} \leqq 1$
Vertical	$\Delta M_P = m \cdot g \cdot L_Z + m \cdot a \cdot L_Z$ $\frac{\lvert \Delta M_P \rvert}{M_P} \leqq 1$ 	$\Delta M_Y = m \cdot g \cdot L_Y + m \cdot a \cdot L_Y$ $\frac{\lvert \Delta M_Y \rvert}{M_Y} \leqq 1$ 	 Load moment is not generated.
Wall Mounting	 $\Delta M_P = m \cdot a \cdot L_Z$ $\Delta M_R = m \cdot g \cdot L_Z$ $\quad \frac{\lvert \Delta M_P \rvert}{M_P} + \frac{\lvert \Delta M_R \rvert}{M_R} \leqq 1$	 $\Delta M_Y = m \cdot a \cdot L_Y$ $\quad \frac{\lvert \Delta M_Y \rvert}{M_Y} \leqq 1$	 $\Delta M_Y = m \cdot g \cdot L_X$ $\quad \frac{\lvert \Delta M_Y \rvert}{M_Y} \leqq 1$

When the load factor of the max. load moment for the calculated load moment is 1 min., it may cause a malfunction or reduce of the expected life.

Selecting Electric Linear Actuators (Using formula calculations)

As illustrated below, the parameters listed below are required when selecting an electric linear actuators for transporting a load from A to B.



The required parameters are as follows:

- Mass of Load (m) or Thrust Force (F)
- Positioning Distance (L)
- Positioning Time (T)
- Repetitive Positioning Accuracy
- Max. Stroke

Among the parameters above, the thrust force and positioning time can be calculated using the formulas below.

●Calculate the Thrust Force

① Calculate the required thrust force when accelerating the load

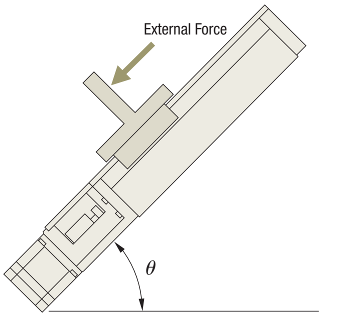
$$Fa = m\{a + g(\sin\theta + \mu \cdot \cos\theta)\}$$

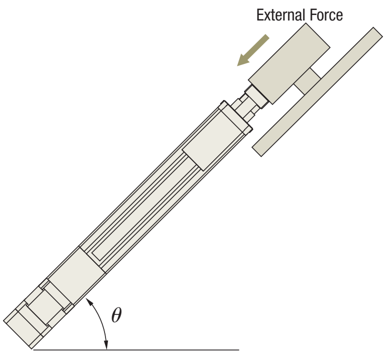
② Calculate the thrust force that allows for pushing and pulling

$$F = Fmax - Fa$$

If the external force applied to the load is smaller than F, then push-pull motion is possible.

F_{max}: Max. thrust force of the electric linear actuators [N]
F_a : Required thrust force during acceleration/deceleration operation [N]
F : Thrust force that allows for pushing or pulling of external force [N]
m : Mass of load mounted to the rod and table [kg]
a : Acceleration [m/s^2]
g : Gravitational acceleration 9.807 [m/s^2]
μ : Friction coefficient 0.01 (Friction coefficient of the guide supporting the load for electric linear actuators)
θ : Angle formed by the traveling direction and the horizontal plane [°]





●Calculate the Positioning Time

① Check the operating conditions.
Check the following conditions:
Installation direction, load mass, positioning distance, starting speed, acceleration, operating speed

② From the above operating conditions, check to see if the drive pattern constitutes a triangular drive or trapezoidal drive.
Calculate the max. speed of triangular drive from the positioning distance, starting speed, acceleration and operating speed. If the calculated max. speed is equal to or below the operating speed, the operation is considered a triangular drive. If the max. speed exceeds the operating speed, the operation is considered a trapezoidal drive.

$$V_{Rmax} = \sqrt{\frac{2 \cdot a_1 \cdot a_2 \cdot L}{a_1 + a_2} \cdot 10^3 + V_S{}^2}$$

$V_{Rmax} \leqq V_R \rightarrow$ Triangular Drive

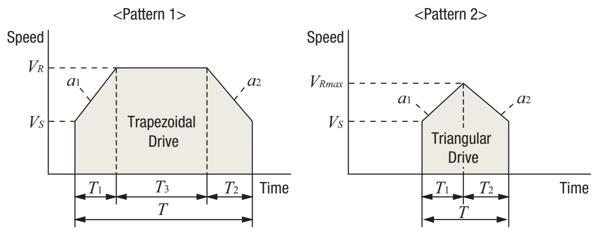
$V_{Rmax} > V_R \rightarrow$ Trapezoidal Drive

③ Calculate the positioning time.
<Trapezoidal Drive>

$$T = T_1 + T_2 + T_3$$
$$= \frac{V_R - V_S}{a_1 \times 10^3} + \frac{V_R - V_S}{a_2 \times 10^3} + \frac{L}{V_R} - \frac{(a_1 + a_2) \times (V_R{}^2 - V_S{}^2)}{2 \times a_1 \times a_2 \times V_R \times 10^3}$$

<Triangular Drive>

$$T = T_1 + T_2$$
$$= \frac{V_{Rmax} - V_S}{a_1 \times 10^3} + \frac{V_{Rmax} - V_S}{a_2 \times 10^3}$$



V_{Rmax}: Calculated max. speed of triangular drive [mm/s]
V_R : Operating speed [mm/s]
V_s : Starting speed [mm/s]
L : Positioning distance [mm]
a_1 : Acceleration [m/s^2]
a_2 : Deceleration [m/s^2]
T : Positioning time [s]
T_1 : Acceleration time [s]
T_2 : Deceleration time [s]
T_3 : Constant speed time [s]

The actual operating time is subject to a small margin of error, so use the calculation only as a reference.

Other conversion formulas are explained below.
The pulse speed and operating speed can be converted using the formula below. Keep the operating speed below the specified max. speed.

$$\text{Pulse Speed [Hz]} = \frac{\text{Operating Speed [mm/s]}}{\text{Resolution [mm]}}$$

The number of operating pulses and traveling amount can be converted using the formula below.

$$\text{Number of Operating Pulses [pulses]} = \frac{\text{Traveling Amount [mm]}}{\text{Resolution [mm]}}$$

The acceleration/deceleration rates and acceleration can be converted using the formula below.

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

Hollow Rotary Actuators

First determine your series, then select your product.
Select the actuator that you will use based on the following flow charts:

Selection Procedure

An overview of the procedure is explained below.

Check the Required Specifications (Equipment specifications)	● Check the required specifications for the hollow rotary actuator based on the equipment specifications. The general items are explained below. • Operating speed • Stopping accuracy • Power supply input • Positioning distance and positioning time • Position holding
Calculate the Load	● Calculate the load inertia. Refer to page H-4 to calculate the inertia for typical configurations.
Select a Actuator	● Using the load inertia – positioning time graph, select an actuator that satisfies the positioning time.
Selection Calculation	● Ensure that the required torque and mechanical strength are within the specification values, and select the actuator.

Sizing and Selection Service

We provide selection services for motor selection from load calculations that requires time and effort.

● Internet

Simple requests for motors can be made using the selection form on our website.
www.orientalmotor.eu

Selecting the DGⅡ Series

This section describes the selection calculations for the **DGⅡ** Series.

(1) Calculate the Load Inertia

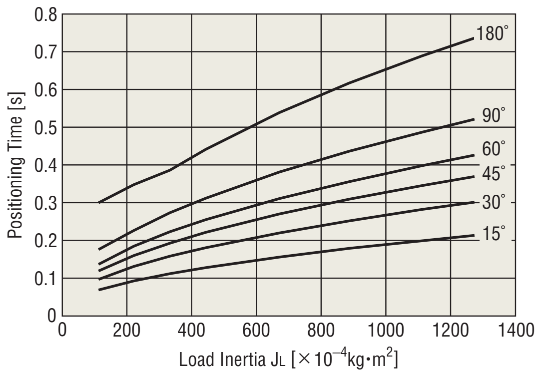
Calculate the inertia (load inertia) of the load (Refer to page H-4). Use 30 times max. the actuator inertia (10 times max. for flat type) as a reference for the inertia of the load.

(2) Selecting the Actuator

① When there is no friction torque, check the positioning time from the Load Inertia – Positioning Time graph for the **DGⅡ** Series. Refer to the load inertia – positioning time graph on page E-131.

Load Inertia – Positioning Time (Reference value)

DG85R



② Determine the positioning time and acceleration/deceleration time.

Provided that:

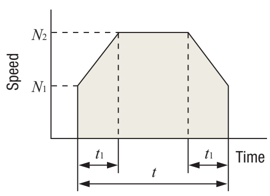
The positioning time is greater or equal to (≧) the lowest positioning time on the load inertia – positioning time graph

Where acceleration/deceleration is time $t_1 \times 2 \leqq$ positioning time.

③ Determine starting speed N_1, and calculate the operating speed N_2 using the formula below. Set N_1 as the low speed [0~n r/min] and do not set it more than the required speed.

$$N_2 = \frac{\theta - 6N_1t_1}{6(t - t_1)}$$

N_2 : Operating speed [r/min]
θ : Positioning angle [˚]
N_1 : Starting speed [r/min]
t : Positioning time [s]
t_1 : Acceleration (deceleration) time [s]



If $N_1 \leqq N_2 \leqq 200$ [r/min] is not achieved in the above formula, return to step ① and recheck the conditions.

(3) Calculate the Required Torque

① Calculate the acceleration torque using the formula below.

$$T_a = (J_1 + J_L) \times \frac{\pi}{30} \times \frac{(N_2 - N_1)}{t_1}$$

T_a : Acceleration torque [N·m]
J_1 : Actuator inertia [kg·m²]
J_L : Total inertia [kg·m²]
N_2 : Operating speed [r/min]
N_1 : Starting speed [r/min]
t_1 : Acceleration (deceleration) time [s]

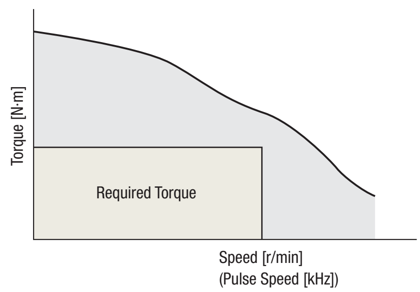
② Calculate the required torque. The required torque is calculated by multiplying load torque of the frictional resistance plus the acceleration torque of the inertia with the safety factor.

$$T = (T_L + T_a)\,S_f$$

T : Required torque [N·m]
T_L : Load torque [N·m]
T_a : Acceleration torque [N·m]
S_f : Safety factor

Please set the safety factor S_f at 1.5 min. (2 min. for light type).

③ Check whether the required torque T falls within the speed – torque characteristics. If the required torque is outside of the speed – torque characteristics, return to step ④, change the conditions and recalculate.



When switching from speed to pulse speed, use the formula below.

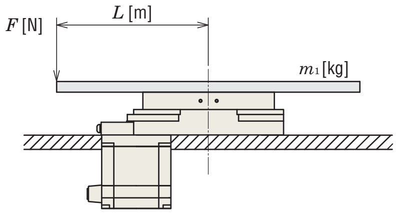
$$f\,[\text{Hz}] = \frac{6N}{\theta s}$$

f : Pulse speed [Hz]
N : Speed [r/min]
θs : Output table step angle [˚/step]

(4) Calculate the Load Moment and Axial Load

When there is a load on the output table as shown below, calculate the load moment and axial load using the formula below, and check that they are within the specification values.

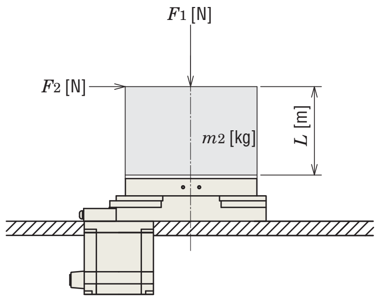
Example 1: When external force F is added distance L from the center of the output table



Load moment [N·m] $M = F \cdot L$

Axial load [N] $F_S = F +$ mass of the load $\cdot\ g$ (gravitational acceleration)

Example 2: When external forces F_1 and F_2 are added to the installation surface of the output table from distance L



Load moment [N·m] $M = F_2 (L + a)$

Axial load [N] $F_S = F_1 +$ mass of jig and load $\cdot\ g$ (gravitational acceleration)

Product Name	**DG85R**	**DG130R**	**DG200R**
Output Table Supporting Bearing	Cross-Roller Bearing	Cross-Roller Bearing	Cross-Roller Bearing
a [m]	0.02	0.03	0.04

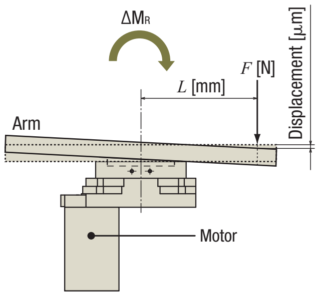
Product Name	Output Table Supporting Bearing	Permissible Moment [N·m]	Permissible Axial Value [N]
DG85R	Cross-Roller Bearing	10	500
DG130R	Cross-Roller Bearing	50	2000
DG200R	Cross-Roller Bearing	100	4000

●Displacement by Moment Load (Reference value)

The output table will be displaced when it receives a moment load.

The graph plots the table displacement that occurs at distance L from the rotation center of the output table when a given moment load is applied in one direction.

The displacement becomes approximately twice the size when the moment load is applied in both the positive and negative directions.



$\Delta M_R = F \times L$

ΔM_R : Load moment in the rolling direction [N·m]

F : External force [N]

L : Distance from the axis of rotation [N]

DG85R