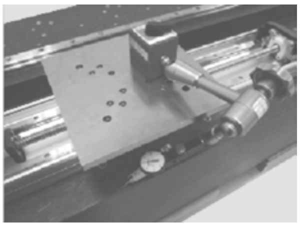
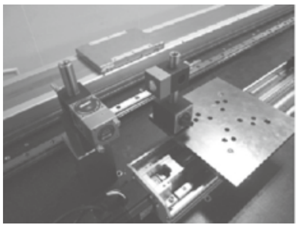
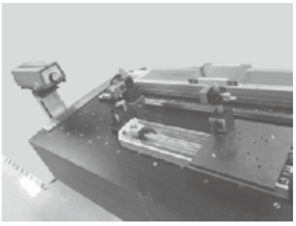
Measuring tools

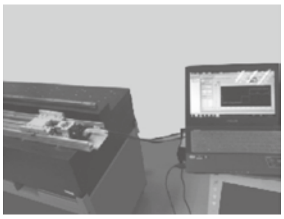



1. Parallelism testing / Height testing	
Measuring tools	Dial gauge and Dial indicator
Measuring methods	1. Fix the actuator on granite. 2. Fix the measuring tools on the actuator's slider. 3. As photo display. 4. Record it as a reference.

2. Absolute straightness accuracy testing	
Measuring tools	Laser interferometer detection
Measuring methods	1. Fix the actuator on granite. 2. Fix the measuring tools on the actuator's slider. 3. As photo display. 4. Print the test report as a recorder.


3. Absolute straightness accuracy testing	
Measuring tools	Laser position detection
Measuring methods	1. Fix the actuator on granite. 2. Use laser to align the slider's slide to the repeatability accuracy. 3. As photo display. 4. Record it as a reference.

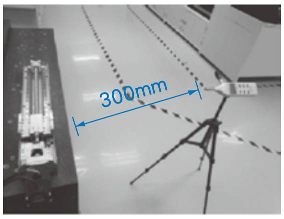


4. Power drive situation testing by motor electric current	
Measuring tools	Mitsubishi servo driver 100W, 200W, 400W
Measuring methods	1. Fix the actuator on granite. 2. Fix the measuring tools on the actuator's slider. 3. As photo display. 4. Record it as a reference.

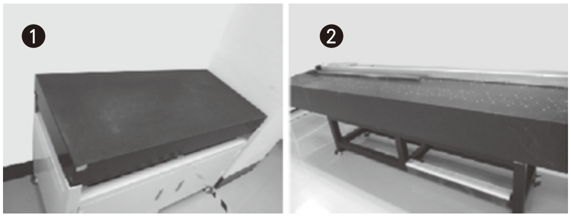
5. Smoothness testing	
Measuring tools	Pull tension gauge
Measuring methods	1. Fix the actuator on granite. 2. Push the slider using pull tension gauge. 3. As photo display. 4. Record it as a reference.

Measuring tools

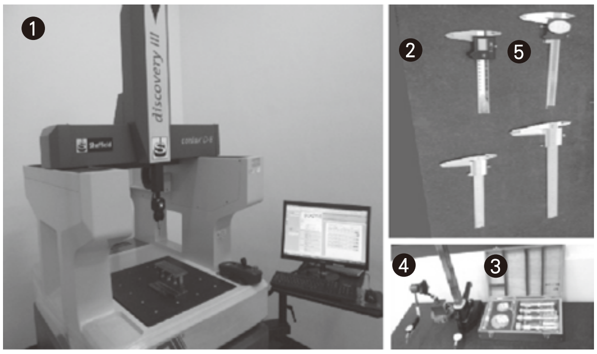
6.Belt tension testing	
Measuring tools	Pull tension gauge
Measuring methods	1. Fix the actuator on granite. 2. Use belt tension gauge to test the vibration of the belt. 3. As photo display. 4. Record it on shipping testing.



7.Decibel testing	
Measuring tools	Decibel meter
Measuring methods	1. Fix the actuator on granite. 2. Decibel meter put at the distance of 300mm. 3. Use motor to drive actuator in high speed. 4. As photo display. 5. Record it on shipping testing report.



8.Measuring tool- Granite platform	
Granite specifications	1. Size 1295mm*600mm*140mm 2. Size 4020mm*800mm*300mm

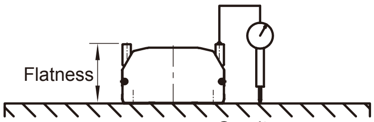


9.Material tools	
Measuring tools	1. 3D Inspection testing machine. 2. Electronic vernier caliper, vernier caliper. 3. Inside micrometer, outside micrometer. 4. Altimeter, vertical meter. 5. Electronic level meter. 6. Dial gauge, Dial indicator. 7. Steel tape, Steel ruler.
Measuring tools calibration standards	Block gauge, ring gauge (regularly qualified) QC Room 1. Control temperature and humidity to keep the stability of the measurement. 2. Measuring tools calibrate regularly.

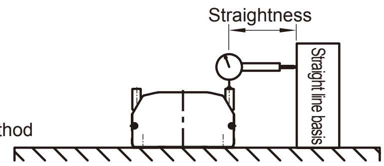
Flatness and straightness standard

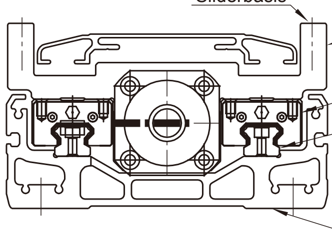
Flatness standard=The parallelism of body basis and slider basis is less then 0.05mm/M
Straightness standard=The parallelism of slider basis and straight line basis is less then 0.05mm/M

Flatness testing method



Straightness testing method

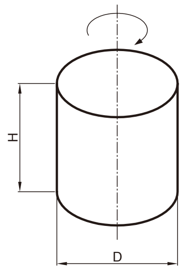




Sectional drawing

Equation of moment of inertia calculation

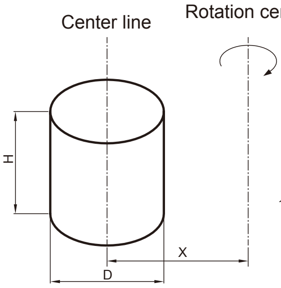
Usually the load is not simple form, and the calculation of the moment of inertia is not easy. As a method, load is replaced with several factors that resemble a simple form for which the moment of inertia can be calculated. The total of the moment of inertia for these factors is the obtained. The objects and equations often used for the calculation of the moment of inertia are shown below.



1.Moment of inertia for cylinder
The moment of inertia(J) for a cylinder having a rotation center such as shown below is given by

$$J = \frac{P\pi D^4 h}{32\times 980} = \frac{WD^2}{8g}\ (kgf\cdot cm\cdot sec^2)$$
$$= \frac{mD^2}{8}\ (Kgm^2)$$

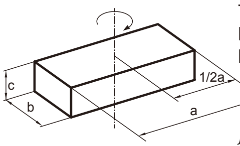
P = Density (kg/cm^3)
g = Gravitational acceleration (cm/sec^2)
W =Weight of cylinder (kgf)
m = Mass of cylinder (kg)



3.When the object's center line is offset from the rotation center
The moment of inertia(J) for a cylinder having a rotation center such as shown below is given by

$$J = \frac{P\pi D^4 h}{32} + \frac{P\pi D^4 h}{4} = \frac{WD^2}{8g} + \frac{WX^2}{G}\ (kgf\cdot cm\cdot sec^2)$$
$$= \frac{mD^2}{8} + mX^2 (Kgm^2)$$

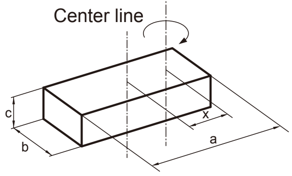
P = Density (kg/cm^3)
g = Gravitational acceleration (cm/sec^2)
W =Weight of cylinder (kgf)
m = Mass of cylinder (kg)



2.Moment of inertia for rectangular parallelepiped
The moment of inertia(J) for a cylinder having a rotation center such as shown below is given by

$$J = \frac{Pabc(a^2+b^2)}{12} = \frac{W(a^2+b^2)}{12g}\ (kgf\cdot cm\cdot sec^2)$$
$$= \frac{M(a^2+b^2)}{12}\ (Kgm^2)$$

P = Density (kg/cm^3)
g = Gravitational acceleration (cm/sec^2)
W =Weight of cylinder (kgf)
m = Mass of cylinder (kg)

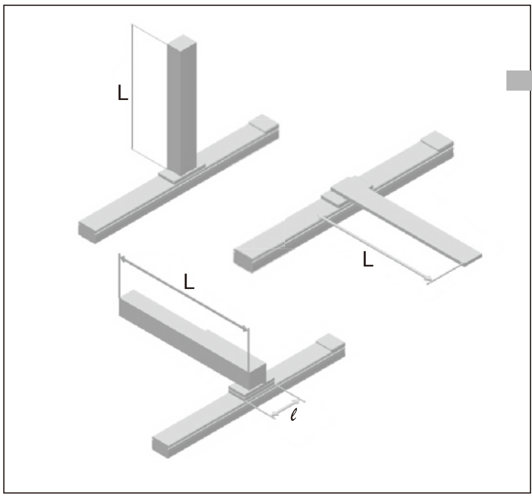


$$J = \frac{Pabc(a^2+b^2)}{12} + \frac{PabcX^2}{G}$$
$$= \frac{W(a^2+b^2)}{12g} + \frac{WX^2}{G}\ (kgf\cdot cm\cdot sec^2)$$
$$= \frac{M(a^2+b^2)}{12} + mX^2 (Kgm^2)$$

W =Weight of prism (kgf)
m = Mass of prism (kg)

Overhang load length

An overhang load length is specified for a slider-type actuator to indicate the length of overhang (offset) from the actuator. When the length of an object mounted to the slider actuator exceeds this length, it will generate vibration and increase the setting time. So, pay attention to the allowable overhang length as well as the allowable dynamic moment.



The allowable overhang load length is determined by the slider length.

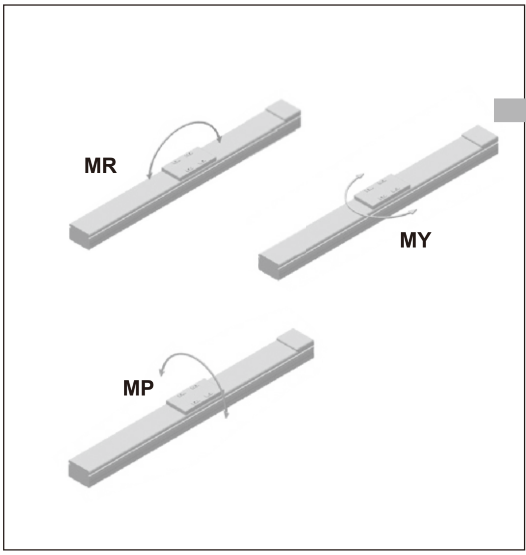
An overhang that exceeds the allowable overhang length will generate vibration and increase settling time.

L/ℓ =5 Within
* Between 3 to 4 for acamera equipped measuring machine.

- For example
  L/ℓ =1.2 Mechanical machine
  L/ℓ =3 Mechanical machine
  L/ℓ =5 Robot

Allowable dynamic moment

The allowable dynamic moment is the maximum offset load exerted on the slider, calculated from the guide life. The direction in which force is exerted on the guide is categorized into 3 directions-MP(pitch), MY(yaw), MR(roll)-the tolerance for each of which are set for each actuator. Applying a moment exceeding the allowable value will reduce the service life of the actuator. Use an auxiliary guide when working within or in excess of these tolerances.



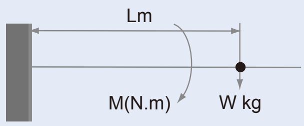
The allowable dynamic moment is calculated from the service life of the guide.

Over the moment would reduce the life of actuator.

*Moment is based on the following basis

M(N.m)=W(kg)×L(m)×9.8

W(kg)=Load
L(m)=Distance from work point to the center of gravity of payload.



Lead accuracy

PMI's precision ground ball screws are controlled in accordance with JIS B 1192.
The permissible values and each part of definitions are shown below.

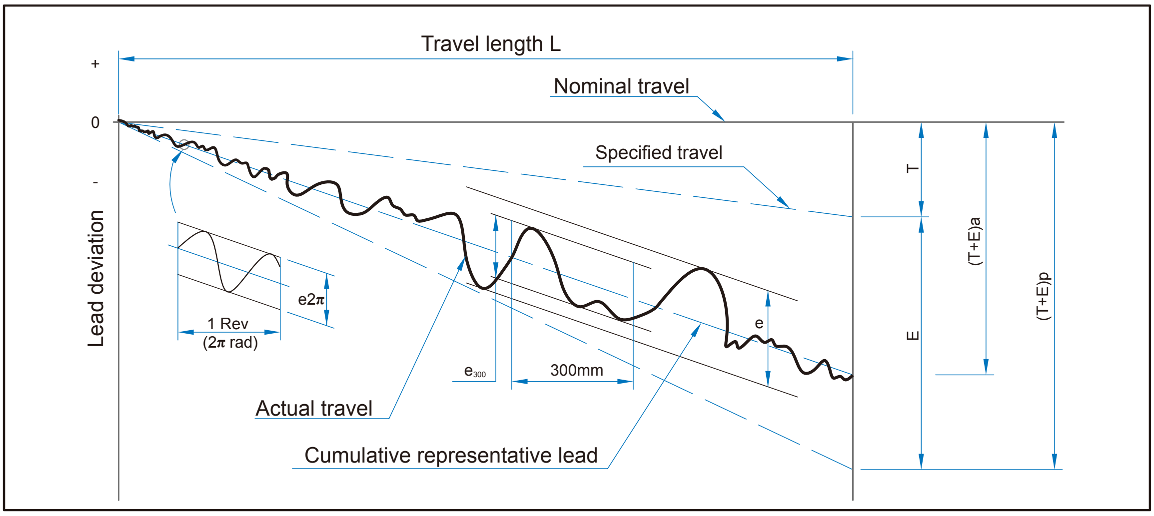


Fig.1 Technical terms concerning the lead

■ Table 1 Terms

T+E	Cumulative representative lead	Cumulative representative lead. A straight line representing the tendency of the cumulative actual lead. This is obtained by least square method and measured by laser system.
P		Permissible value.
a		Actual value.
T	Specified travel specify the target value	Specified travel. This value is determined by customer and maker as it depends on different application requirements.
E	Cumulative representative lead error	Accumulated reference lead deviation. This is allowable deviation of specified travel. It is decided by both of the accuracy grade and effective thread length.
e	Change	Total relative lead variation maximum width of variation over the travel length.
e_{300}		Lead deviation in random 300 mm.
$e_{2\pi}$		Lead deviation in random 1 revolution 2π rad.

■ Table 2 Accumulated reference lead deviation (±E) and total relative variation (e)

Effective thread length(mm)

Grade		C0		C1		C2		C3		C4		C5		C6	C7	C8
Over	up to	E	e	E	e	E	e	E	e	E	e	E	e	±0.025 / 300mm	±0.050 / 300mm	±0.120 / 300mm
	315	4	3.5	6	5	5	7	12	8	12	12	23	18			
315	400	5	3.5	7	5	7	7	13	10	14	12	25	20			
400	500	6	4	8	5	8	7	15	10	16	12	27	20			
500	630	6	4	9	6	9	7	16	12	18	14	30	23			
630	800	7	5	10	7	10	7	18	13	20	14	35	25			
800	1000	8	6	11	8	11	8	21	15	22	16	40	27			
1000	1250	9	6	13	9	13	9	24	16	25	18	46	30			
1250	1600	11	7	15	10	15	10	29	18	29	20	54	35			
1600	2000			18	11	18	11	35	21	35	22	65	40			
2000	2500			22	12	21	13	41	24	41	25	77	46			
2500	3150			26	15	25	15	50	29	50	29	93	54			
3150	4000			32	18	30	18	62	35	62	35	115	65			
4000	5000					36	21	76	41	76	41	140	77			
5000	6300							85	50	85	50	170	96			
6300	8000							106	62	106	62	213	115			
8000										132	75	265	140			

■ Table 3 Accuracy grade

Variation in random 300mm (**e_{300}**) and wobble (**$e_{2\pi}$**)

α_{522}

Grade	C0	C1	C2	C3	C4	C5	C6	C7	C10
JIS	3.5	5		8		18		50	210
PMI	3.5	5	7	8	12	18	25	50	210

$\alpha_{4\pi}$

Grade	C0	C1	C2	C3	C4	C5
JIS	3	4		6		8
PMI	3	4	4	6	8	8