Selection Calculations For Linear & Rotary Actuators

Electric Linear Slides and Electric Cylinders

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 slide or electric cylinder 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-23.)
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 slides and electric cylinders (only for cylinders equipped with shaft guide covers) is within the specified values.
Refer to page H-20 for the load moment formula.

Sizing and Selection Service

We provide sizing and selection services for motor section from your application specification requirements.

● Phone

Requests for sizing and section can be made online by contacting our technical support team at:

USA/Canada:	TEL: 800-468-3982
Mexico:	TEL: 01-800-681-5309

● Website

Requests for sizing and section can be made online by contacting our technical support team at techsupport@orientalmotor.com.

Use our online Motor Sizing Tool to calculate the necessary torque, speed, stopping accuracy and the system inertia that is important to consider when selecting a proper motor for the application.

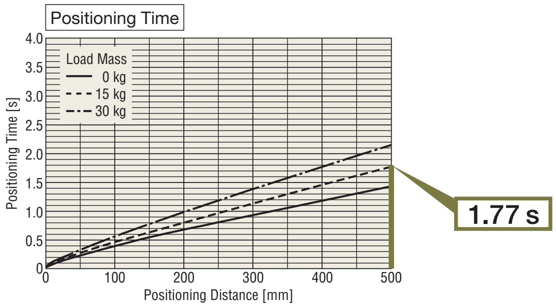
Tentative Selection of Linear & Rotary Actuators

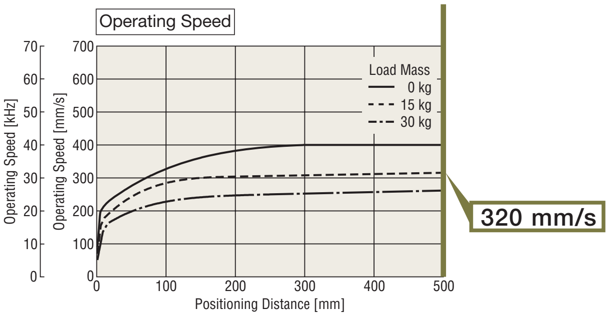
Confirming Using the Positioning Distance – Positioning Time Graph:

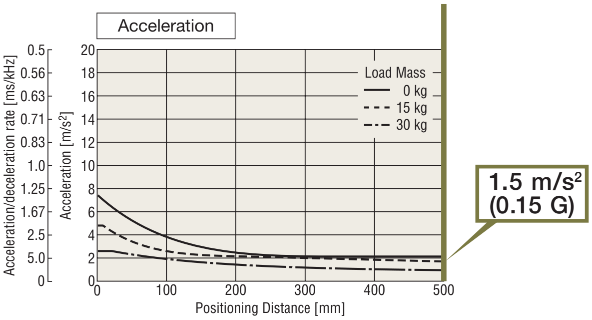
(1) Use the graph to confirm the positioning time necessary for a positioning distance of 500 mm.
(2) If the positioning time requirement is satisfied, check the operating speed and acceleration.
(3) If the positioning time requirement is not satisfied, select a different product.

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)







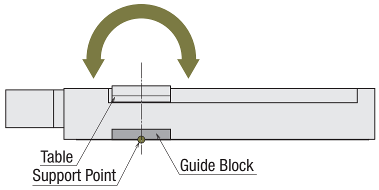
Selection Calculations
Motors
Linear & Rotary Actuators
Cooling Fans
Service Life
Stepper Motors
Servo Motors
Standard AC Motors
Brushless Motors/AC Speed Control Motors
Gearheads
Cooling Fans

Calculating Load Moment

When a load is transported with electric linear slides or electric cylinders (units equipped with shaft guide covers only), 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.

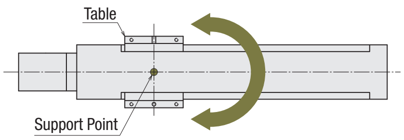
●Load Moment of Electric Linear Slides

Pitching Direction (M_P)



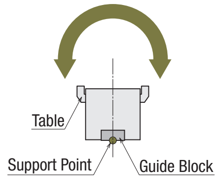
(Linear Slide Bottom Face, Center of Table)

Yawing Direction (M_Y)



(Center of Table)

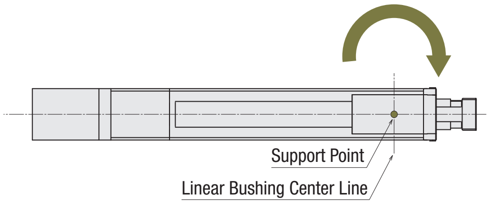
Rolling Direction (M_R)



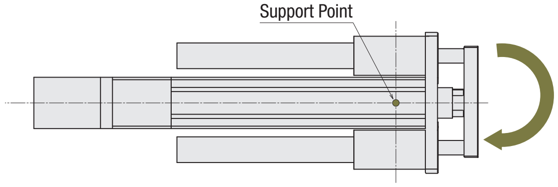
(Linear Slide Bottom Face, Center of Table)

●Load Moment of Electric Cylinders (Units equipped with shaft guide covers only)

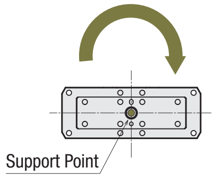
Pitching Direction (M_P)



Yawing Direction (M_Y)

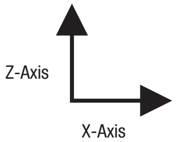


Rolling Direction (M_R)

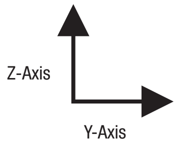


Even though the selected linear and rotary actuators satisfy the load mass and positioning time requirements, when the center of gravity of the load is overhung from the table's center, the run life may decrease as a result of the load moment. Load moment calculations must be completed and whether the 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.

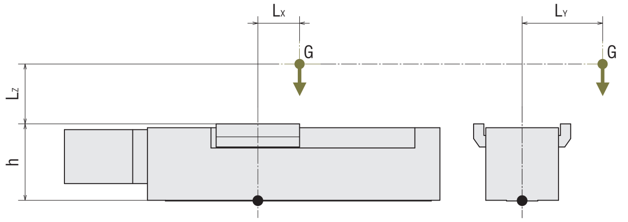
Calculate the load moment of the electric linear slides and electric cylinders (units equipped with shaft guide covers only) based on loads that are applied. Check that the static permissible moment and dynamic permissible moment are within limits and check that strength is sufficient.



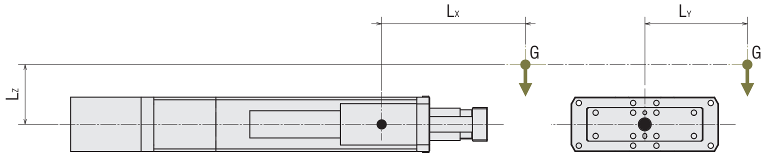
G: Position of the Load's Center of Gravity



●Electric Linear Slide



●Electric Cylinder (Units equipped with shaft guide covers only)



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.

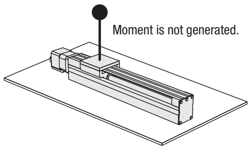
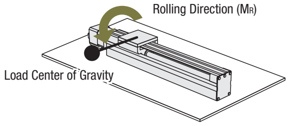
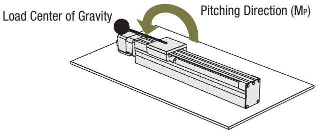
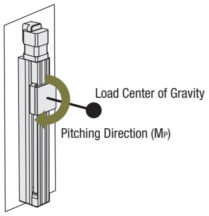
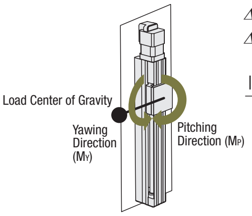
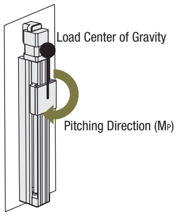
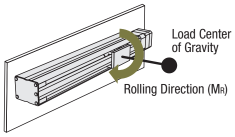
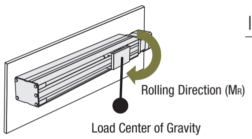
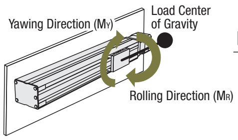
●For Multiple Loads (n)

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

●Electric Linear Slides

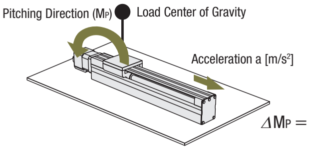
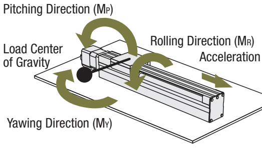
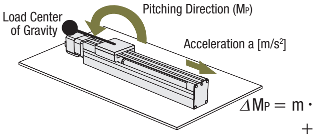
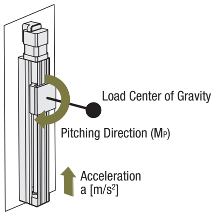
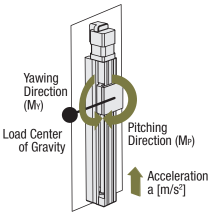
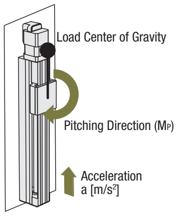
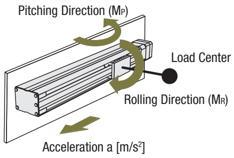
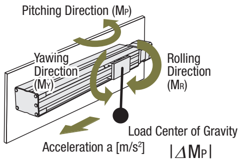
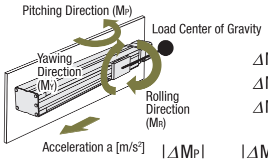
◇Concept of Static Moment Application

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	 $\Delta M_P = m \cdot a \cdot (L_Z+h)$ $\Delta M_R = m \cdot g \cdot (L_Z+h)$ $\frac{\lvert\Delta M_P\rvert}{M_P} + \frac{\lvert\Delta M_R\rvert}{M_R} \leqq 1$	 $\Delta M_P = m \cdot a \cdot (L_Z+h)$ $\Delta M_Y = m \cdot a \cdot L_Y$ $\Delta M_R = m \cdot g \cdot (L_Z+h)$ $\frac{\lvert\Delta M_P\rvert}{M_P} + \frac{\lvert\Delta M_Y\rvert}{M_Y} + \frac{\lvert\Delta M_R\rvert}{M_R} \leqq 1$	 $\Delta M_P = m \cdot a \cdot (L_Z+h)$ $\Delta M_Y = m \cdot g \cdot L_X$ $\Delta M_R = m \cdot g \cdot (L_Z+h)$ $\frac{\lvert\Delta M_P\rvert}{M_P} + \frac{\lvert\Delta M_Y\rvert}{M_Y} + \frac{\lvert\Delta M_R\rvert}{M_R} \leqq 1$

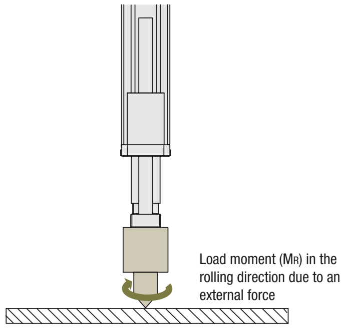
The linear guide of the electric linear slide is designed as reference for the life of each series. However, when the load factor of the load moment for the calculated static and dynamic permissible moment or max. load moment is 1 more, it goes below the expected life distance. Use the formula below to approximate the expected life distance.

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

✻The expected life of the guide components is 5000 km.
The expected life of products with bearings and ball screws is 3000 km for a 6 mm lead screw pitch, and 5000 km for a 12 mm lead screw pitch.

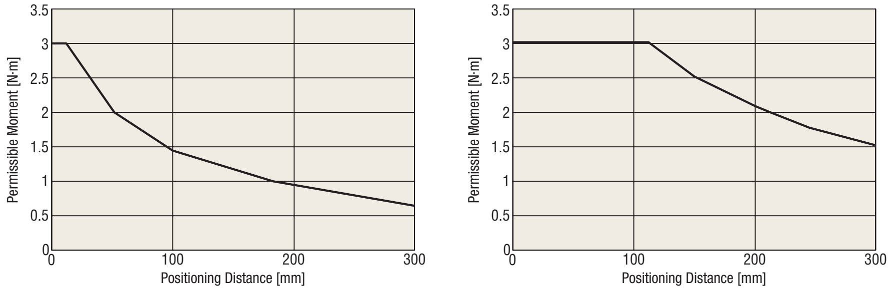
●Electric Cylinders (Units equipped with shaft guide covers only)

If the positioning distance is large for a cylinder equipped with a shaft guide cover, the permissible moment M_R in the rolling direction, that the shaft guide can receive, becomes smaller. If the shaft guide receives the moment from the rolling direction when stopped, due to external forces such as screw tightening, check the figure below for the usable range of static permissible moment. Please refer to the technical reference materials on the Oriental Motor website for other information on the concepts of static moments or dynamic moments.



•Static Permissible Moment in the Rolling Direction (M_R)

◇**EAC4W** ◇**EAC6W**

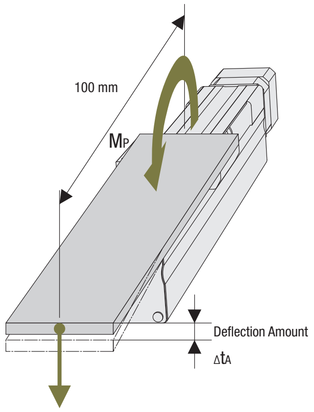


■Deflection and Rigidity of the Table

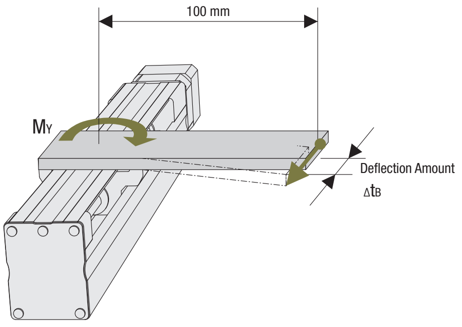
When a load moment is applied to the table of an electric linear slide, the table is being supported by the linear guide. The action of load moment causes balls in the linear guide to deflect, and as a result, displacement of the load is observed. Shown below are the actual displacements that were measured when a load moment was applied to an electric linear slide.

<Measurement Conditions>

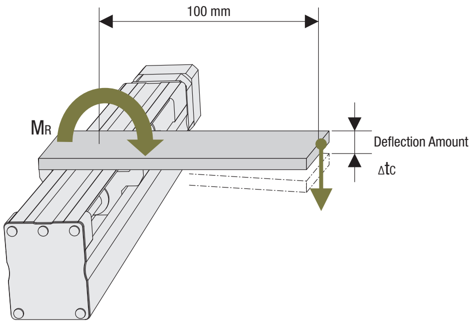
A 100 mm overhung plate was fixed on a linear slide table and a load moment equivalent to the dynamic permissible moments (M_P, M_Y, M_R) was applied in each direction. The deflection of the tip (Δt_A, Δt_B, Δt_C) was measured under these conditions.



Pitching Direction



Yawing Direction



Rolling Direction

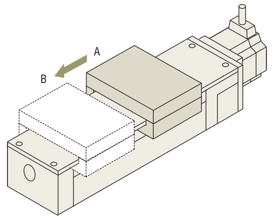
Table Deflection under Dynamic Permissible Moment

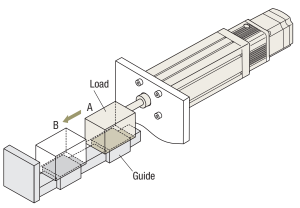
Series	Product	Pitching Direction		Yawing Direction		Rolling Direction	
		M_P [N·m]	Δt_A [mm]	M_Y [N·m]	Δt_B [mm]	M_R [N·m]	Δt_C [mm]
EAS Series	**EAS4**	16.3	0.11	4.8	0.03	15.0	0.38
	EAS6	31.8	0.11	10.3	0.03	40.6	0.41

✻Deflection of the 100 mm plate is ignored.
✻Deflection characteristics do not change among different table types.

Selecting Electric Linear Slides and Cylinders (Using formula calculations)

As illustrated below, the parameters listed below are required when selecting an electric linear slides and electric cylinders 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

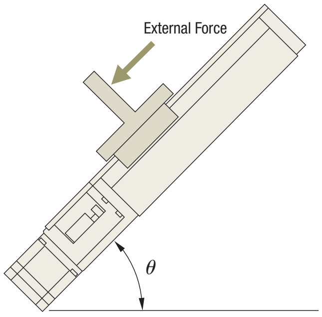
$$F_a = m\{a + g(\sin\theta + \mu \cdot \cos\theta)\}$$

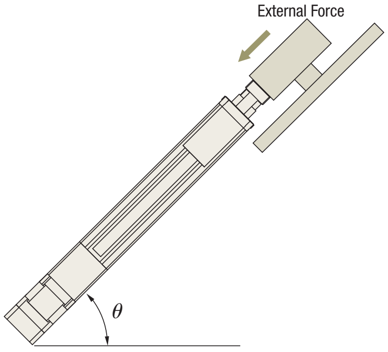
② Calculate the thrust force that allows for pushing and pulling

$$F = F_{max} - F_a$$

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 slides and cylinders [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 slides)
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.

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

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

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

③ Calculate the positioning time.

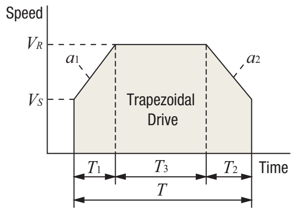
<Trapezoidal Drive>

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

<Triangular Drive>

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

<Pattern 1>



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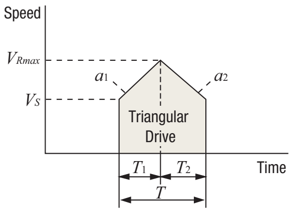


V_{Rmax}: Calculated max. speed of triangular drive [mm/s]
V_R : Operating speed [mm/s]
V_s : Starting speed [mm/s]
L : Positioning distance [mm]
a_1 : Acceleration [m/s^2]
a_2 : Deceleration [m/s^2]
T : Positioning time [s]
T_1 : Acceleration time [s]
T_2 : Deceleration time [s]
T_3 : Constant speed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

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

Compact 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 compact linear actuator based on the equipment specifications.
  The general items are explained below.
- Frame size
- Load mass
- Thrust
- Table height
- Stroke
- Pushing force

▼

Tentative Selection of Linear & Rotary Actuator

- Check that the positioning time of the tentatively selected unit 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-26.)

If the required positioning time is satisfied, check the operating speed and acceleration.

▼

Selection Calculations

- If the actuator is equipped with a guide, take into account the calculated acceleration conditions and check that the dynamic permissible moment applied to the actuator is within the specified values. Refer to the Oriental Motor website for the load moment formula.

Sizing and Selection Service

We provide sizing and selection services for motor section from your application specification requirements.

●Phone

Requests for sizing and section can be made online by contacting our technical support team at:

USA/Canada:	TEL: 800-468-3982
Mexico:	TEL: 01-800-681-5309

●Website

Requests for sizing and section can be made online by contacting our technical support team at techsupport@orientalmotor.com.

Use our online Motor Sizing Tool to calculate the necessary torque, speed, stopping accuracy and the system inertia that is important to consider when selecting a proper motor for the application.

Selecting Compact Linear Actuators

●Calculate the Thrust Force

① Calculate the required thrust force when accelerating the load.

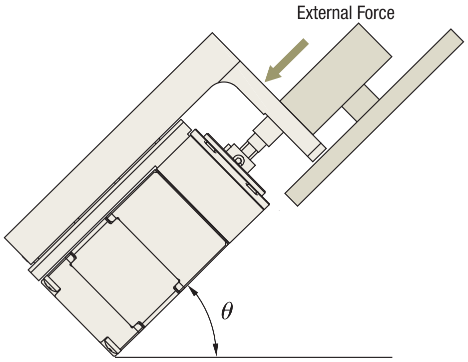
$$F_a = m\{a + g(\sin\theta + \mu \cdot \cos\theta)\}$$

② Calculate the thrust force that allows for pushing and pulling.

$$F = F_{max} - F_a$$

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 actuator [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 [kg]
a : Acceleration [m/s^2]
g : Gravitational acceleration 9.807 [m/s^2]
μ : Friction coefficient of the guide supporting the load 0.01
θ : Angle formed by the traveling direction and the horizontal plane [°]

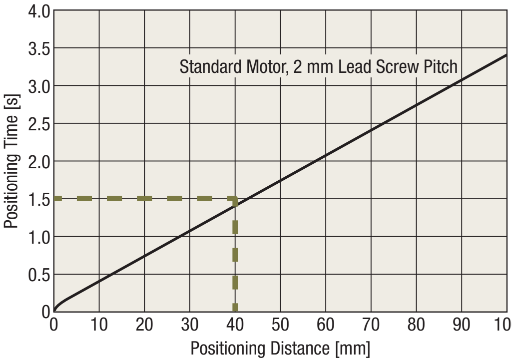


●Checking the Positioning Time

Check whether the actuator can perform the necessary positioning within the specified time. This can be done by obtaining a rough positioning time from the graph or by obtaining a fairly accurate positioning time by calculation. Each of the check procedures is explained below.
The actual operating time is subject to a small margin of error, so use the calculation only as a reference.

◇Obtaining from a Graph

Example) Tentatively select **DRL42G-04A2P-KD**, and check the positioning time when traveling amount is 40 mm, the load is 5 kg, and it is driven vertically. Confirm that the required specifications are within the product specifications values.
Check the Positioning distance – positioning time graph for the **DRL42**.



Using the above graph, it is confirmed that the load can be positioned over a positioning distance of 40 mm in less than 1.5 seconds.

◇Using Formula Calculations

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.

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

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

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

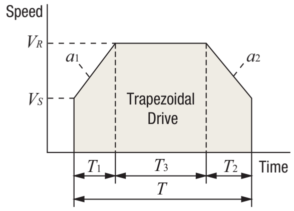
③ Calculate the positioning time.
<Trapezoidal Drive>

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

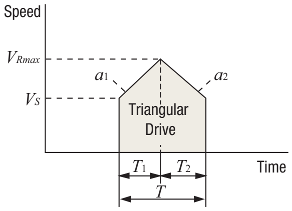
<Triangular Drive>

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

<Pattern 1>



<Pattern 2>

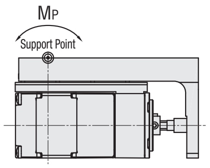


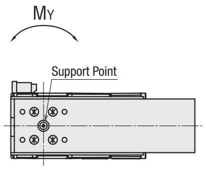
V_{Rmax}: Calculated max. speed of triangular drive [mm/s]
V_R : Operating speed [mm/s]
V_s : Starting speed [mm/s]
L : Positioning distance [mm]
a_1 : Acceleration [m/s^2]
a_2 : Deceleration [m/s^2]
T : Positioning time [s]
T_1 : Acceleration time [s]
T_2 : Deceleration time [s]
T_3 : Constant speed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

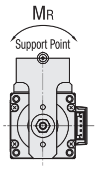
Calculating Load Moment

When a load is transported with a linear actuator equipped with a guide, the load moment acts on the linear guide if the position of load's center of gravity is offset from the center of the 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.
Even if the selected actuator satisfies the load mass and positioning time requirements, the running life may be decreased by the load moment. If an actuator equipped with a guide is selected, load moment calculations must be completed to check that the conditions are within the specification values. For details, please refer to the technical reference pages on the Oriental Motor website.

•Actuators equipped with guides







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 sizing and selection services for motor section from your application specification requirements.

●Phone

Requests for sizing and section can be made online by contacting our technical support team at:

USA/Canada: TEL: 800-468-3982
Mexico: TEL: 01-800-681-5309

●Website

Requests for sizing and section can be made online by contacting our technical support team at techsupport@orientalmotor.com.

Use our online Motor Sizing Tool to calculate the necessary torque, speed, stopping accuracy and the system inertia that is important to consider when selecting a proper motor for the application.

Selecting the DGⅡ Series

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

(1) Calculate the Load Inertia

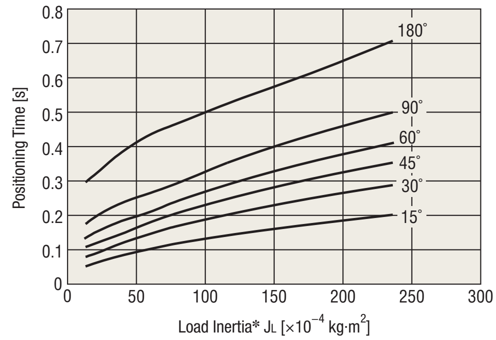
Calculate the inertia (load inertia) of the load (Refer to page H-4). Use 30 times max. the actuator inertia (10 times max. for flat type) as a reference for the inertia of the load.

(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)

DG60



② Determine the positioning time and acceleration/deceleration time.

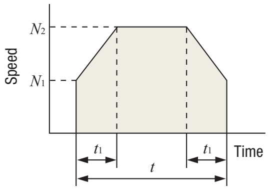
Provided that:

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]

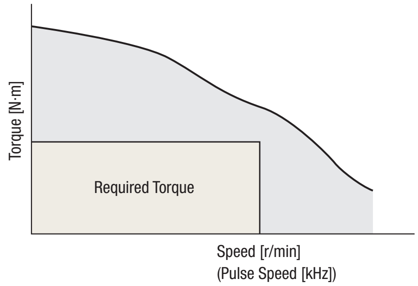
② Calculate the required torque. The required torque is calculated by multiplying load torque of the frictional resistance plus the acceleration torque of the inertia with the safety factor.

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

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.

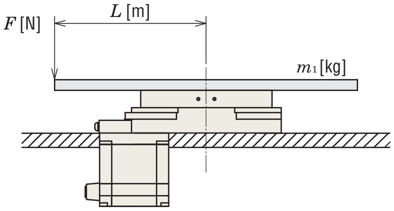
$$f\,[\text{Hz}] = \frac{6N}{\theta s}$$

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.

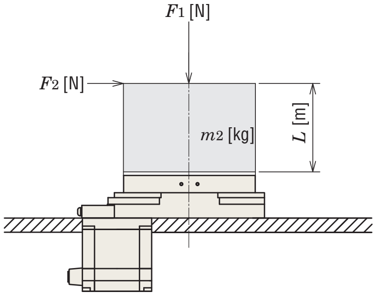
Example 1: When external force F is added distance L from the center of the output table



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] $M = F_2 (L + \mathrm{a})$

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

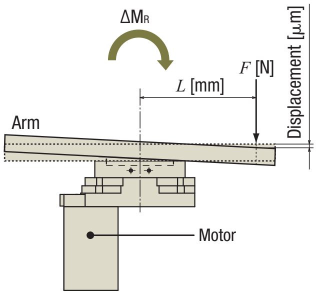
Product Name	**DG60**	**DG85R**
Output Table Supporting Bearing	Deep-Groove Ball Bearing	Cross-Roller Bearing
a [m]	0.01	0.02

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

Product Name	Output Table Supporting Bearing	Permissible Moment [N·m]	Permissible Axial Value [N]
DG60	Deep-Groove Ball Bearing	2	100
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]

DG60