Manual Stages Guide

Operating Environment of Manual Stages

Use manual positioning stages within the following environment temperature range.
Contact us for information regarding using the stages outside the given operational environment temperature range.

＊Operating environment

Category	Operational environment temperature
Stainless steel manual stages	–20°C ～ +120°C
Stages with digital micrometer head	0°C ～ +40°C
Other manual stages	–20°C ～ +70°C

＊Recommended environment
23°±5°C, 60±10% (without condensation)

Operating environment temperature changes depending on various conditions such as the type of positioning stage, installation and operation conditions.
Avoid use of the stages in the following sites.

- Sites subject to water or oil
- Sites subject to direct sunlight or radiant heat
- Sites subject to dirt and dust
- Sites subject to vibration or impact
- Sites close to fire
- Sites subject to inflammable gas and corrosive gas

Installation Direction (Mounting)

The values in the specifications of each product are based on installation on a horizontal surface.
Note that load capacity and other specifications will significantly change for upside down, lateral horizontal and other installation orientations.

Category	Positioning Slide	Part Number	Upside Down	Lateral Horizontal (Inclination)	Lateral Vertical
Linear	Extended contact ball bearing guide method	TSD	○	○	○
	Extended contact ball bearing guide method (flat Z)	TSD-**3	×	×	×
	Extended contact ball bearing guide method (flat Z)	TSD-**UD	○	○	○
	Crossed roller method	TAM	○	○	○
	Dovetail slide method	TASB, TAR	○	○	○
Rotation	Extended contact ball bearing guide method	KSPT	○	○	○
	Crossed roller method	KSPB	○	○	○
	Fitting method	KSP, KSPA, KSW, KSC	△	△	△
Gonio	Extended contact ball guide method	GOHT, GOHT-S	○	○	○
	Dovetail slide method	GOH, GOHB	○	○	○

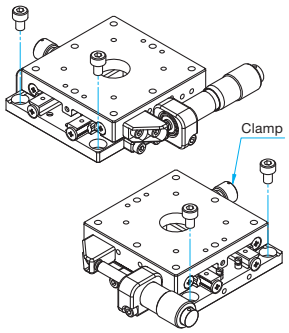
○: Possible with limits on load and moment, etc.
△: May significantly deteriorate precision depending on installation orientation, but possible with limits on load and moment, etc.
×: Not allowed

Note) When using stages in lateral vertical direction, refer to the actuator specifications. Reference Chapter F Actuators

Mounting Methods of Stages

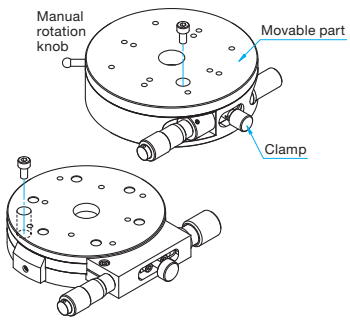
Mounting methods differ depending on the stage type; some stages require the table surface to be moved (by loosening the clamp), and some stages can be directly mounted.

Linear Stage

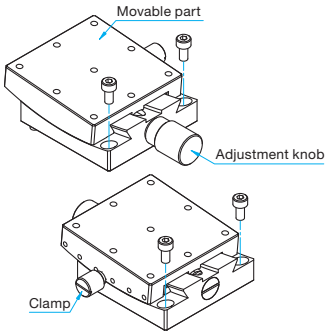


Loosen the clamp, turn the micrometer head, and then move the stage to mount.

Rotation Stage



Gonio Stage



Loosen the clamp, turn the adjustment knob, and then move the stage to mount. Attach the accessory screws to the two mounting holes, and do the same thing on the other side.

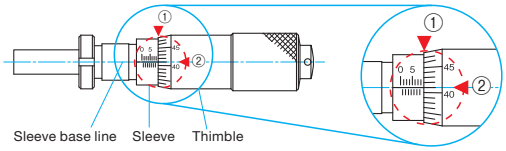
Accessory Screws

Mounting bolts described in the external dimensions in the catalog are included.

How to Read Micrometer Head and Vernier Scale

Micrometer head and vernier scale are available for reading the stage position.

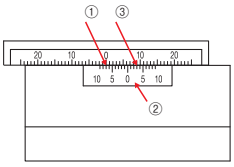
How to Read a Micrometer Head



If the readable resolution is 0.01mm

1. Read the mark on the sleeve that lines up with the edge of thimble ① in units of 0.5mm. In this case, 8.5mm.
2. Read the value ② on the thimble that lines up with the sleeve base line in units of 0.01mm. In this case, 0.41mm.
3. Lastly, sum up 1. and 2. to confirm the current position of the manual stage. 8.5mm+0.41mm=8.91mm

How to Read a Vernier Scale



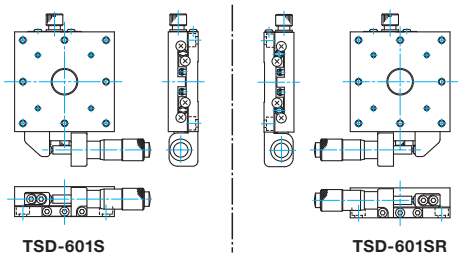
1. Read the mark on scale ① that is coincident with the 0-mark on vernier scale ② in units of 1mm. In this case, 7mm.
2. Read mark ① where the mark on vernier scale ② and that on scale ① line up in units of 0.1mm. In this case, 0.3mm.
3. Lastly, sum up 1. and 2. to confirm the current position of the stage. 7mm+0.3mm=7.3mm

Opposite Models

When installation spaces have constraints or symmetrical systems are required, we offer opposite models without price difference. The configuration and orientation of opposite models are as follows.

■For single axis

Opposite models will be axially symmetrical in the external dimensions.

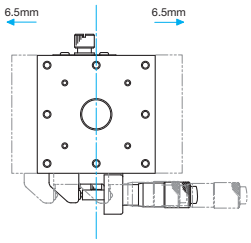


TSD-601S　　TSD-601SR

Travel

Travel is described with ±.

(E.g.) In the case of ±6.5mm, with the outline drawing position as the center, move for (+)6.5mm in one direction, and move for (-)6.5mm in the opposite direction. In this case, the full travel is 13mm.



Grease Used

We use an appropriate grease for each of our manual stages according to the respective characteristics.

Relevant Product	TSD TSDT	TAM	IPWS	GOH GOHT	KSP KSPT	TADC	TSDH	TSDS
Grease	High durability grease			Optical special grease			Low dust generation grease	Vacuum grease
Usable Temperature Range	–20°C ~ 70°C						–40°C ~ 120°C	–0°C ~ 250°C

■High Durability Grease

A high-grade versatile grease for industrial use. It is best suited for electric motor bearings or machine tool bearings which are particularly required for high quality and high performance.
In addition, it is excellent in noise reduction, and can be used for a wide range of applications.

■Low Dust Generation Grease (AFF Grease manufactured by THK Co., Ltd.)

Best suited for use in clean rooms because of its excellent low dust generation properties. Since its viscosity resistance is low, its rolling resistance is stable and excellent in following capability at low speed. Compared with other low dust generation greases, this grease can offer longer greasing intervals because of its excellent fretting resistance.

■Vacuum Grease (Fomblin Grease YVAC2)

This grease is widely used for various vacuum equipment and for clean rooms. The grease vapor pressure is 5×10 (–13 power) Torr at 20°C.

■Optical Special Grease

This grease is used in many precision equipment fields because, in addition to lubricating properties, it has high cold resistance and heat resistance, low oozing properties, no influence on the coating surface, and is harmless to resins.

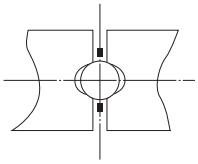
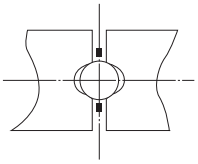
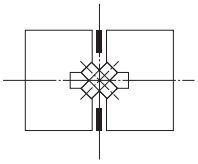
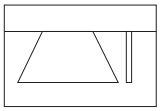
* We can also replace the greases with ones not listed above. Contact our International Sales Division for more information.

Translation Stages Guide

Stages used for positioning in X, Y and Z directions (in 3-dimensional plane).

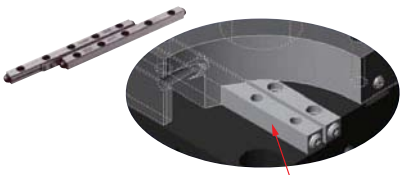
Suitable for various purposes including optical experiments for research and development and assembly in systems.

Guide Structure

Guide Method	Extended Contact Ball Bearing Guide		Crossed Roller Guide	Dovetail Slide Method
Part Number	**TSD/TSDH/TSDT/TSDS**	**TADC**	**TAM, TAMC**	**TASB/TAR**
Primary Material	Steel / Stainless steel	Aluminum	Aluminum	Brass
Structure				
Shape				
Outline of Guide	A guide is directly processed on the lower and upper plates of the stage, quenched and ground. Steel balls are positioned between them.	Positioning slide having cylindrical rollers arranged orthogonally one after another in a V groove rail.	Positioning slide having quenched and ground guides screwed on the aluminum bottom and top plates, and balls between them.	Face-fitting positioning slide having trapezoidal male and female sections.
Stage Thickness	◎	○	○	△
Stiffness	◎	○	○	○
Travel Accuracy	◎	○	○	△
Resolution	◎	◎	◎	△
Weight	△	◎	◎	○

Crossed Roller Guide

Line contact of rollers in a V groove rail offers high stiffness. In addition, low friction and almost no differential slip are suitable for minute feeding.

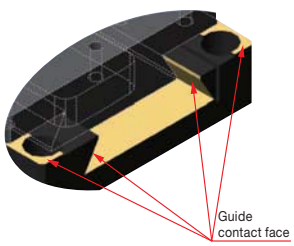


Crossed roller guide

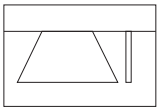
■Features■
Crossed roller guide enabled high precision and high stiffness.
Aluminum body offers light-weight.

Dovetail Slide Method

The dovetail groove method with face-fitting guide mechanism is used. Its high friction coefficient is not suitable for fine positioning, but very effective in simple positioning.



Guide contact face



Face-fitting positioning slide having trapezoidal male and female sections

■Features■
The simple guide structure offers low price.
Highly stable due to face-fitting guide.
Compact design is ideal for assembly in systems or fixing in confined spaces.

Extended Contact Bearing Ball Guide (TSD/TSDH/TSDT/TSDS Series)

These products are developed based on Sigma Koki's original processing technology.

■Features

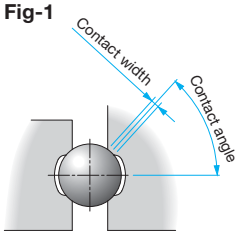
①High Precision ②High Load Capacity ③High stiffness ④High Durability ⑤Low Profile

■High Load Capacity and High Stiffness

- **The four-array contact structure achieves high load capacity and high stiffness (13 times stiffer than the V groove)**

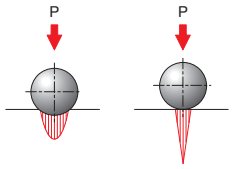
As shown in Fig-1, ball guides are machined across the arcs so that they have R groove structure and good contact with a ball allowing stable load capacity against the load in the directions where contact with the ball occurs frequently.

Fig-1



Ball contact structure

Fig-2



Pressure distribution of one ball

■High Durability

- **Long life and free of maintenance**

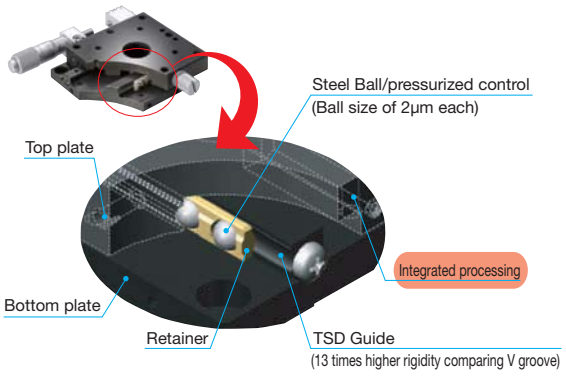
Fig-2 shows the pressure distribution of the R groove and the flat surface. As shown in the figure, pressure exerted on the R groove is dispersed and does not reach inside. Thus, metal fatigue and wear are reduced. Reference Data for durability is listed. E014

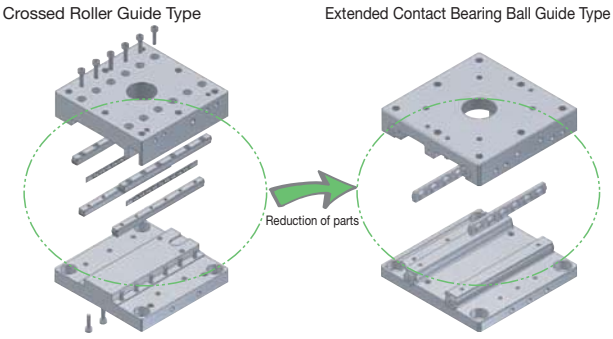
■High Precision

- **The integral (simultaneous) machining achieves high precision (straightness: 0.7 µm or lower)**

As shown in Fig-3, the top and bottom plates are integrally and simultaneously machined using an originally devised machining jig to minimize respective machining errors. That is, to maintain high precision, these plates are machined in virtually the same state as when a ball is inside.

Fig-3



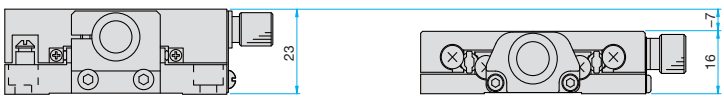


■Low Profile

- **Reduction in the number of parts enables low profiling**

Fig-4 shows a comparison of thickness of a crossed roller stage and a ball guide stage. The integration of the guides into the top and bottom plates allows low profiling of the ball guide stage virtually the same state as when a ball is inside.

Fig-4



TAM-601C (Crossed Roller Stage) TSDH-601C (Ball Guide Stage)

* The TSDT series further reduces the stage thickness to 10mm.
Reference E016

Option for Translation Stages

Option Code

Option Code						
	Stage Size	Axis number	Micrometer head positioning	Opposite Model	Type of Micrometer head	Standard of length
TSD	25	1	C	–	FP	–
TAM	40	2	S	R	DM	EE
TSDH	60	3			WP	UU
	65				DL	
	80				DG	
	100					

Axis number
1 : X Axis
2 : XY Axis
3 : Z Axis

Micrometer head positioning
C : Center
S : Side

Opposite Model
–
R : Opposite Model

Standard of length
– : METRIC
EE : METRIC (M6)
UU : INCH

Option Code	Reference
FP : Fine-pitch Screw Adjusters	F010
DM : Differential Micrometer Heads	F006
WP : Sub-micron Worm Drive Micrometer Heads	F007
DL : Angled Micrometer Heads	F008
DG : Micrometer Heads (Digital display)	F005

Guide

▶If you can not change the feed operation in the specification of the Option Code, please consult our Sales Division.

Micrometer control position / feed control

Change the micrometer control position or feed control to suit your purpose
.....Select according to your purpose such as for price reduction and space saving.

Price Reduction

Option code **FP**
FPSA
Fine-pitch Screw Adjusters
Reference F010

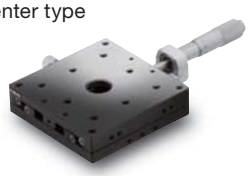
Price of manual stages can be reduced. Ideal for positioning that does not require measurement, and installation in confined spaces.

(e.g.) **TSD-601CFP**

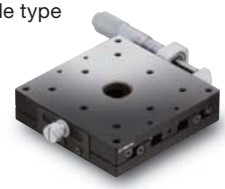
(e.g.) **TSD-601SFP**

Standard Micrometer Heads
Reference F004

Center type



Side type



High Resolution

Option code **DM**
MHF2-13 Micrometer Heads
Reference F006

Fine positioning is possible by switching between coarse and fine adjustments.

(e.g.) **TSD-601SDM**

Space Saving

Option code **WP**
WGP Sub-Micron Differential Micrometers
Reference F007

Offer low price and space saving coarse/fine adjustment micrometer heads. Coarse and fine drive control is possible throughout the full travel.

(e.g.) **TSD-601SWP**

Improving Work Efficiency

Option code **DL**
MDC-**
Angled Micrometer Heads
Reference F008

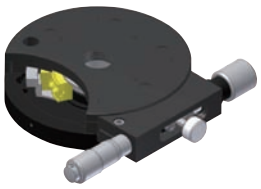
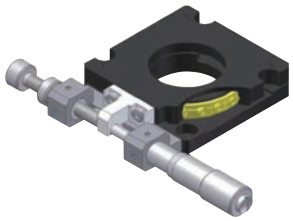
Unidirectional control units increases work efficiency.

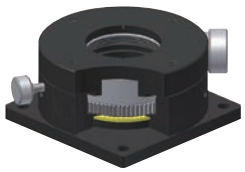
(e.g.) **TSD-601SDL**

Stages used for adjustment by rotating samples.

Coarse/fine movement type, transmission hole type, low-profile square type and other types are available to suit your purpose.

Structures and Features

Guide Method	Lapping	Crossed Roller	Extended Contact Ball Bearing Guide
Part Number	**KSP/KSPA/KSPS**	**KSPB**	**KSPT**
Primary Material	Brass / Stainless steel	Brass	Steel
Structure			
Features	High resolution, coarse movement of 360° and fine movement of ±5° are possible, and models with a transmission hole at the center of the stage can be used when a transmission hole is required	Transmission hole, high precision, high resolution, and high load capacity	Ultra thin, flexibly support any installation orientation
Stage Thickness	○	○	◎
Rigidity	○	◎	○
Travel Accuracy	○	◎	◎
Coarse Rotation Range	360°	360°	±10°
Resolution	○	◎	◎
Weight	◎	○	◎

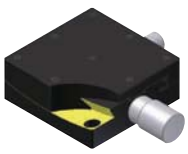
Guide Method	Lapping (partly crossed roller)	Dovetail Slide Method
Part Number	**KSW**	**KSSA**
Primary Material	Brass (part Aluminum)	Brass
Structure		
Features	Since driven by worm gear, precision adjustment is possible for over 360°	Unique rotation stage having square table surface Rotation Stage
Stage Thickness	△	△
Rigidity	○ (Aluminum is △)	○
Travel Accuracy	○	◎
Coarse Rotation Range	360°	±3 – ±5° (depending on the stage)
Resolution	○	△
Weight	◎	○

Goniometer Stages Guide

Goniometers are rotation stages that rotate about an axis that is located at a distance above the surface of the stage.

Used for direction adjustment and correction, or tilting and rotation of samples.
Products with different guide mechanisms or feed mechanisms are also available.

Structures and Features

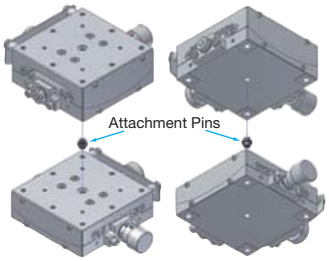
Guide Method			Extended Contact Ball Bearing Guide			Dovetail Slide Method	
Part Number			GOHT		GOHTA	GOH	GOHB
Primary Material			SUS440C quench hardened		Aluminum	Brass	Brass
Feeding mechanism			Gear Drive	Micrometer Head	Gear Drive	Gear Drive	Screw
Structure							
Stage Size [mm]	15 × 15	METRIC	—		—	○	—
	25 × 25	METRIC	—		—	○	—
	40 × 40	METRIC	○		—	○	○
		INCH	○		—	○	—
	60 × 60	METRIC	○		—	○	○
	65 × 65	METRIC	○		—	○	—
		INCH	○		—	○	—
	120 × 120	METRIC	—		○	—	—
Features			Unique product High precision Ideal for frequent operations		Precision and high stiffness High load capacity	Low price Cost effective	Cost effective Ideal for permanent fixation High durability
Load Capacity			◎	△	◎	○	△
Rigidity			◎	◎	◎	○	○
Travel Accuracy			◎	◎	◎	○	○
Resolution			○	◎	○	○	◎
Weight			○	○	△	○	○

2D CAD 3D CAD

Attachment Pins (Alignment Pins)

Attachment Pins (Alignment Pins) insure that two stages that are stacked have their centers alignment, reducing assembly time.

Catalog Code W7112



- An $\alpha\beta$ axis stack is easily assembly by attaching an alignment pin at the top center of a GOHT series stage, and inserting it into the hole in the lower surface of the top stage.
- Ideal not only for assembly of single axis stages, but also for positioning when mounting on instruments or devices.

Specifications

Part Number	GOHT-AP-10
Compatible Products	GOHT-40·60, TSDH-60
Primary Material	SUS303
Finish	None
Quantity [pieces]	10
Weight [kg]	0.0005

Attention

▶In case of single shipment, this product is delivered only by mail.

Extended Contact Ball Bearing Guide Method (GOHT/GOHTA Series)

These products are developed based on Sigma Koki's original processing technology.

■Features

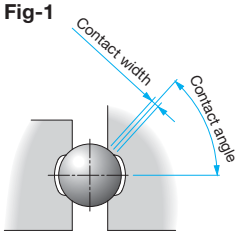
①High Precision ②High Load Capacity ③High Stiffness

■High Load Capacity and High Stiffness

- **The four-array contact structure achieves high load capacity and high stiffness (13 times stiffer than the V groove)**

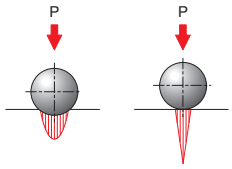
As shown in Fig-1, ball guides are machined across the arcs so that they have R groove structure and good contact with a ball allowing stable load capacity against the load in the directions where contact with the ball occurs frequently.

Fig-1



Ball contact structure

Fig-2



Pressure distribution of one ball

■High Durability

- **Long life and free of maintenance**

Fig-2 shows the pressure distribution of the R groove and the flat surface. As shown in the figure, pressure exerted on the R groove is dispersed and does not reach inside. Thus, metal fatigue and wear are reduced. Reference Data for durability is listed. E015

■High Precision

- **Our original processing technology achieved an integral structure of the main body and the guides**

As shown in Fig-3, because the crossed roller type goniometer stage, which has been the mainstream, has the guide separate from the main body, there are many parts. Assembling a large number of parts caused errors or variation, resulting in translation errors, that is, deviation in the most important rotation center when the stage moved. Our goniometer stage as shown in Fig-4, has the guide integrated into the main body in order to compensate for assembly errors or variation by machining accuracy. With the integral structure, the displacement of the rotation center is reduced.

Fig-3

Crossed Roller Guide Type　　Extended Contact Ball Guide Type (GOHT)

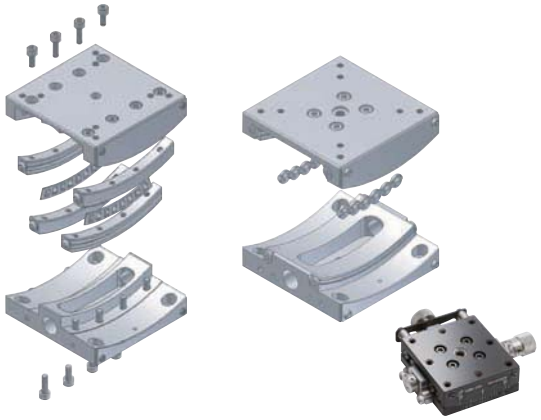
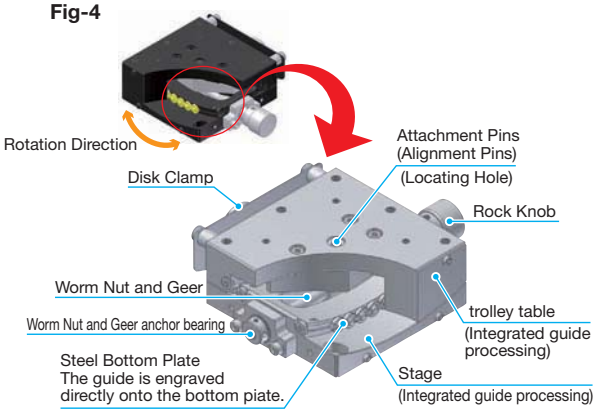


Fig-4

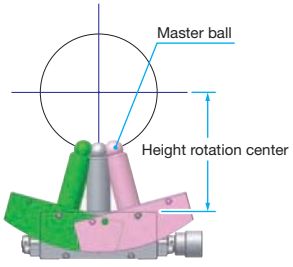


<Rotation Center Displacement>

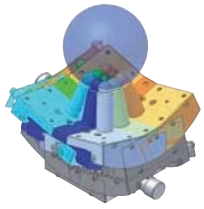
- Our ball guide goniometer stage　　ϕ0.007mm or less
- Crossed roller goniometer stage manufactured by another company　　ϕ0.01mm or less

<Reference>

- Measuring method of the displacement of rotation center.
  Installing the "master ball" on the top of stage surface.
  Then sequentially positioning in a certain direction from the starting point to the travel end.
  Measuring by three-dimensional measuring device the position of the master ball in each position.
  From the coordinate data and obtains the fluctuation width of the circular orbit, determine the center of rotation displacement amount.



α axis



$\alpha\beta$ axis

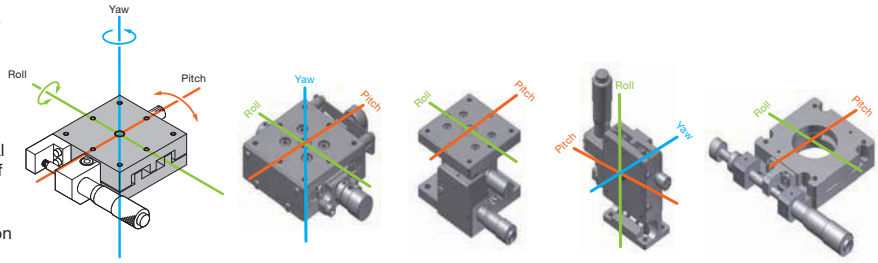
Definitions of Specifications and Terminology

Interpretation of the Specification Table

	Specifications		
1…	Part Number		***-**
2…	Opposite Model		***-**R
3…	Stage Size		**×**mm
4…	Micrometer Position		
5…	Travel		±**mm
6…	Lead of Actuator		**mm
7…	Guide Method		
8…	Primary Material		
	Finish		
9…	Load capacity		**N (**kgf)
10…	Travel Accuracy	Straightness	*μm
11…		Pitch	**″
12…		Yaw	**″
13…	Max. Moment Capacity	Pitch	**N·m
		Roll	**N·m
		Yaw	**N·m
14…	Moment Stiffness	Pitch	**″/N·cm
		Roll	**″/N·cm
		Yaw	**″/N·cm
15…	Parallelism		*μm
16…	Running Parallelism		*μm
17…	Weight		**kg

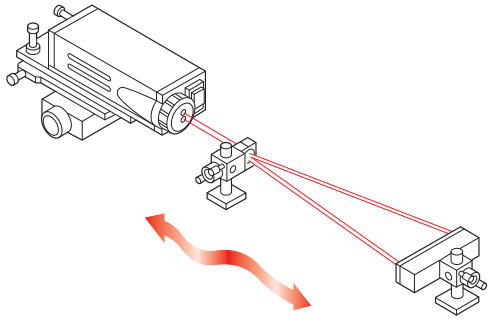
1 Part Number
2 Opposite Model
3 Stage Size
4 Micrometer Position — Position of the micrometer with respect to the stage surface is indicated as center or side.
5 Travel
* Indicated by plus and minus using the reference position of product (when the top and bottom plates are at the same position) as the reference position. (On the outline drawing in the catalog, travel in one direction is indicated by +mm and in the opposite direction is indicated by –mm with the outline drawing position as the reference position.)
* It indicates the full travel range, it the reference position can not be determined.
6 Lead of Actuator — Change in position when the feed control (micrometer head, fine-pitch screw or the like) is turned one time.
7 Guide Method
* Extended Contact Ball Bearing Guide
* Crossed roller guide
* Dovetail Slide method
* Leadscrew driving method
* Lapping method
* V groove screw
* Special guide methods other than the ones listed on the left are available. Refer to the specification table of each product.
8 Primary Material Finish — Material used for the product and surface finishing.
9 Load Capacity — Load capacity at the center of the stage (static load).
* Please contact our International Sales Division if you require to use them above the ruted load capacity.
10 Travel Accuracy: Straightness (units: μm) — Indicates a deviation from the straight line connecting the start and end points of the full travel of a linear stage.
11 : Pitch — Indicates the degree of tilt around the axis in the horizontal plane perpendicular to the direction of travel when moving the stage for full travel.
12 : Yaw — Indicates the degree of tilt around the axis in the vertical plane perpendicular to the direction of travel when moving the stage for full travel.
: Roll — Indicates the degree of tilt around the axis in the horizontal plane parallel to the direction of travel when moving the stage for full travel.
13 Max. Moment Capacity (units: N·m) — Load capacity of the stage when a sample is placed away from the center of the stage.
14 Moment Stiffness (units: ″/N·cm) — Stage strength against a load exerted at a position away from the center of the table top (the table center and the center of gravity of a sample does not match). Indicates the degree of tilt of the table top (sec) when 1N load is exerted at the position 1cm away from the center of the stage surface.
15 Parallelism — Parallelism of the stage top surface against the stage bottom surface.
16 Running Parallelism — Parallelism of the stage top surface against the stage bottom surface when the stage is moved for full travel.
17 Weight — Self weight of the product.

[Memo]
The drawing shows the types of tilt when a linear stage travels.
Towards the direction of travel...
Pitch Rotation around the axis in the horizontal plane perpendicular to the direction of travel
Yaw Rotation around the axis in the vertical plane perpendicular to the direction of travel
Roll Rotation around the axis in the horizontal plane parallel to the direction of travel

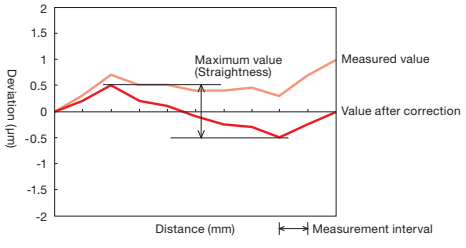


Definition of Terms in the Specification Table

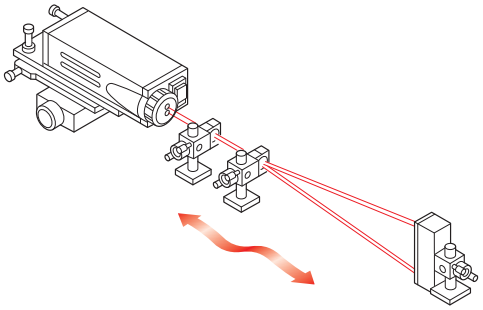
■Straightness (horizontal direction) [Units: μm]



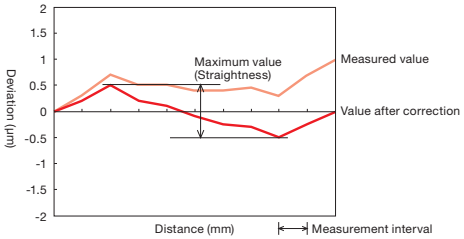
Move the stage and stop it at regular intervals throughout the full travel of the stage. At each point, measure the deviation from a reference position in the horizontal plane. The maximum deviation after correcting the deviation throughout the full travel to 0 is the straightness in the horizontal plane.



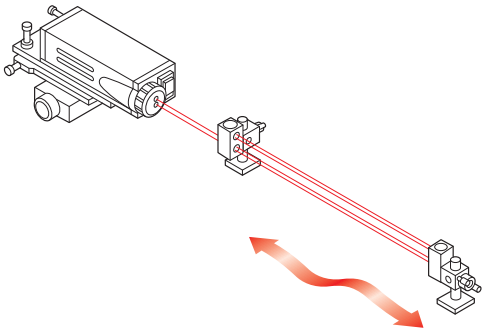
■Straightness (vertical direction) [Units: μm]



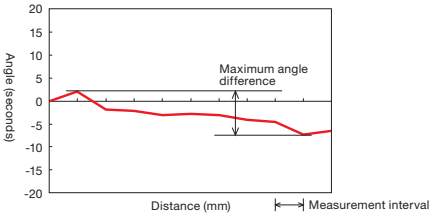
Move the stage and stop it at regular intervals throughout the full travel of the stage. At each point, measure the deviation from a reference position in the vertical plane. The maximum deviation after correcting the deviation throughout the full travel to 0 is the straightness in the vertical plane.



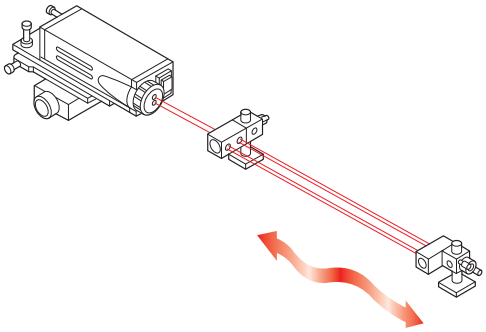
■Pitch [Units: ″]



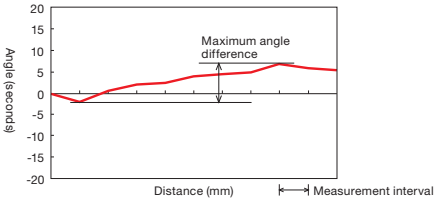
Move the stage and stop it at regular intervals throughout the full travel of the stage. At each point, measure the degree of tilt in the vertical plane. The maximum angular difference is the pitch.



■Yaw [Units: ″]

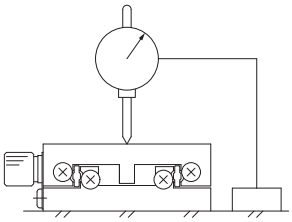


Move the stage and stop it at regular intervals throughout the full travel of the stage. At each point, measure the degree of tilt in the horizontal plane. The maximum angular difference is the yaw.



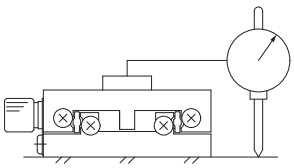
■Parallelism [Units: μm]

Fix a test indicator on an optical breadboard, bring it into contact with the top surface of the stage, and measure while moving it over the whole surface of the stage. The maximum difference of the displacement value of the test indicator is the parallelism.



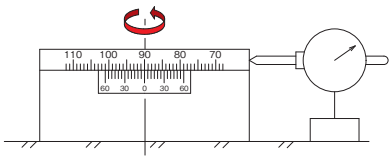
■Running Parallelism [Units: μm]

Fix a stage on an optical breadboard. Fix a test indicator on the top surface of the stage, bring it into contact with the top surface of the optical breadboard, and measure while moving the stage for the full travel. The maximum difference of the displacement value of the test indicator is the running parallelism.



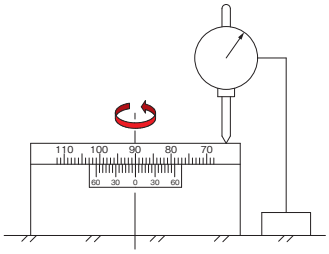
■Eccentricity [Units: μm]

Fix a rotation stage on an optical breadboard. Bring a test indicator into contact with the circumference of the rotation stage, and measure while turning the stage through one full rotation of 360°. Half of the maximum difference of the displacement value of the test indicator (misalignment) is the eccentricity.



■Wobble [Units: μm]

Fix a test indicator on an optical breadboard, bring it into contact with the edge of the top surface of a rotation stage, and measure while turning the stage for through one full rotation of 360°. The maximum difference of the displacement value of the test indicator is the wobble.



Durability Data of Manual Ball Guide Stages

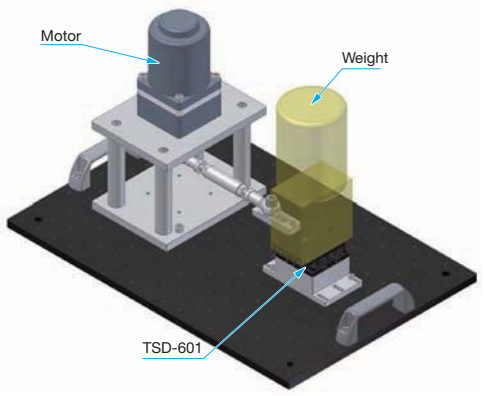
Application Systems
Optics & Optical Coatings
Opto-Mechanics
Bases
Manual Stages
Actuators & Adjusters
Motoeized Stages
Light Sources & Laser Safety
Index
Guide
X Axis Stages
XY Axis Stages
Z Axis Stages
XZ Axis Stages
XYZ Axis Stages
Rotation Stages
Goniometer
Tilt Stages
Vacuum
Ball Bearing Guide
Crossed Roller
Dovetail
Lapping
V Groove Screw
Ohters
15 × 15 mm
25 × 25 mm
40 × 40 mm
60 × 60 mm
65 × 65 mm
80 × 80 mm
100 × 100 mm
120 × 120 mm
Others

Translation Stage

[Test Procedure]
Reciprocate the stage with a load placed vertically on its upper surface, and measure the state change at that time.

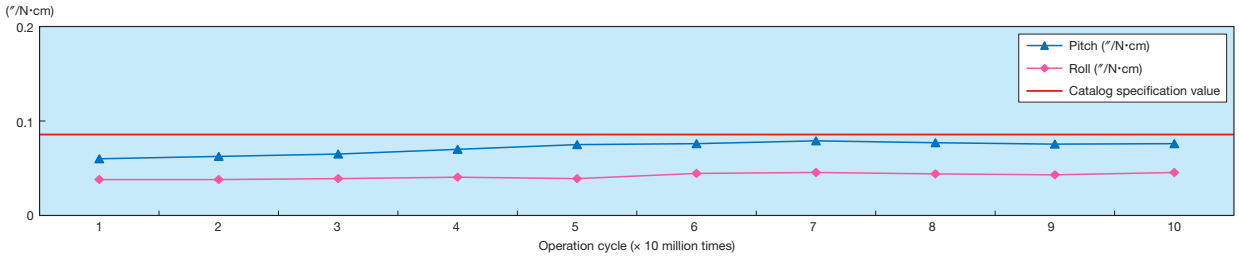
[Test Conditions]

Measurement Sample	**TSD-601**
Load	100N
Procedure	13 mm × Both ways/sec (continuous operation)
Operation Cycles (Distance)	10 million times (260 km)

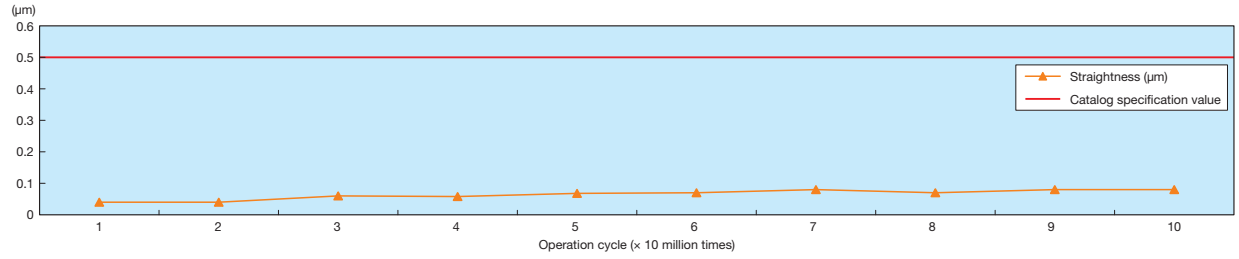


● **TSD series**
After 10 million cycles of operation, the guide performance is stable without significant change in the stiffness, straightness, pitching, yawing, and running parallelism of the stage guide.

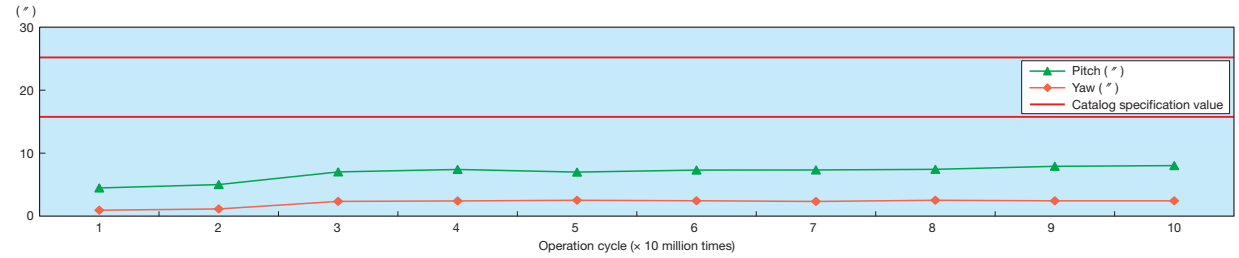
Moment Stiffness



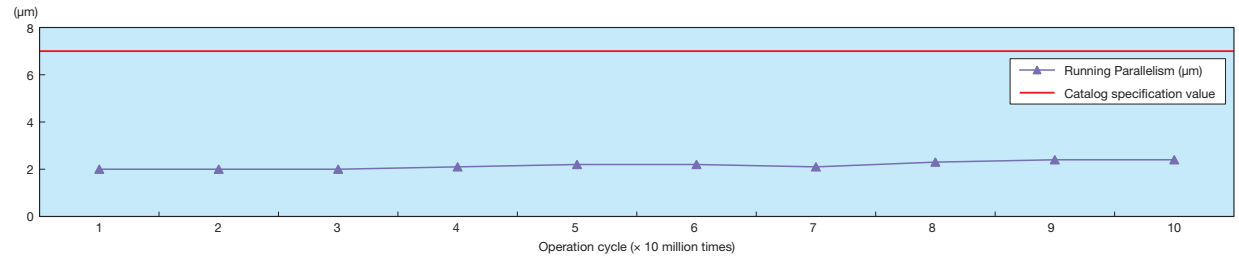
Straightness



Pitch / Yaw



Running Parallelism

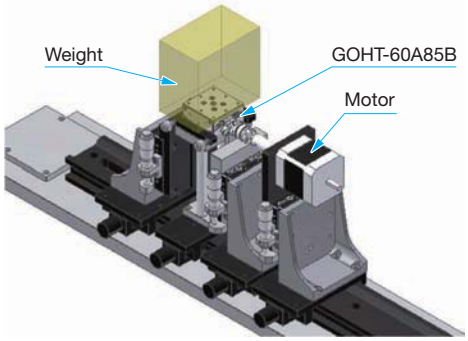


Goniometer Stage

[Test Procedure]
Reciprocate the stage with a load placed vertically on its upper surface, and measure the state change at that time.

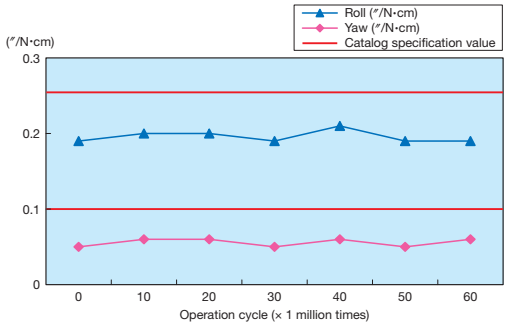
[Test Conditions]

Measurement Sample	**GOHT-60A85B**
Load	50N
Procedure	±15° × One way/sec (continuous operation)
Operation Cycles (Distance)	600,000 times (30 km)

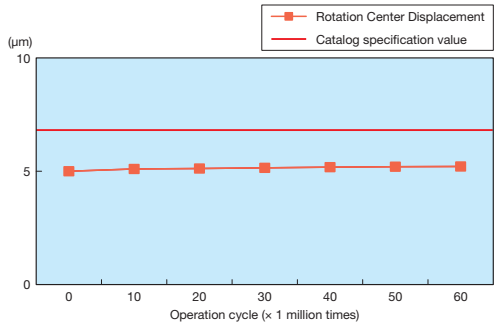


● **GOHT series**
After 600,000 cycles of operation, the guide performance is stable without significant change in the stiffness and rotation center displacement of the stage guide.

Moment Stiffness



Rotation Center Displacement

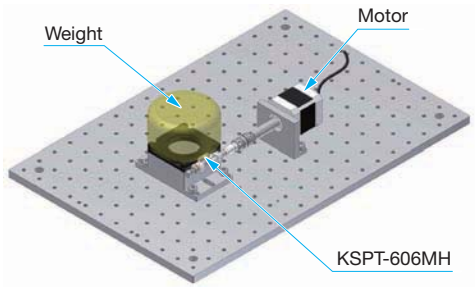


Rotation Stage

[Test Procedure]
Reciprocate the stage with a load placed vertically on its upper surface, and measure the state change at that time.

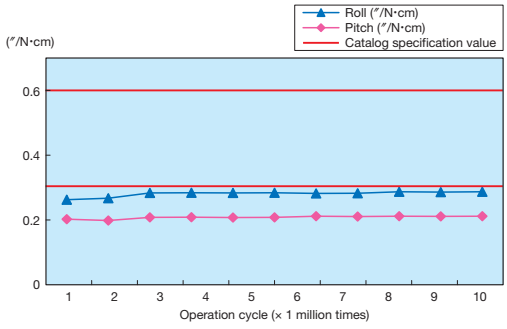
[Test Conditions]

Measurement Sample	**KSPT-606MH**
Load	100N
Procedure	±10° × Both ways/sec (continuous operation)
Operation Cycles (Distance)	100,000 times (1km)



● **KSPT series**
After 100,000 cycles of operation, the guide performance is stable without significant change in the stiffness, wobble, and parallelism of the stage guide.

Moment Stiffness



Wobble / Parallelism