General Explanation

IKO Selection of Precision Positioning Table

IKO Precision Positioning Table should be selected taking the points related to the required conditions into careful consideration. Typical selection procedure is shown below.

1 Check for operational condition
- Stroke length to be used
- Mounting space (height, width, length)
- Mounting direction
- Applied load size and direction
- Operation pattern
- Operating environment

2 Check for the required accuracy
- Positioning accuracy
- Positioning repeatability
- Parallelism in table motion A, B
- Straightness
- Squareness

3 Temporary selection of table model
- Feeding mechanism of slide table
- Size
- Stroke length
- Number of axes

4 Temporary selection of motor
- Type and size of motor

5 Consideration of maximum speed and resolution
- Ball screw lead
- Maximum number of revolutions of the motor
- Encoder specification

6 Consideration of operation patterns
- Marginal acceleration time
- Effective torque
- Inertia
- Positioning time

Re-consideration (6 → 3) / Determination (6 → 7)

7 Consideration of system
- Selection of controller
- With or without sensor
- Connection cord
- Interface with external devices

8 Final checking
- Re-check for operational condition
- Cost and delivery
- Additional machining
- Special table

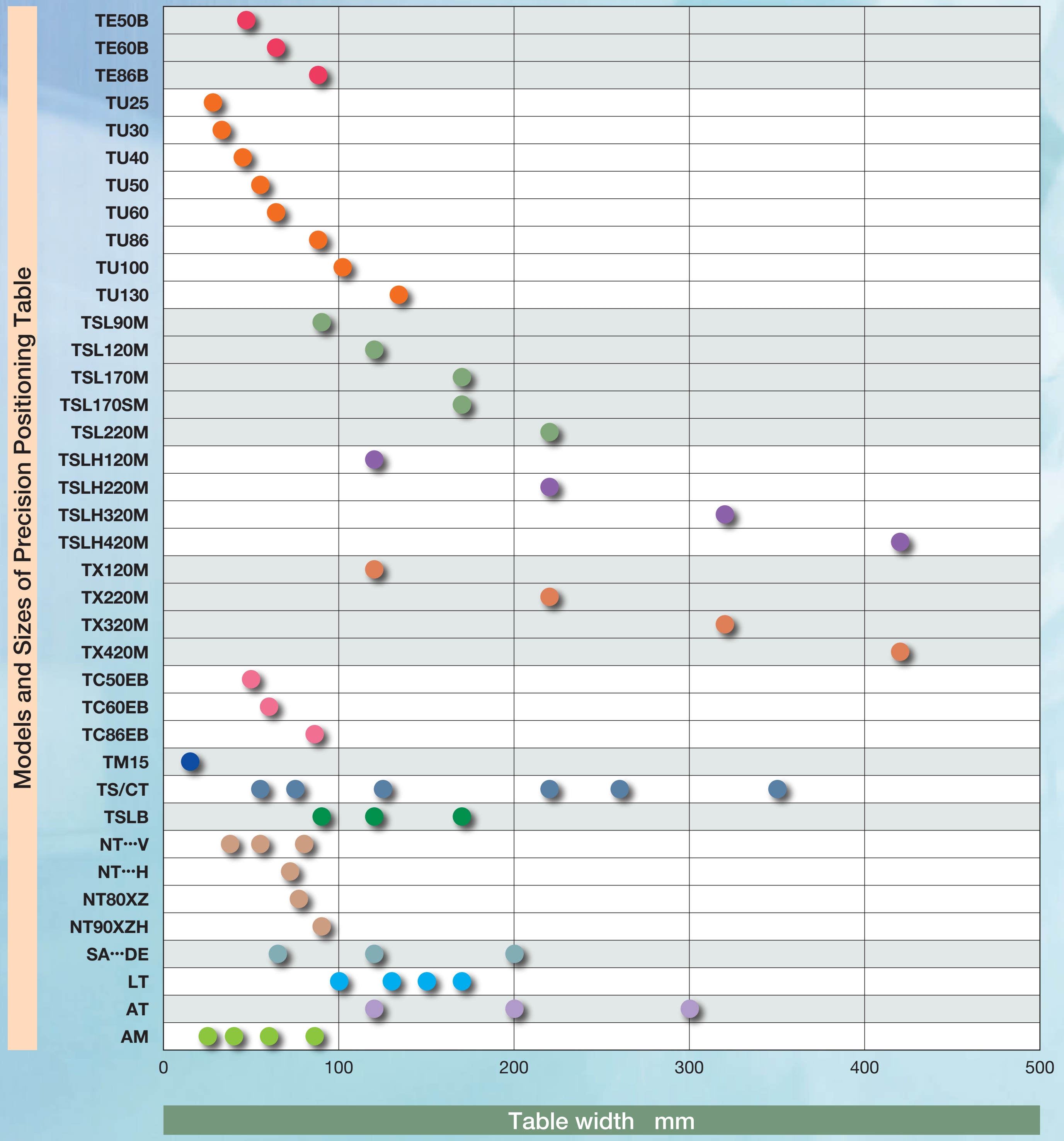
IKO Characteristics of Precision Positioning Table

Series	Model	Stroke length mm	Positioning repeatability	Positioning accuracy	High speed	Rigidity
Precision Positioning Table TE	TE···B	50 ~ 800	○	○	○	○
Precision Positioning Table TU	TU	30 ~ 1 400	○	○	○	○
Precision Positioning Table L	TSL···M	50 ~ 1 000	○	○	○	○
Precision Positioning Table LH	TSLH···M	100 ~ 800	○	○	○	◎
	CTLH···M	100 ~ 500	○	○	○	◎
Super Precision Positioning Table TX	TX···M	100 ~ 800	◎	◎	○	◎
	CTX···M	100 ~ 400	◎	◎	○	◎
Cleanroom Precision Positioning Table TC	TC···EB	50 ~ 800	○	○	○	△
Micro Precision Positioning Table TM	TM	10 ~ 60	○	○	△	△
Precision Positioning Table TS/CT	TS	25 ~ 250	○	○	△	△
	CT	15 ~ 250	○	○	△	△
Precision Positioning Table LB	TSLB	300 ~ 1 200	△	△	◎	○
Nano Linear NT	NT···V, XZ, XZH	10 ~ 120	◎	△	◎	△
	NT···H	25 ~ 65	◎	◎	○	○
Alignment Stage SA	SA···DE/X	10 ~ 20	◎	△	○	△
Linear Motor Table LT	LT···CE	200 ~ 1 200	◎	△	◎	△
	LT···LD	240 ~ 2 760	◎	△	◎	○
	LT···H	410 ~ 2 670	◎	△	◎	○
Alignment Module AM	AM	30 ~ 120	○	○	○	○

Feeding mechanism	Applied motor	With or without sensor	Linear motion rolling guide	Applications
C-Lube ball screw	AC servomotor/ Stepper motor	Selection	U-shaped Track Rail Linear Way with C-Lube built in	Assembler, Processing machine, Measuring equipment
Ball screw			U-shaped Track Rail Linear Way	Assembler, Processing machine, Measuring equipment
C-Lube ball screw		Provided as standard	C-Lube Linear Way (Parallel arrangement of 2 ways)	Assembler, Processing machine, Measuring equipment
				Precision processing machine, Precision measuring equipment Machine tool, Assembler
	AC servomotor		C-Lube Linear Roller Way Super *MX* (Parallel arrangement of 2 ways)	Precision processing machine, Precision measuring equipment Machine tool, Assembler
	AC servomotor/ Stepper motor	Selection	U-shaped Track Rail Linear Way with C-Lube built in	Semiconductor related device, LCD related device
Ball screw			Linear Way (Parallel arrangement of 2 ways)	Precision measuring equipment, Assembling machine
			Anti-Creep Cage Crossed Roller Way Crossed Roller Way	Precision measuring equipment, Prober Image processing unit, Exposure equipment
Timing belt	Stepper motor	Provided as standard	Linear Way (Parallel arrangement of 2 ways)	High speed conveyor, Palette changer
AC linear servomotor			C-Lube Linear Way Linear Way (Parallel arrangement of 2 ways)	Semiconductor related device, Medical equipment
			Anti-Creep Cage Crossed Roller Way	Semiconductor related system, Precision measuring equipment
			C-Lube Linear Way (Parallel arrangement of 2 ways)	Semiconductor related device, Medical equipment
				Semiconductor related device, High speed conveyor
Ball screw	AC servomotor/Stepper motor		U-shaped Track Rail Linear Way	Semiconductor related device, LCD related device

1N=0.102kgf=0.2248lbs.
1mm=0.03937inch

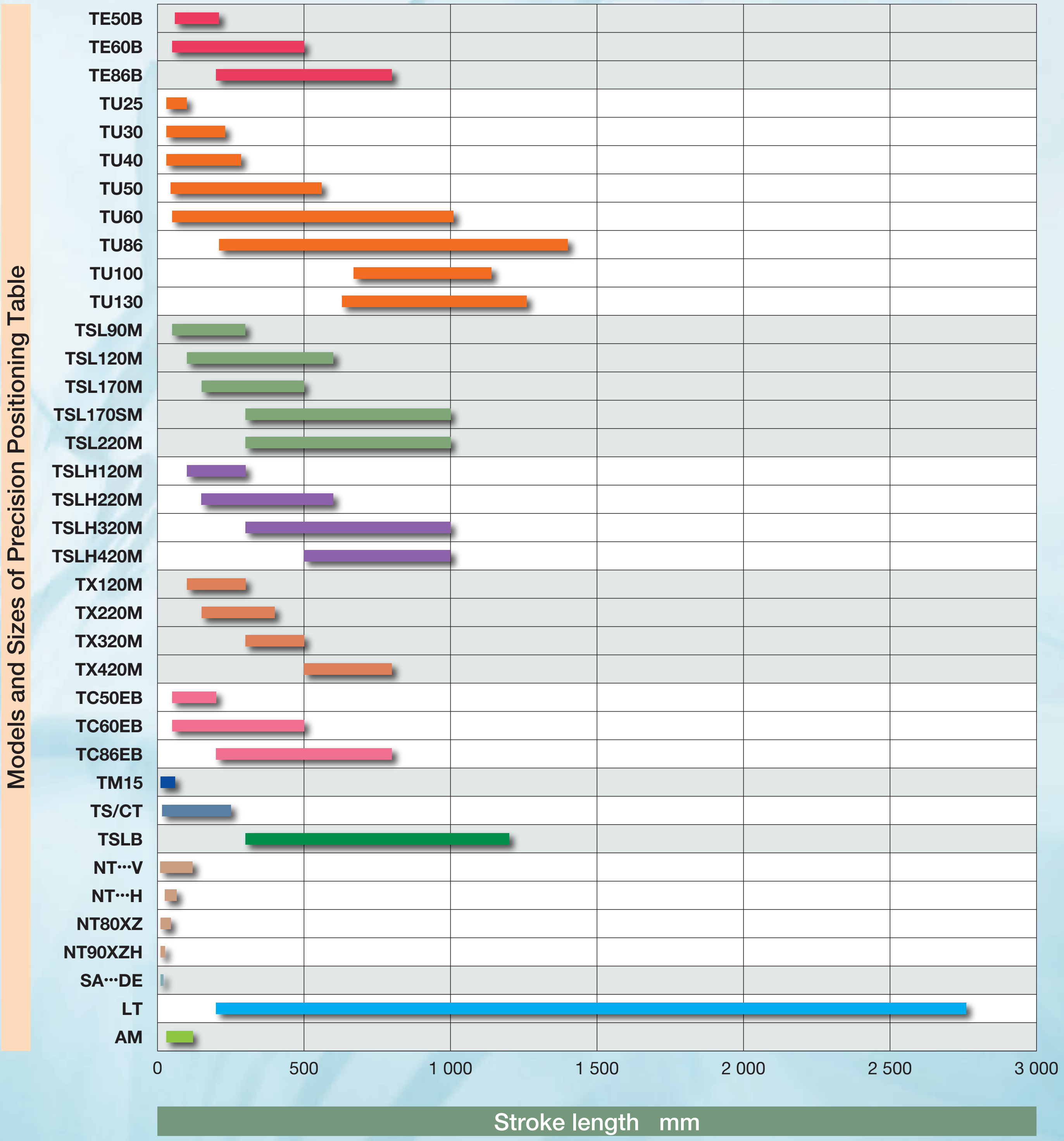
Size of Precision Positioning Table



How to see the above graph

- The values shown in the graph are for reference. For details, see the explanation of each model.

Stroke Length of Precision Positioning Table



How to see the above graph

- The values shown in the graph are for reference. For details, see the explanation of each model.
- Length of a bar represents a standardized range of stroke length.

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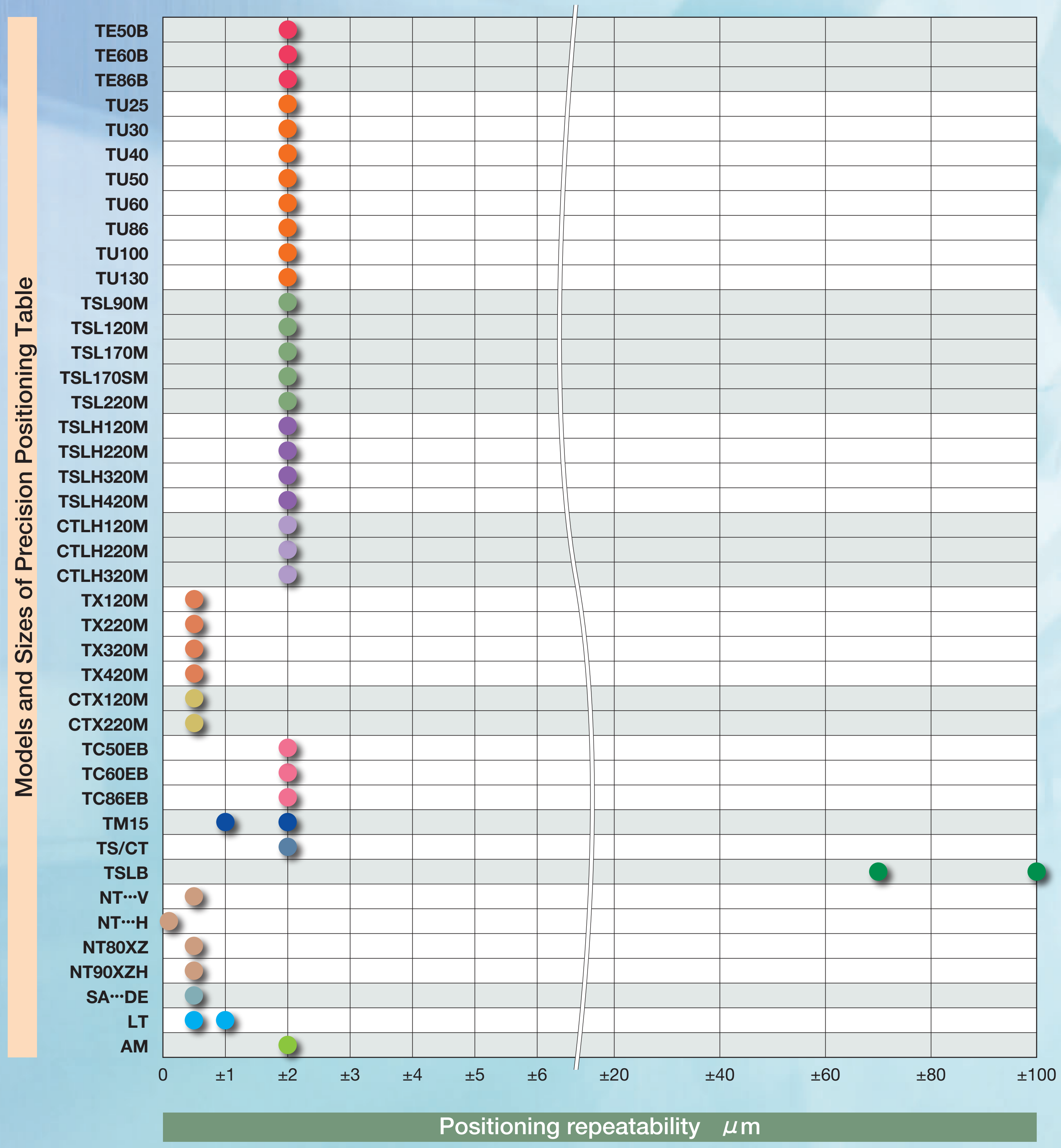
1mm=0.03937inch

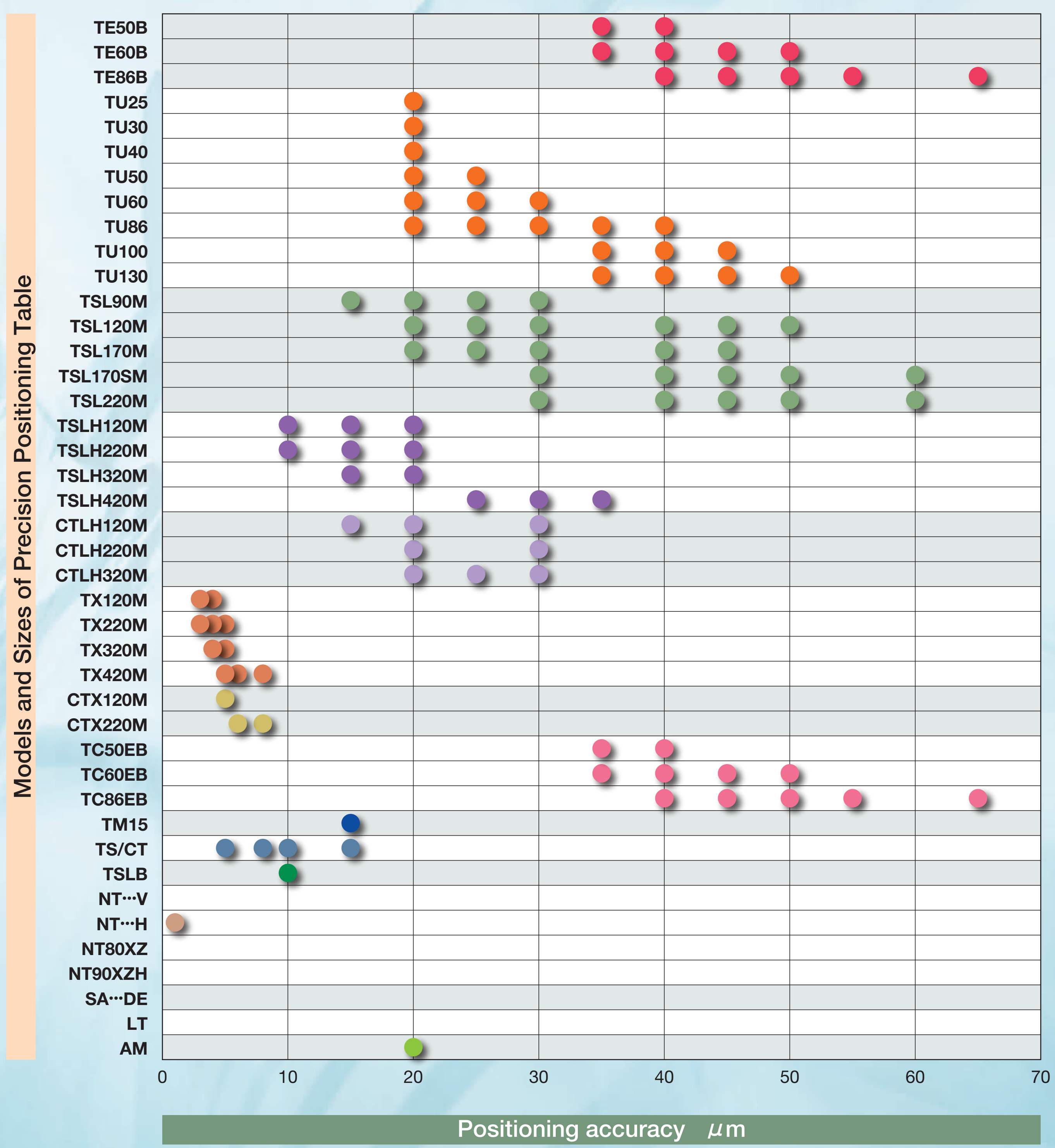
Positioning Repeatability of Precision Positioning Table



How to see the above graph

- The values shown in the graph are for reference. For details, see the explanation of each model.
- For models of ball screw drive, the value of the case selected ground ball screw is indicated.
- When two or more values are indicated for a model, this means that the applicable value depends on the stroke length.
- For TU, the value of the standard table is indicated.
- CTLH···M, CTX···M and CT are tables of two-axis specification.
- SA···DE represents value in X-axis.

Positioning Accuracy of Precision Positioning Table



How to see the above graph

- The values shown in the graph are for reference. For details, see the explanation of each model.
- For models of ball screw drive, the value of the case selected ground ball screw is indicated.
- When two or more values are indicated for a model, this means that the applicable value depends on the stroke length.
- For TU, the value of the standard table is indicated.
- CTLH···M, CTX···M and CT are tables of two-axis specification.

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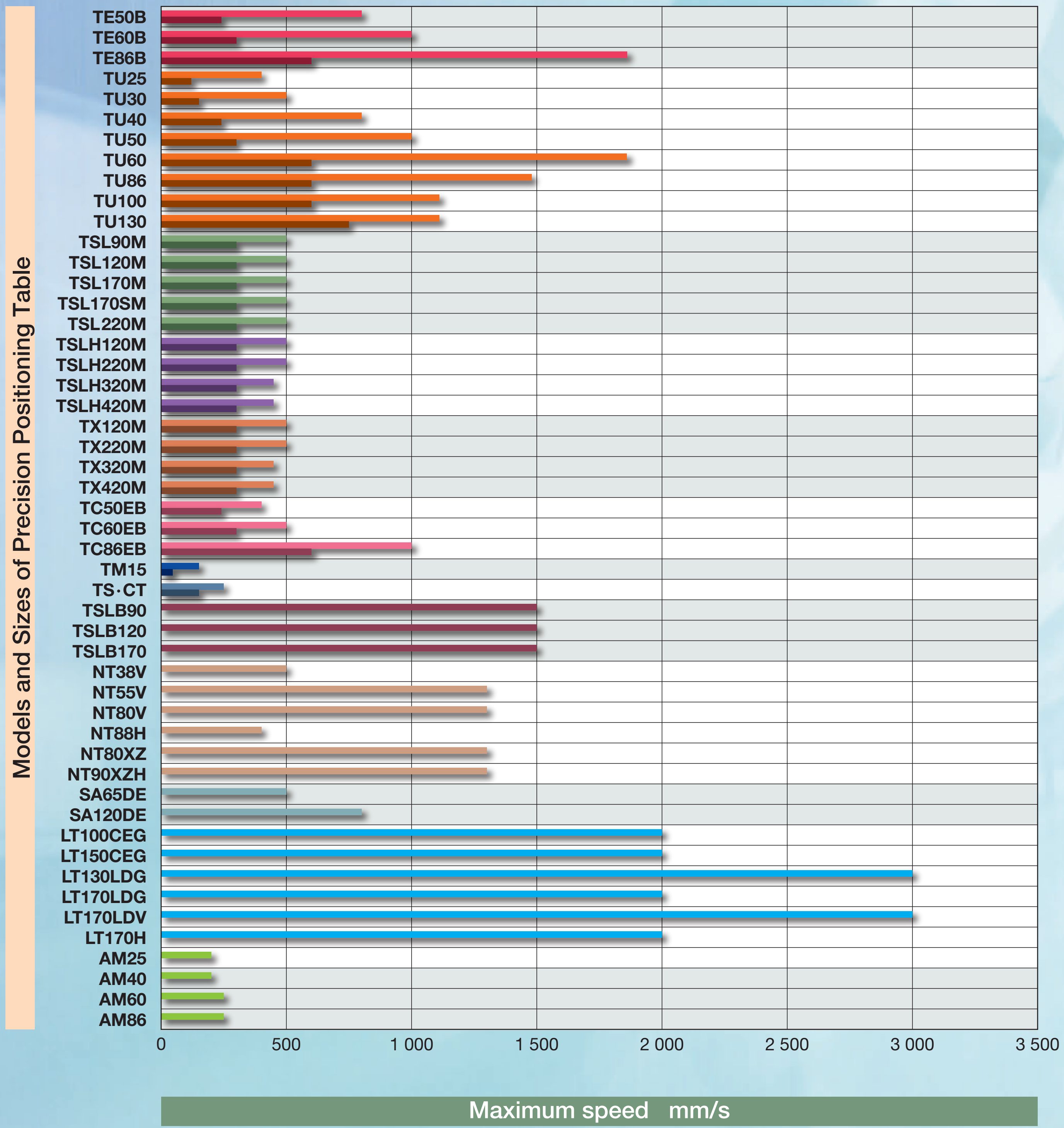
1mm=0.03937inch

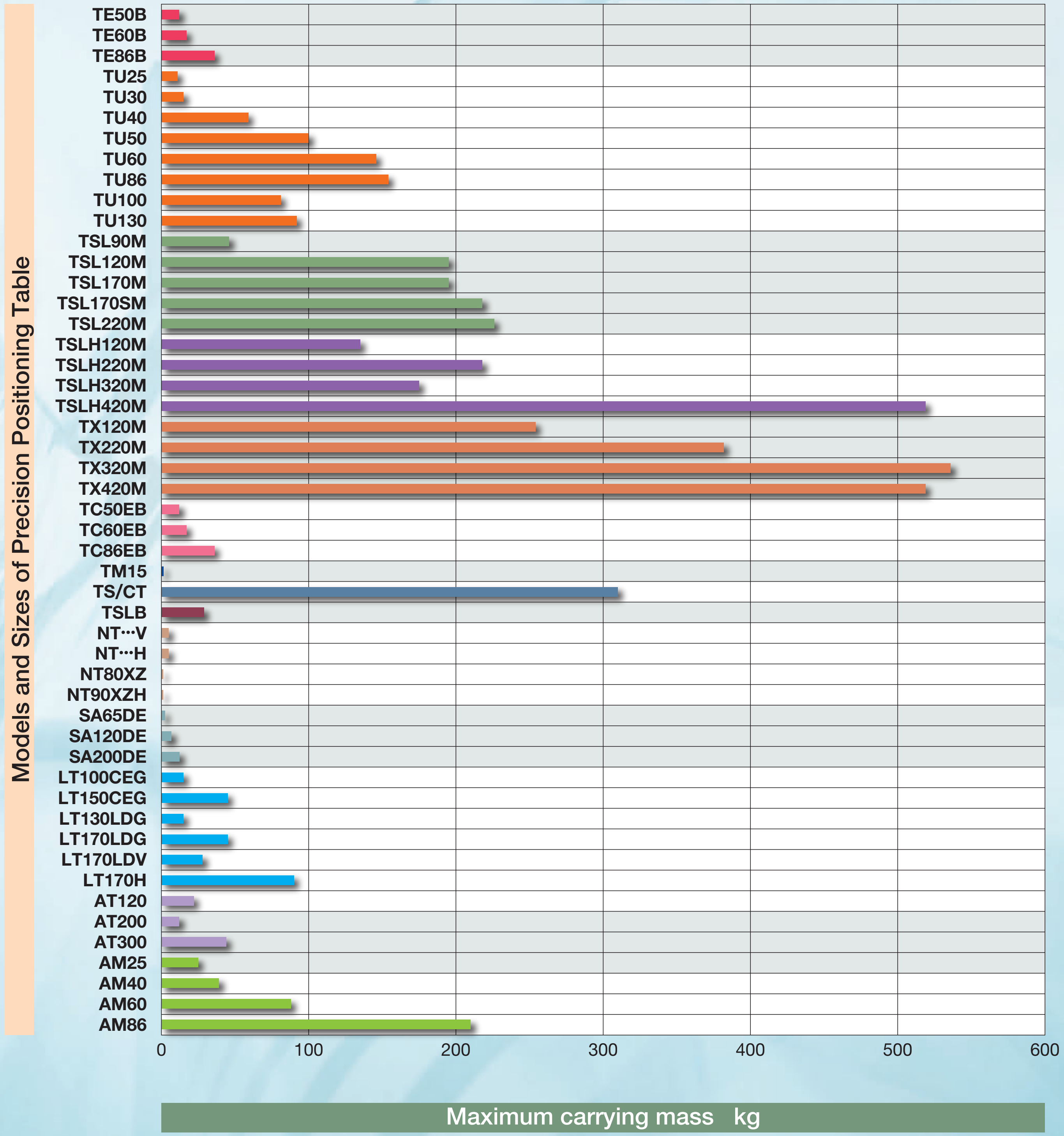
Maximum Speed of Precision Positioning Table



How to see the above graph

- The values shown in the graph are for reference. For details, see the explanation of each model.
- For models of ball screw drive, the value with the longest ball screw lead allowable is indicated.
- The upper sections indicate values of AC servomotor, whereas the lower sections indicate values of stepper motor specification.
- The ball screw drive type may sometimes be restricted by the allowable number of revolution of ball screw depending on the stroke length.

Carrying Mass of Precision Positioning Table



How to see the above graph

- The values shown in the graph are for reference. For details, see the explanation of each model.
- Values of LT, NT···V, NT···H, NT···XZ, NT···XZH, and SA···DE indicate the maximum load masses.

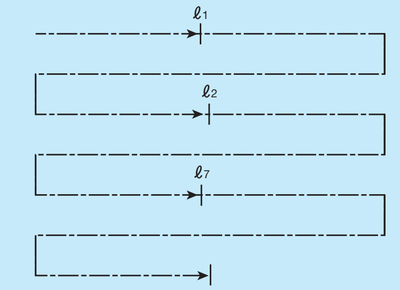
1N=0.102kgf=0.2248lbs.
1mm=0.03937inch

Accuracy

Accuracy standard of precision positioning table varies depending on models and measurement methods are described below. In addition, model testing according to the use conditions such as dynamics testing may be conducted on request. Please contact IKO for details.
Precision positioning table is supplied with an inspection sheet or certificate of passing inspection regarding accuracy standard of each model.

Positioning repeatability

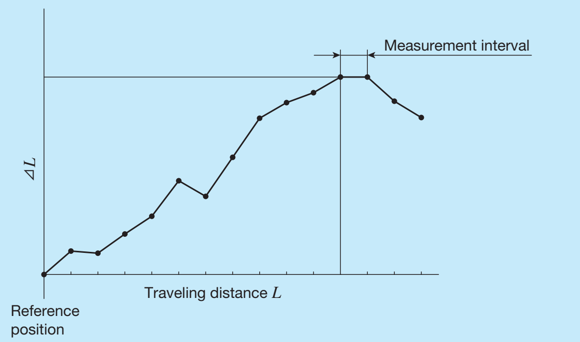
Repeat positioning to any one point from one direction 7 times to measure the stop position and obtain 1/2 of the maximum reading difference.
In principle, perform this measurement at the center and each end of the stroke length and take the maximum obtained value as the measurement value. Indicate the 1/2 of the maximum difference with ±.



1/2 of largest difference in measurement values, ℓ_1, ℓ_2, $\cdots\ell_7$

Positioning accuracy

Perform positioning successively in the certain direction from the reference position, measure the difference between actual travel distance at each position and the theoretical travel distance, and indicate the maximum difference within the stroke length as an absolute value.

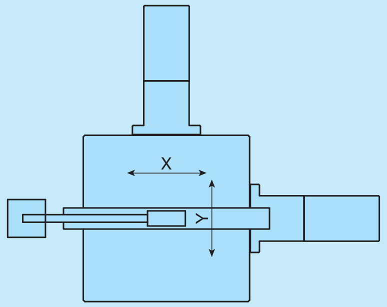


ΔL = (Distance actually traveled) − (Command value for traveling distance)

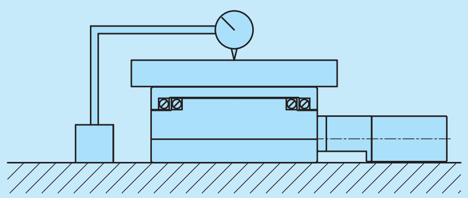
Parallelism in table motion A

Refers to parallelism (indicator fix) of the slide table motion and flat surface (precision positioning table mounting surface).

● When the stroke is shorter than the slide table length
Fix the test indicator on the stool on which the precision positioning table is mounted, place the straight-edge on the slide table, and apply the test indicator at the center of the slide table. Make a measurement across almost whole area of the stroke length in X and Y directions, and take the maximum reading difference as a measurement value.

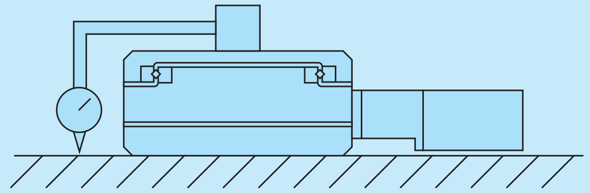


● When the stroke is longer than the slide table length
Fix the test indicator on the stool on which the precision positioning table is mounted, place the straight-edge on the slide table, and apply the test indicator at the center of the slide table. Make a measurement across almost whole area of the stroke length while moving the table by the length of the table during strokes in X and Y directions, and take the maximum reading difference as a measurement value.



Parallelism in table motion B

Refers to parallelism (indicator travel) of the slide table motion and flat surface (table mounting surface).
Fix the indicator at the center of the slide table, apply the test indicator on the stool on which the precision positioning table is mounted, make a measurement across almost whole area of the stroke length in X and Y directions, and take the maximum reading difference as a measurement value.

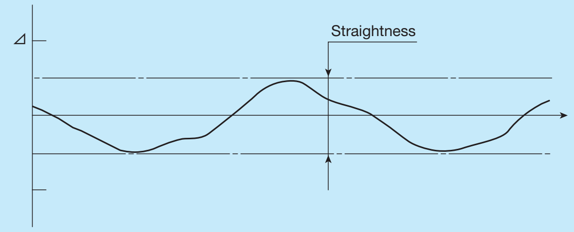


Straightness

Refers to an extent of deviation from the ideal straight line of the slide table motion, which should be linear.

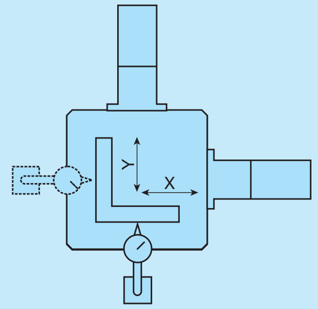
- Straightness in horizontal: Motion of the slide table travel axis in left and right (horizontal) direction.
- Straightness in vertical: Motion of the slide table travel axis in up and down (vertical) direction.

These are measured by a test bar and indicator or laser running straightness measurement system. The measurement value is represented by the interval between two straight lines in parallel with each other, when placed so that the interval becomes minimal.



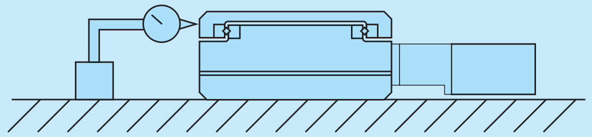
Squareness of XY motion

Refers to squareness of X-and Y-axis motions.
Fix a square scale on the slide table taking either travel axis direction as a reference, apply the test indicator perpendicular to the reference travel axis and take the maximum reading difference within the stroke length of the axis as a measurement value.



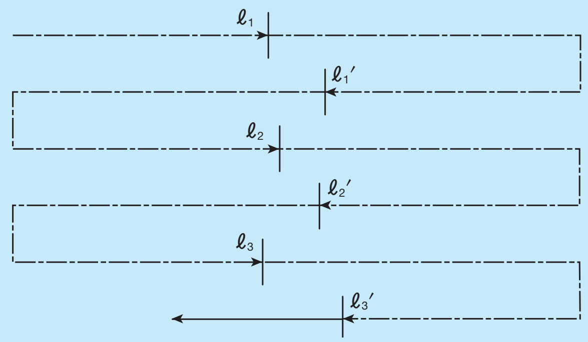
Backlash

Feed to the slide table and take reading of the test indicator when it is moved slightly as a reference. Then, move the slide table in the same direction with the given load from such condition without the feed gear and release the load. Obtain the difference from the reference value at this point.
Perform this measurement at the center and each end of the stroke length and take the maximum obtained value as the measurement value.



Lost motion

Perform positioning in the forward direction for one position and measure the position (ℓ_1 in the figure). Then give a command to move it in the same direction and give the same command in the backward direction from the position to perform positioning in the backward direction. Measure the position (ℓ_1' in the figure). Further, give a command to move it in the backward direction and give the same command in the forward direction from the position to perform positioning in the forward direction. Measure the position (ℓ_2 in the figure). Subsequently, repeat these motions and measurements and obtain the difference between average values of stop position of the 7 positionings in forward and backward directions.
Perform this measurement at the center and each end of the motion and take the maximum obtained value as the measurement value.



Measurement value of lost motion

$$= \left|\frac{1}{7}(\ell_1+\ell_2+\cdots\ell_7)-\frac{1}{7}(\ell_1'+\ell_2'+\cdots+\ell_7')\right|\max$$

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1mm=0.03937inch

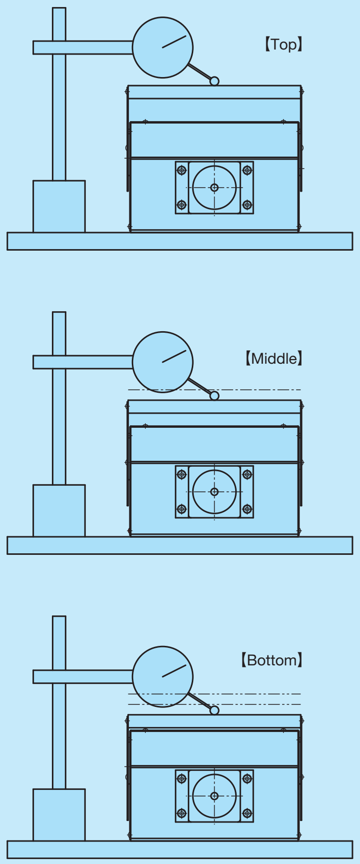
Measurement of parallelism during table elevating

At the lower most step of the table (H_{min}), align the indicator with 0 value at the measurement point E on the table upper surface with the table mounting surface as a reference, and measure heights at the remaining 8 points (A to I) with the value as a reference.
Lift up the table and perform the same measurement at middle (H_{mid}) and upper (H_{max}) steps. Then obtain each maximum difference between measurement values at the same point at lower, middle and upper steps.
Take the maximum difference value among all the 9 points as the parallelism during table elevating.

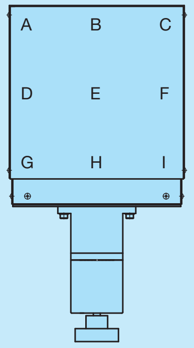
[Sample calculation of parallelism during table elevating]

Measuring point	Measurement value (μm)			
	Lower	Middle	Upper	Maximum difference
A	1	2	1	1
B	2	−1	3	4
C	3	4	5	2
D	4	2	1	3
E	0	0	0	0
F	−1	2	3	4
G	−2	3	3	5
H	−3	2	3	6
I	−4	−2	−4	2

If measurement values are as those indicated in the table, the maximum difference value among all points should be 6μm at the point H.
As a result, the parallelism during elevating of this table is 6μm.



[Measuring method]

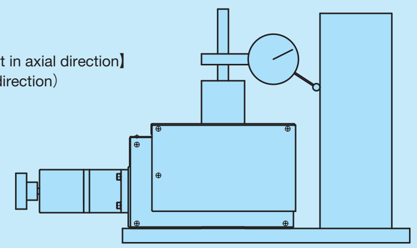


[Measuring point]

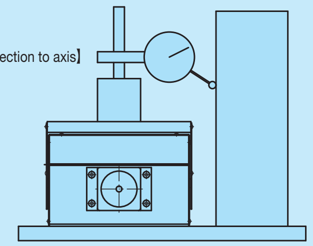
Measurement of squareness during table elevating

The squareness during table elevating relative to a square scale shall be the squareness during table elevating.
At the lower step of the table (H_{min}), align the indicator with 0 relative to a square scale. The maximum difference in pick test deflection at the time when it is stroked from the lower step of the table (H_{min}) to the upper step (H_{max}) in the condition shall be the squareness during table elevating. (Straightness component at the time of table stroke is included.)
Place a square scale at the position 10mm away from the table edge, make a measurement for 2 directions, ball screw axial direction and direction perpendicular to the axis - and take the maximum value between the 2 values as the straightness during table elevating.

[Measurement in axial direction]
(X direction)



[Measurement in perpendicular direction to axis]
(Y direction)



Carrying Mass, Load Mass, Allowable Load

■ Maximum carrying mass

The maximum carrying mass is the mass that satisfies the following ①, ②, and ③. It is set for TE···B, TU, TSL···M, TSLH···M, TX···M, TC···EB, TM, TS/CT, TSLB, AT, AM, TZ, and TZ···X. The value changes by the position of the mass loaded (length L, height H). It is calculated by the formula (L, H) = (0, 0).

① The mass for which the rating life of the linear motion rolling guide, ball screws or support bearings is 18,000 hours when continually driving at the maximum speed for each model and size with the acceleration/deceleration time of 0.2s.
② The mass for which the acceleration 0.3G can be acquired in general.
③ The mass calculated based upon the basic static load rating of the linear motion rolling guide you are using.

Note that the value calculated varies depending on various conditions, such as the size, ball screw specifications, slide table length, or stroke length. The value shown at the specifications of each model was calculated based on the most severe conditions that are typical for each size. For detailed values, please contact IKO.

■ Maximum load mass

The maximum load mass refers to the maximum mass of a steel cube that ensures necessary acceleration: acceleration 0.5G for linear motion and acceleration 0.5G in outer circumferential for rotational motion. It is restricted by thrust (torque) characteristics of the motor used, and the larger the carrying mass is, the longer the marginal acceleration time becomes. For linear motor drive models (LT, NT···V, NT···H, NT···XZ and NT···XZH) and direct drive models (SA···DE), the dynamic load mass representing the relation between acceleration and load mass in standard traveling models is set.

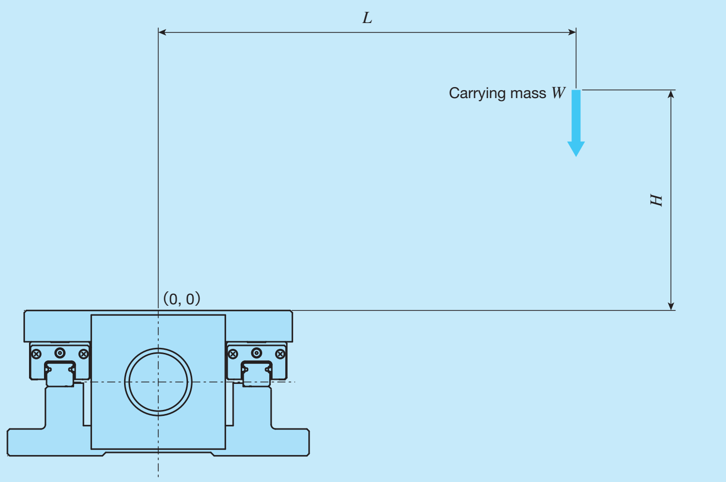


Fig. 1 Carrying mass position

1N=0.102kgf=0.2248lbs.
1mm=0.03937inch

Maximum Speed and Resolution

■ Maximum speed

The maximum speed of precision positioning table is defined by the following equation.
The ball screw drive type is restricted by the allowable number of ball screw revolutions which vary by the stroke length. For the timing belt drive, it is calculated with the maximum number of motor revolutions of 900(min^{-1}). See the specifications of each model for details.
Each linear motor drive model has fixed maximum speed. See the specifications of each model.

Ball screw drive

$$\text{Maximum speed (mm/s)} = \text{Ball screw lead (mm)} \times \frac{\text{Allowable number of revolutions of ball screw } (min^{-1})}{60}$$

Timing belt drive

$$\text{Maximum speed (mm/s)} = \text{Pulley pitch diameter} \times \pi \text{ (mm)} \times \frac{\text{Maximum number of revolutions of the motor } (min^{-1})}{60}$$

(Pulley pitch diameter$\times \pi$ = 100mm)

To obtain the actual positioning time, the operation pattern must be considered according to conditions such as acceleration / deceleration time and stroke length. See the section of consideration of operation patterns.

■ Resolution

Resolution refers to the minimum feed rate allowed for precision positioning table and can be obtained by the following equation.
Each linear motor drive model has fixed resolution. See the specifications of each model.

Ball screw drive

$$\text{Resolution (mm/pulse)} = \frac{\text{Ball screw lead (mm)}}{\text{Number of fraction sizes per motor rotation (pulse)}}$$

Timing belt drive

$$\text{Resolution (mm/pulse)} = \frac{\text{Pulley pitch diameter} \times \pi \text{ (mm)}}{\text{Number of fraction sizes per motor rotation (pulse)}}$$

(Pulley pitch diameter$\times \pi$ = 100mm)

Consideration of Operation Patterns

■ Calculation of positioning time

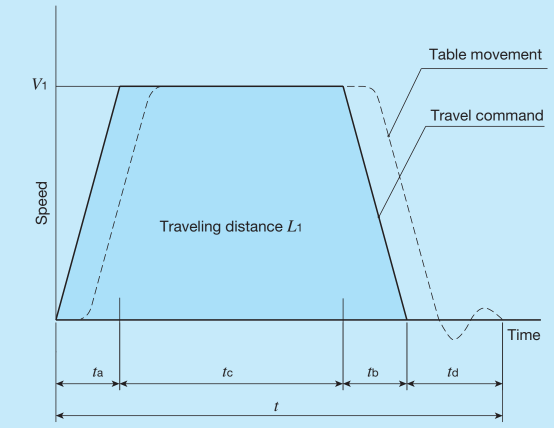
The positioning time taken when the precision positioning table actually moves can be obtained by the following equation.
For applications requiring high precision positioning, the settling time from completion of command pulse input to full stop of the table at the positioning point and vibration damping time of the machine device must be considered in addition to the constant speed traveling time and acceleration / deceleration time.

Long-distance positioning

Long distance in this context refers to distance for which there is enough constant speed traveling time even taking into account the acceleration / deceleration time.

$$t = \frac{L_1}{V_1} + \frac{t_a + t_b}{2} + t_d$$

where
- t : Positioning time s
- t_a, t_b : Acceleration/deceleration time s
- t_c : Constant speed traveling time s
- t_d : Settling time s
- L_1 : Traveling distance mm
- V_1 : Traveling speed (set speed) mm/s

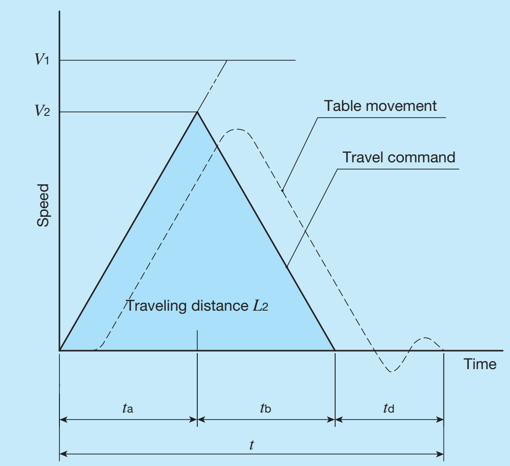


Short-distance positioning

Short distance in this context refers to distance for which there is no constant speed traveling time because deceleration occurs before reaching to constant speed traveling.

$$t = \frac{L_2}{V_2} + \frac{t_a + t_b}{2} + t_d$$

where
- t : Positioning time s
- t_a, t_b : Acceleration/deceleration time s
- t_d : Settling time s
- L_2 : Traveling distance mm
- V_1 : Set speed mm/s
- V_2 : Traveling speed mm/s



1N=0.102kgf=0.2248lbs.
1mm=0.03937inch

■ Calculation of marginal acceleration time

Torque (thrust force) required for driving of precision positioning table comes to the highest during acceleration. Torque (thrust force) required for this acceleration is limited by motor output torque (linear motor thrust force). Therefore, the marginal acceleration time with table used horizontally is calculated by the following equation.

For ball screw drive and timing belt drive

● Applied torque T_L

$T_L = T_0 + \mu Wg \cdot \frac{\ell}{2\pi\eta}$ [N·m] ······Ball screw drive

$T_L = T_0 + (Wg \times \text{Wedge reduction ratio}) \cdot \frac{\ell}{2\pi\eta}$ [N·m] ···Applicable to TZ

$T_L = T_0 + \mu Wg \cdot \frac{r}{\eta}$ [N·m] ······Timing belt drive

● Acceleration torque T_a

$T_a = (J_T + J_M + J_C + J_L) \cdot \frac{2\pi N}{60 t_a}$ [N·m]

$J_L = W \cdot \left(\frac{\ell}{2\pi}\right)^2$ [kg·m²] ·········Ball screw drive

$J_L = W \cdot \left(\frac{\ell}{2\pi}\right)^2 \times \text{Wedge reduction ratio}^2$ [kg·m²] ······Applicable to TZ

$J_L = W \cdot r^2$ [kg·m²] ·········Timing belt drive

● Torque required for acceleration T_P

$T_P = T_L + T_a$ [N·m] $(T_P \times k < T_M)$

● Marginal acceleration time t_a

$t_a = (J_T + J_M + J_C + J_L) \cdot \frac{2\pi N}{60} \cdot \frac{k}{T_M - T_L}$ [s]

[In case of AT]

● Applied torque T_L

$T_L = T_0 + \mu Wg \cdot \frac{\ell}{2\pi\eta}$

● Carrying mass inertia J_L

$J_L = W \cdot \left(\frac{\ell \cdot R_0}{2\pi L}\right)^2$

● Distance to rotator L

Model	ℓ [m]	L [m]
AT120A	0.001	0.100
AT200A	0.001	0.130
AT300A	0.002	0.186

T_0 : Starting torque N·m
μ : Friction coefficient of rolling guide (0.01)
W : Carrying mass kg
ℓ : Ball screw lead m
r : Pulley pitch radius (0.0159m)
η : Efficiency 0.9
J_T : Table inertia kg·m²
J_M : Motor inertia kg·m²
J_C : Coupling inertia
J_L : Carrying mass inertia kg·m²
N : Number of revolutions of motor min⁻¹
t_a : Acceleration time s
g : Gravity acceleration (9.8m/s²)
T_M : Motor output torque N·m
· For the stepper motor, it is the output torque at the number of motor revolutions N.
· For the AC servomotor, it is the maximum (momentary) torque at the number of revolutions N.
k : Factor of safety
(AC servomotor : 1.3)
(stepper motor : 1.5~2)
Wedge reduction ratio: 0.5 in case of 1 : 2
: 0.25 in case of 1 : 4
R_0 : Distance from the center of the table to the center of gravity of the load m
L : Distance from the center of the table to the rotator m

In case of linear motor drive

● Force from acceleration F_a

$F_a = (W_L + W_T) \cdot \frac{V}{t_a}$ [N]

● Thrust force required for acceleration F_P

$F_P = F_a + F_L$ [N]

● Marginal acceleration time t_a

$t_a = \frac{(W_L + W_T) \cdot V \cdot k}{F_M - F_L}$ [s]

μ : Friction coefficient of rolling guide (0.01)
W_T: Mass of moving table kg
W_L: Carrying mass kg
F_R : Running resistance N
(LT170H: 40N)
F_C : Cord pull-resistance[1] N
(LT Series: About 1.0N)
(NT Series: None)
F_M: Linear motor thrust force N
(maximum thrust at traveling speed V)
t_a : Acceleration time s
V : Traveling speed m/s
g : Gravity acceleration 9.8 m/s²
k : Factor of safety (1.3)

Note [1] Cord pull-resistance varies depending on cord mass and how to pull it. Use the an expected resistance value for calculation.

[In case of LT···CE, LT···LD]

● Friction resistance of rolling guide F_f

$F_f = \mu (W_L + W_T) g$ [N]

However, minimum value of F_f shall be as follows.
For LT100CE: 2.5N
For LT150CE: 5.0N
For LT130LD: 6.0N
For LT170LD: 6.0N

● Force from running resistance F_L

$F_L = F_f + F_C$ [N]

[In case of LT···H]

● Running resistance F_R

LT170H: 40N

● Speed coefficient f_V

Traveling speed V[m/s]	LT170H
0.5 or less	1
Above 0.5 and below 1.0	1.5
Above 1.0 and below 1.5	2.25

● Force from running resistance F_L

$F_L = f_V \cdot F_R + F_C$ [N]

[In case of NT38V]

● Force from running resistance F_L

F_L = 0.25N

[In case of NT55V/NT80V]

● Force from running resistance F_L

F_L = 1.5N

[In case of NT80XZ]

● Force from running resistance F_L

Horizontal axis: F_L = 1.5N
Vertical axis: F_L = 0.5N [2]

[In case of NT90XZH]

● Force from running resistance F_L

Horizontal axis: F_L = 2.0N
Vertical axis: F_L = 2.0N [2]

[In case of NT88H]

● Force from running resistance F_L

F_L = 0.5N

Note [2] It is the resistance value for the stroke of ±5mm from the equilibrium point in the center area of the stroke range, assuming the spring system balance mechanism of the vertical axis.
The value changes depending on the spring mounting position or the stroke width in the actual calculation. Please verify using the actual machine.

1N=0.102kgf=0.2248lbs.
1mm=0.03937inch

In case of direct drive (SA···DE)

[In case of SA···DE/X(Y)]

- Friction resistance of rolling guide F_f

  F_f value shall be as follows.

  In case of SA65DE/X 0.5N

  In case of SA120DE/X 3.0N

- Force from running resistance F_L

  $F_L = F_f + F_c$ [N]

- Force from acceleration F_a

  $F_a = (W_L + W_T)\cdot\frac{V}{t_a}$ [N]

- Thrust force required for acceleration F_P

  $F_P = F_a + F_L$ [N]

- Marginal acceleration time t_a

  $t_a = \frac{(W_L + W_T)\cdot V\cdot k}{F_M - F_L}$ [s]

W_T: Mass of moving table kg

W_L: Carrying mass kg

F_c: Cord pull-resistance(1) N

F_M: Linear motor thrust force N (maximum thrust at traveling speed V)

t_a : Acceleration time s

V : Traveling speed m/s

k : Factor of safety (1.3)

Note (1) Cord pull-resistance varies depending on cord mass and how to pull it. Use the an expected resistance value for calculation.

[In case of SA···DE/S]

- Friction resistance of rolling guide M_f

  M_f value shall be as follows.

  In case of SA65DE/S 0.03N·m

  In case of SA120DE/S 0.1N·m

  In case of SA200DE/S 0.2N·m

- Torque from rotation resistance M_L

  $M_L = M_f + M_c$ [N·m]

- Torque from acceleration M_a

  $M_a = (J_L + J_T)\cdot\frac{R}{t_a}$ [N·m]

- Torque required for acceleration M_P

  $M_P = M_a + M_L$ [N·m]

- Marginal acceleration time t_a

  $t_a = \frac{(J_L + J_T)\cdot R\cdot k}{M_M - M_L}$ [s]

J_L : Inertia moment of load kg·m^2

J_T : Inertia moment of moving table kg·m^2

M_c : Cord pull-resistance(2) N·m

M_M: Alignment stage torque N·m

t_a : Acceleration time s

R : Traveling speed rad/s

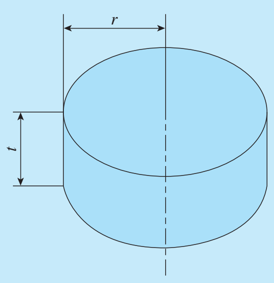
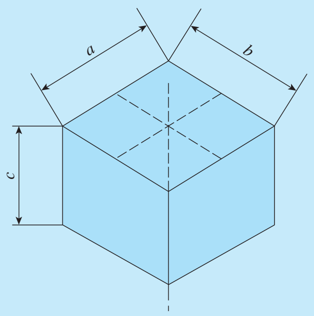
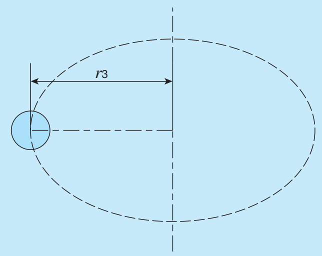
k : Factor of safety (1.3)

Note (2) As there is no cord for θ-axis moving table, set the cord pull-resistance to 0 if the load does not pull cord.

Calculate the inertia moment of load by referencing calculation formulas below.

Calculation of inertia moment

p: density, m: mass

Cylinder	Quadrangular prism	Offset rotation
		
$J_L = \frac{1}{2}\cdot\pi\cdot p\cdot t\cdot r^4$ $= \frac{1}{2}\cdot m\cdot r^2$	$J_L = \frac{1}{12}\cdot p\cdot a\cdot b\cdot c\cdot(a^2+b^2)$ $= \frac{1}{12}\cdot m\cdot(a^2+b^2)$	$J_L' = J_L + m\cdot r_3^2$ J_L': Inertia moment from rotation center J_L: Inertia moment when rotating around the center of gravity

■ Calculation of effective torque and effective thrust force

As a large torque (thrust force) is required for acceleration / deceleration when the precision positioning table is driven, the effective torque (effective thrust force) may become larger than the motor's rated torque (rated thrust) depending on the operation rate of each pattern in case the AC servomotor or linear motor drive is used. Continuing the operation in this condition may cause overheating and seizure of the motor. So ensure that the effective torque (effective thrust force) is smaller than motor's rated torque (rated thrust). The effective torque (effective thrust force) by the operation pattern of table is calculated by the following equation. If the rated torque (rated thrust) of the motor is larger than the effective torque (effective thrust force), continuous operation according to the operation pattern is possible.

If AC servomotor is used

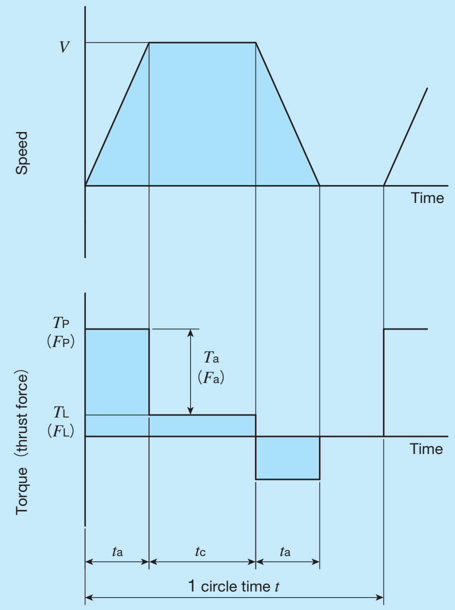
- Effective torque T_{rms}

$$T_{rms} = \sqrt{\frac{T_P^2\times t_a + (T_P - 2\times T_L)^2\times t_a + T_L^2\times t_c}{t}} \text{ [N·m]}$$

In case of linear motor drive

- Effective thrust force F_{rms}

$$F_{rms} = \sqrt{\frac{F_P^2\times t_a + (F_P - 2\times F_L)^2\times t_a + F_L^2\times t_c}{t}} \text{ [N]}$$



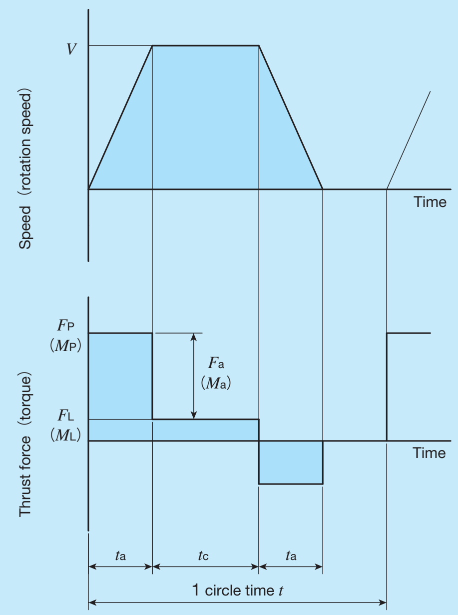
In case of direct drive (SA···DE)

- Effective thrust force (applicable to SA···DE/X(Y)) F_{rms}

$$F_{rms} = \sqrt{\frac{F_P^2\times t_a + (F_P - 2\times F_L)^2\times t_a + F_L^2\times t_c}{t}} \text{ [N]}$$

- Effective torque (applicable to SA···DE/S) M_{rms}

$$M_{rms} = \sqrt{\frac{M_P^2\times t_a + (M_P - 2\times M_L)^2\times t_a + M_L^2\times t_c}{t}} \text{ [N·m]}$$

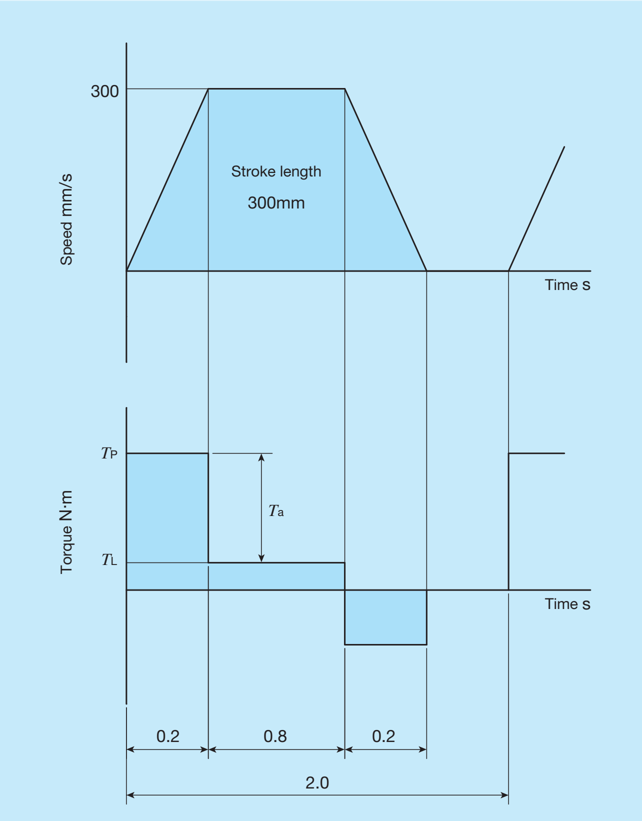


■ Consideration example of operation pattern

If AC servomotor is used

● Usage conditions

Mounting direction		Horizontal usage
Carrying mass	W	30kg
Stroke length	L	300mm
Traveling speed (set speed)	V	300mm/s
Acceleration/deceleration time	t_a	0.2s
Constant speed traveling time	t_c	0.8s
1 cycle time	t	2.0s



● Temporary selection of positioning table

Temporarily select TU60S49/AT103G10S03.

Basic specification

Ball screw lead	ℓ	10mm
Stroke length		300mm
Maximum speed		500mm/s
Starting torque	T_S	0.08N·m
Table inertia	J_T	0.93×10^{-5}kg·m²
Coupling inertia	J_C	0.290×10^{-5}kg·m²

● Motor specification

AC servomotor used		SGMAV-01A
Rated torque		0.318N·m
Motor inertia	J_M	0.380×10^{-5}kg·m²

● Calculation of torque required for acceleration

・Applied torque T_L

$$T_L = T_s + \mu W g \cdot \frac{\ell}{2\pi\eta}$$

$$= 0.08 + 0.01\times30\times9.8\times\frac{0.01}{2\times\pi\times0.9}$$

$$\fallingdotseq 0.09\text{N·m}$$

・Acceleration torque T_a

$$J_L = W\cdot\left(\frac{\ell}{2\pi}\right)^2$$

$$= 30\times\left(\frac{0.01}{2\times\pi}\right)^2 \fallingdotseq 7.60\times10^{-5}\text{kg·m}^2$$

$$N = V\times\frac{60}{\ell} = 0.3\times\frac{60}{0.01} = 1800\text{min}^{-1}$$

$$T_a = (J_T+J_M+J_C+J_L)\cdot\frac{2\pi N}{60 t_a}$$

$$= (0.93+0.380+0.290+7.60)\times10^{-5}\times\frac{2\times\pi\times1800}{60\times0.2}$$

$$\fallingdotseq 0.09\text{N·m}$$

・Torque required for acceleration T_P

$$T_P = T_L + T_a = 0.09 + 0.09 = 0.18\text{N·m}$$

At this point, check that the $T_P\times k$ (factor of safety) is smaller than motor's output torque T_M.
If this value is exceeded, review the maximum speed and acceleration / deceleration time.
For the operation pattern under consideration, it is smaller than the output torque T_M as indicated below.

$$T_M = 0.318\times3 \fallingdotseq 0.95\text{N·m}$$

$$T_P\times k = 0.18\times1.3 = 0.23\text{N·m} < T_M$$

● Consideration of effective torque

・Effective torque T_{rms}

$$T_{rms} = \sqrt{\frac{T_P^2\times t_a + (T_P-2\times T_L)^2\times t_a + T_L^2\times t_c}{t}}$$

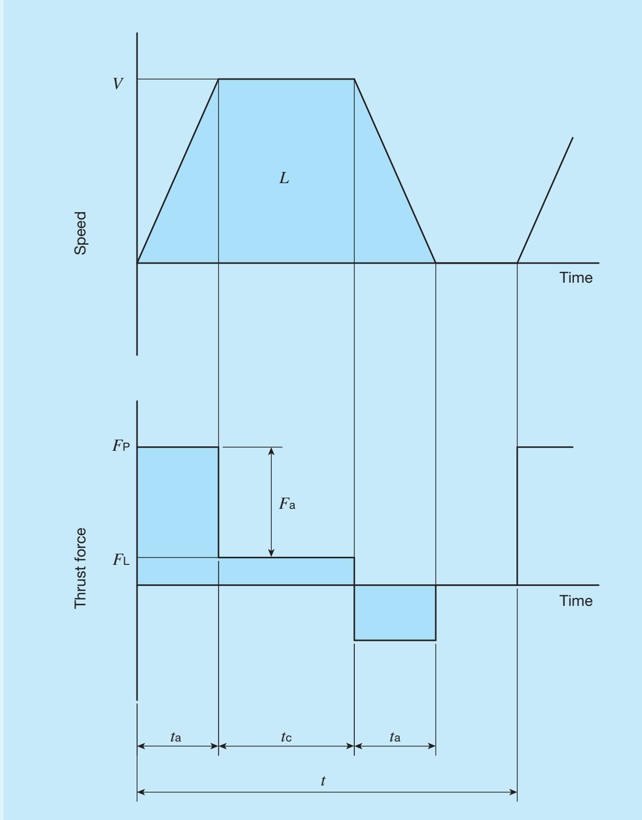
$$= \sqrt{\frac{0.23^2\times0.2+(0.23-2\times0.09)^2\times0.2+0.09^2\times0.8}{2.0}}$$

$$\fallingdotseq 0.09\text{N·m}$$

As motor's rated torque is larger than the effective torque T_{rms}, it can be judged that continuous operation in the operation pattern under consideration is possible.

In case of linear motor drive

The effective thrust force may exceed the rated thrust depending on the operation rate of Linear Motor Table, leading to motor overheating and seizure that may cause breakage and human injury. Before operations, ensure that the effective thrust force is below the rated thrust.
Described below is an example of consideration of operation pattern with LT170HS. Temporarily set the operation pattern as indicated below considering the carrying mass and acceleration from the dynamic load mass chart in page Ⅱ-288.



Setting items

Table specification	Model		LT170HS (natural air cooling)
	Mass of moving table	W_T	4.0kg See page Ⅱ-302
	Maximum thrust at traveling speed V	F_M	About 550N See page Ⅱ-288
	Running resistance	F_R	See [In case of LT···H] in the section of calculation of marginal acceleration time.
	Speed coefficient	f_V	
Carrying mass		W_L	30kg
Traveling distance		L	1.2m
Traveling speed (set speed)		V	1.5m/s
Time		t_a	0.3s
		t_c	0.5s
		t	2.5s
Cord pull-resistance		F_c	1.0N Expected value
Factor of safety		k	1.3
Ambient temperature			30℃

STEP1 Calculation of thrust force required for acceleration

①Force from running resistance F_L

$$F_L = f_V\times F_R + F_c = 2.25\times40+1 = 91\text{N}$$

②Force from acceleration F_a

$$F_a = (W_L+W_T)\cdot\frac{V}{t_a}$$

$$= (30+4.0)\times\frac{1.5}{0.3} = 170\text{N}$$

③Thrust force required for acceleration F_P

$$F_P = F_a + F_L$$

$$= 170+91 = 261\text{N}$$

At this point, check that the $F_P\times k$ (factor of safety) is below the thrust characteristics curve in page Ⅱ-288. If this value is exceeded, review the maximum speed for operating pattern and acceleration / deceleration time.
You can see in the example pattern that it is below the thrust characteristics curve.
Maximum thrust F_M at 1.5m/s=About 550N

$$F_P\times k = 261\times1.3 = 339.3\text{N} < F_M$$

STEP2 Consideration of effective thrust force

・Effective thrust force F_{rms} can be obtained as follows.

$$F_{rms} = \sqrt{\frac{F_P^2\times t_a + (F_P-2\times F_L)^2\times t_a + F_L^2\times t_c}{t}}$$

$$= \sqrt{\frac{261^2\times0.3+(261-2\times91)^2\times0.3+91^2\times0.5}{2.5}}$$

$$\fallingdotseq 103\text{N}$$

At this point, check that F_{rms} is below the rated thrust. If the rated thrust is exceeded, review the maximum speed for operating pattern and acceleration / deceleration time. (For LT···H, thrust characteristics vary depending on ambient temperature. See the rated thrust characteristics diagram.)

For the example pattern, the rated thrust is about 117N at the ambient temperature of 30℃, so the value is 103N< 117N (rated thrust) and it can be judged that continuous operation is possible.

1N=0.102kgf=0.2248lbs.
1mm=0.03937inch

In case of Alignment Stage SA

The effective thrust force may exceed the rated thrust (or the effective torque exceeds the rated torque) depending on the operation rate of Alignment Stage SA, leading to motor overheating and seizure that may cause breakage and human injury. Before operations, ensure that the effective thrust force is below the rated thrust (or the effective torque is below the rated torque).
Described below is an example of consideration of operation pattern with Alignment Stage SA120DE/XYS.
Temporarily set an operation pattern as indicated below considering the marginal acceleration time.

Setting items

Table model			SA120DE/XYS
Load mass		W_L	5.0kg
Inertia moment of load		J_L	1.0×10^{-2}kg·m^2
X-axis operation pattern	Mass of moving table	W_T	5.9kg
	Set stroke	L	0.01m
	Maximum speed	V	0.1m/s
	Acceleration/deceleration time	t_a	0.05s
	Constant speed traveling time	t_c	0.05s
	Cycle time	t	0.4s
	Cord pull-resistance	F_c	1.0N
Y-axis operation pattern	Mass of moving table	W_T	3.4kg
	Set stroke	L	0.01m
	Maximum speed	V	0.1m/s
	Acceleration / deceleration time	t_a	0.05s
	Constant speed traveling time	t_c	0.05s
	Cycle time	t	0.4s
	Cord pull-resistance	F_c	1.0N
θ-axis operation pattern	Inertia moment of moving table	J_T	2.0×10^{-3}kg·m^2
	Set operating angle	L	0.1πrad 18°
	Maximum speed	R	πrad/s 180°/s
	Acceleration/deceleration time	t_a	0.05s
	Constant speed traveling time	t_c	0.05s
	Cycle time	t	0.4s
	Cord pull-resistance	M_c	0.0N·m
Factor of safety		k	1.3

STEP1 Calculation of thrust force required for X-axis acceleration

① Force from running resistance F_L

$F_L = F_f + F_c = 3.0 + 1.0 = 4.0$N

② Force from acceleration F_a

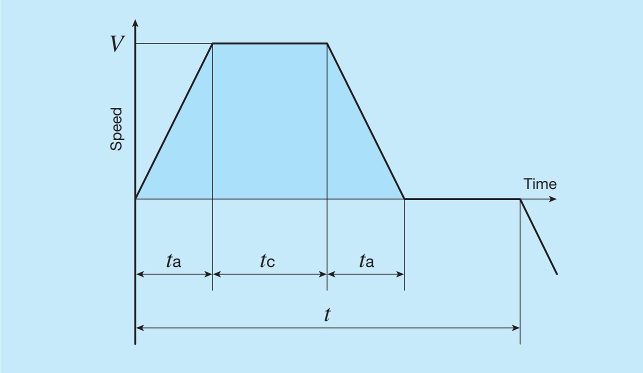
$$F_a = (W_L + W_T)\cdot\frac{V}{t_a}$$

$$= (5.0+5.9)\times\frac{0.1}{0.05} = 21.8\text{N}$$

③ Thrust force required for acceleration F_P

$F_P = F_a + F_L$
$= 21.8 + 4.0 = 25.8$N

At this point, check that the $F_P \times k$ (factor of safety) is below the maximum thrust in page Ⅱ-264. If this value is exceeded, review the maximum speed for operating pattern and acceleration / deceleration time.
You can see in the example pattern that it is below the maximum thrust.
The maximum thrust F_M of SA120DE/X=70N
$F_P \times k = 25.8\times1.3 = 33.54\text{N} < F_M$



STEP2 Consideration of effective thrust force

・Effective thrust force F_{rms} can be obtained as follows.

$$F_{rms} = \sqrt{\frac{F_P^2\times t_a + (F_P - 2\times F_L)^2\times t_a + F_L^2\times t_c}{t}}$$

$$= \sqrt{\frac{25.8^2\times0.05 + (25.8-2\times4.0)^2\times0.05 + 4.0^2\times0.05}{0.4}}$$

$\fallingdotseq 11.17$N

At this point, check that F_{rms} is below the rated thrust. If the rated thrust is exceeded, review the maximum speed for operating pattern and acceleration / deceleration time. In the example pattern, it can be judged that continuous operation is possible.

STEP3 Consideration of thrust force and effective thrust force required for Y-axis acceleration

Perform the same calculation as X-axis.
If the operation pattern is the same, the condition is lighter for Y-axis as its mass of moving table is smaller. So that is omitted in this example.

STEP4 Consideration of torque required for θ-axis acceleration

① Torque from rotation resistance M_L
$M_L = M_f + M_c$
$= 0.1 + 0.0 = 0.1$N·m

② Torque from acceleration M_a

$$M_a = (J_L + J_T)\cdot\frac{R}{t_a}$$

$$= (0.01 + 0.002)\times\frac{\pi}{0.05} \fallingdotseq 0.754\text{N·m}$$

③ Torque required for acceleration M_P
$M_P = M_a + M_L$
$= 0.754 + 0.1 = 0.854$N·m

At this point, check that the $M_P \times k$ (factor of safety) is below the maximum torque in page Ⅱ-264. If this value is exceeded, review the maximum speed for operating pattern and acceleration / deceleration time. You can see in the example pattern that it is below the maximum torque.

Maximum torque M_M of SA120DE/S=2.0N·m
$M_P \times k = 0.854\times1.3 \fallingdotseq 1.11\text{N·m} < M_M$

STEP5 Consideration of effective torque

・Effective torque M_{rms} can be obtained as follows.

$$M_{rms} = \sqrt{\frac{M_P^2\times t_a + (M_P - 2\times M_L)^2\times t_a + M_L^2\times t_c}{t}}$$

$$= \sqrt{\frac{0.854^2\times0.05 + (0.854-2\times0.1)^2\times0.05 + 0.1^2\times0.05}{0.4}}$$

$\fallingdotseq 0.38$N·m

At this point, check that M_{rms} is below the rated torque. If the rated torque is exceeded, review the maximum speed for operating pattern and acceleration / deceleration time. In the example pattern, it can be judged that continuous operation is possible.

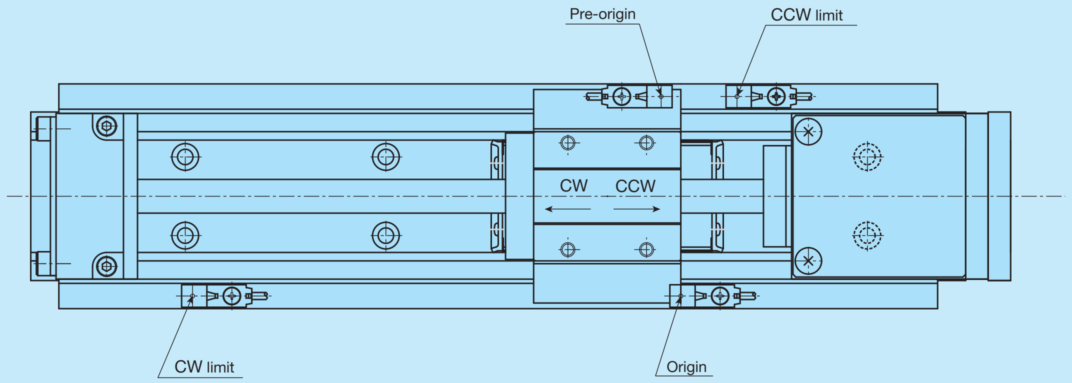
※Caution If the load is offset from the rotation center, X- and Y-axis acceleration / deceleration generates torque load on the θ-axis. So extra care must be exercised.

1N=0.102kgf=0.2248lbs.
1mm=0.03937inch

Sensor Specification

Precision positioning table is equipped with CW and CCW limit sensors for overrun prevention and pre-origin and origin sensors for machine origin detection. For some table models, these sensors are provided as standard equipment, and for the other models, mounting is specified by identification numbers.
Types of sensors used for Precision positioning table are listed in Table 1 and specifications of each sensor in Table 2 to 4.
For connector specifications for NT···V, SA200DE/S, LT and TM, see Table 5.1 to 5.2. For other tables, wires are unbound, so that the sensor output connector and mating-side must be prepared separately by customer.
For sensor timing chart, please see section of sensor specifications of each model. In addition, unless otherwise stated, sensor positions can be fine-adjusted. Please make adjustment on your own.

Table 1 Sensor types

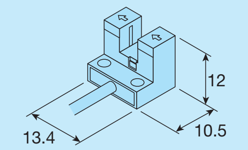
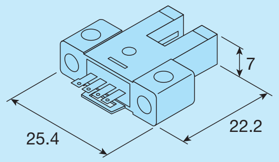
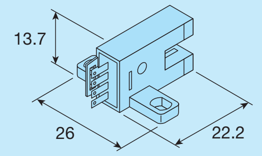
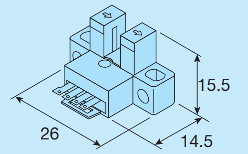
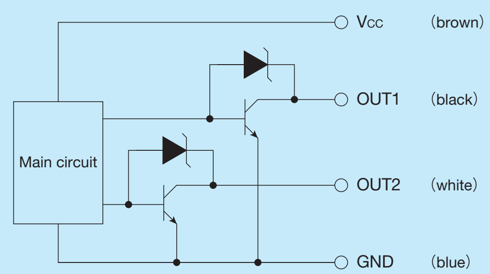


A mark tube with engraved signal name (ORG, PORG, CW or CCW) is inserted into the unbound-wire specification sheath.

Table model (Sensor)		CW limit	CCW limit	Pre-origin (PORG)	Origin (ORG)
TE···B[1]		Proximity sensor	Proximity sensor	Proximity sensor	Proximity sensor
TU[1]		Proximity sensor	Proximity sensor	Proximity sensor	Proximity sensor
TSL···M		Proximity sensor	Proximity sensor	Proximity sensor	Photo sensor ④[2]
TSLH···M・CTLH···M		Photo sensor ③	Photo sensor ③	Photo sensor ③	Photo sensor ④[2]
TX···M・CTX···M		Photo sensor ③	Photo sensor ③	Photo sensor ③	Photo sensor ④[2]
TC···EB[1]		Proximity sensor	Proximity sensor	Proximity sensor	Proximity sensor
TM[1][4]		Magnetic sensor[5]	Magnetic sensor[5]	Magnetic sensor[5]	Magnetic sensor[5]
TS/CT[1]	TS55/55・CT55/55	Micro switch[6]	Micro switch[6]	Proximity sensor	Photo sensor ③
	TS75/75	Photo sensor ①	Photo sensor ①	Photo sensor ①	Photo sensor ①
	CT75/75	Photo sensor ③	Photo sensor ③	Photo sensor ③[5]	Photo sensor ③[5]
	Other than listed above	Photo sensor ③	Photo sensor ③	Photo sensor ③	Photo sensor ②[2]
TSLB		Proximity sensor	Proximity sensor	Proximity sensor	Proximity sensor
LT···CE[1]		Proximity sensor[3]	Proximity sensor[3]	Proximity sensor[3]	Encoder[3][5]
LT···LD		Proximity sensor[3][5]	Proximity sensor[3][5]	Proximity sensor[3][5]	Encoder[3][5]
LT···H		Proximity sensor[3][5]	Proximity sensor[3][5]	Proximity sensor[3][5]	Encoder[3][5]
NT···V[1]		Proximity sensor	Proximity sensor	Proximity sensor	Encoder[3][5]
AT		Proximity sensor[5]	Proximity sensor[5]	–	–
AM		Proximity sensor	Proximity sensor	Proximity sensor	–[2]
SA···DE	SA200DE/S	Proximity sensor[5]	Proximity sensor[5]	Proximity sensor[5]	Encoder[3][5]
	Other than listed above	Magnetic sensor[5][6]	Magnetic sensor[5][6]	Magnetic sensor[5][6]	Encoder[3][5][6]
TZ		Proximity sensor[5]	Proximity sensor[5]	Proximity sensor[5]	Proximity sensor[2][5]

Notes [1] Mounting a sensor is specified using the corresponding identification number. For the other models, sensors are equipped as standard equipment.
[2] No origin sensor is provided if an attachment for AC servomotor or linear encoder is selected. Use C phase or Z phase signal of AC servomotor or linear encoder to be installed on your own. For AM, only AC servomotor is selected.
[3] Each signal is output from applicable dedicated programmable control unit or dedicated driver.
[4] Sensors are built in the table and each signal is output from a dedicated sensor amplifier. When the AC servomotor is used, use encoder's C phase for origin signals.
[5] Sensor (encoder) positions cannot be fine-adjusted.
[6] This is built in the substrate.

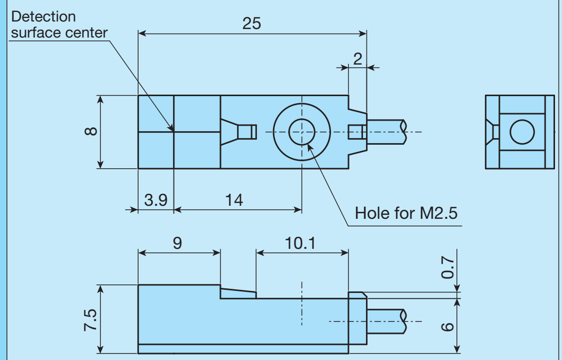
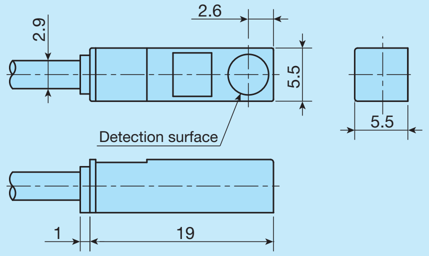
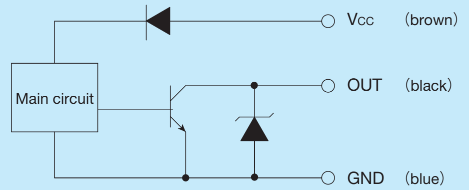
Table 2 Photo sensor specifications

Item (Sensor)	Limit, pre-origin and origin			
	① PM-L24	② PM-K54	③ PM-T54	④ PM-L54
Manufacturer	Panasonic Industrial Devices SUNX Co., Ltd.			
Shape (mm)				
Output connector models [1]	–	CN-14H-C1 (lead length: 1 m) or CN-14H-C3 (lead length: 3 m)		
Power supply voltage	DC5~24V ±10%			
Current consumption	15mA or less			
Output	NPN transistor open collector ・Maximum input current : 50mA ・Applied voltage : 30VDC or less ・Residual voltage : 0.7V or less at input current of 50mA 0.4V or less at 16mA			
Output operation	ON/OFF upon light entrance; selective [2]			
Operation indication	Red LED (ON upon light entrance)			
Circuit diagram				

Notes [1] Selected according to the applicable models.
[2] For CT75/75, use OUT1 (black) for CW limit and CCW limit and OUT2 (white) for pre-origin and origin. For the other models, use OUT1 (black) for all.
Remarks 1. Wire the sensor cords on your own.
2. Lead runs off by at least 200mm from the table end. Actual length varies depending on stroke length.

1N=0.102kgf=0.2248lbs.
1mm=0.03937inch

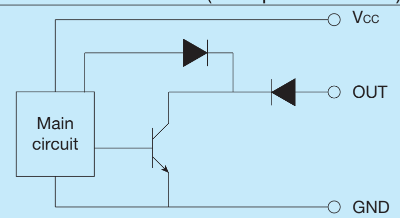
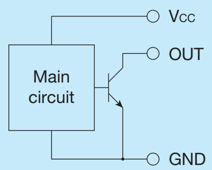
Table 3 Specifications of proximity sensor

Item		SA200DE/S	TZ120, TZ200H and TZ200X	Other models	TZ120X
Manufacturer		Azbil Corporation			OMRON Corporation
Model(1)	Pre-origin	APM-D3A1F-S	APM-D3B1F-S	APM-D3B1-S APM-D3B1F-S	E2S-W14 1M
	CW limit	APM-D3A1-S	APM-D3B1-S	APM-D3B1-S	E2S-W14 1M
	CCW limit		APM-D3B1F-S		E2S-W14 1M
	Origin	Encoder	APM-D3A1-S	APM-D3A1-S	E2S-W13B 1M
Shape mm					
Power supply voltage		DC12～24V ±10%			
Current consumption		10mA or less			13mA or less
Output		NPN open collector · Maximum input current: 30mA or less (resistance load) · Applied voltage : DC26.4V or less · Residual voltage : 1V or less at input current of 30mA			NPN open collector · Maximum input current: 50mA · Applied voltage : DC30V or less · Residual voltage : 1V or less at input current of 50mA
Output operation	Pre-origin	ON in proximity	OFF in proximity		
	Limit	ON in proximity	OFF in proximity		
	Origin	Encoder	ON in proximity		
Operation indication	Pre-origin	Orange LED (ON upon detection)	Orange LED (OFF upon detection)		
	Limit	Orange LED (ON upon detection)	Orange LED (OFF upon detection)		
	Origin	—	Orange LED (ON upon detection)		
Circuit diagram					

Remarks: 1. Wire the sensor cords on your own (except for NT···V/SC).
2. Lead runs off by at least 200mm from the table end. Actual length varies depending on stroke length.

Note (1) Model numbers apply to manufacturer standard products. Depending on the total length of the product, the cable length may be a different from that of standard products.

Table 4 Specifications of magnetic sensor

Item		TM	SA65DE, SA120DE
Power supply voltage		DC12 to 24V ±10%	DC5 to 24V ±10%
Current consumption		65mA or less(1)	10mA or less
Output(2)		NPN open collector · Maximum input current: 12mA · Applied voltage : DC36V or less · Residual voltage: 1.7V or less at input current of 12mA : 1.1V or less at input current of 4mA	NPN open collector · Maximum input current: 10mA · Applied voltage: DC26.4V or less · Residual voltage: 1V or less at input current of 10mA
Output operation	Pre-origin	OFF in proximity	ON in proximity
	Limit	OFF in proximity	ON in proximity
	Origin	ON in proximity	Encoder
Operation indication	Pre-origin	Red LED (ON upon detection)	—
	CW (+) limit	Yellow LED (ON upon detection)	—
	CCW (-) limit	Red LED (ON upon detection)	—
	Origin	Red LED (ON upon detection)	—
Circuit diagram			

Notes (1) Current consumption of the whole system including sensor amplifier.
(2) Output per circuit.

Table 5.1 Connector specifications (NT55V/SC, NT80V/SC, SA200DE/S and LT)

Pin No.	Signal name	Connector used (Product of Molex Japan) Body side	Connector used (Product of Molex Japan) Mating side
1	Pre-origin(1)	Housing 1625-12R1 Terminal 1855TL	Housing 1625-12P1 Terminal 1854TL
2	Pre-origin		
3	+direction limit		
4	−direction limit		
5	Power input (for pre-origin)(1)		
6	GND (for pre-origin)(1)		
7	Power input (for pre-origin)		
8	GND (for pre-origin)		
9	Power input (for +direction limit)		
10	GND (for +direction limit)		
11	Power input (for −direction limit)		
12	GND (for −direction limit)		

Note (1) For B-table of LT/T2.

Table 5.2 Connector specifications (for TM)

Pin No.	Signal name	Connector used (Product of Molex Japan) Body side	Connector used (Product of Molex Japan) Mating side
1	Origin	Housing 43020-0600 Terminal 43031-0010	Housing 43025-0600 Terminal 43030-0007
2	Pre-origin		
3	CW limit		
4	CCW limit		
5	Power input		
6	GND		

Remark: When the AC Servomotor is used, use encoder's C phase for origin signals.

1N=0.102kgf=0.2248lbs.
1mm=0.03937inch

Mounting

■ Processing accuracy of mounting surface

Accuracy and performance of Precision positioning table are affected by accuracy of mating mounting surface. Therefore, processing accuracy of the mounting surface must be considered according to usage conditions such as required motion performance and positioning accuracy.
Reference flatness of the mating mounting surface under general usage conditions is indicated in Table 6.
In addition, the base on which a table is mounted receives a large reactive force, so take enough care about the rigidity of the base.

Table 6 Accuracy of mounting surface unit: μm

Model	Flatness of the mounting surface
NT…H	5
TX TM	8
TS/CT NT…V NT…XZ NT…XZH SA…DE	10
TSLH…M	15
TE…B TU TSL…M TC…EB LT AM	30
TSLB	50

■ Tightening torque for fixing screw

Typical tightening torque to fix the Precision positioning table is indicated in Table 7. If sudden acceleration / deceleration occurs frequently or moment is applied, it is recommended to tighten them to 1.3 times higher torque than that indicated in the table. In addition, when high accuracy is required with no vibration and shock, it is recommended to tighten the screws to torque smaller than that indicated in the table and use adhesive agent to prevent looseness of screws.

Table 7 Screw tightening torque unit: N·m

Bolt size	Female thread component		
	Steel	Aluminum alloy	
			Screw insert
M2 ×0.4	0.31	About 60% of steel value	About 80% of steel value
M3 ×0.5	1.7 (1)		
M4 ×0.7	4.0		
M5 ×0.8	7.9		
M6 ×1	13.3		
M8 ×1.25	32.0		
M10×1.25	62.7		

Note (1) As tightening torque for NT…V, 1.1N·m is recommended. (When using a steel base)

Precaution for Use

■ Safety precautions

- Be sure to earth the ground terminal (The grounding resistance is 100Ω or less.). It may lead to electric shock and fire.
- Use only the power voltage indicated on the device. Otherwise, it may lead to fire and malfunction.
- Do not touch any electrical component with wet hand. It may lead to electric shock.
- Do not bend forcibly, twist, pull, heat or apply heavy load on the cord. It may lead to electric shock and fire.
- Do not put your finger into any opening during table operations. It may lead to injury.
- Do not touch any moving part during table operations. It may lead to injury.
- When removing the electrical component cover, be sure to turn the power off and disconnect the power plug. It may lead to electric shock.
- Do not touch the terminal for 5 minutes after shutting down the power. Otherwise, electric shock due to residual voltage may occur.
- When installing / removing the connection terminal, be sure to turn the power off and disconnect the power plug in advance.Otherwise, it may lead to electric shock and fire.

■ Precaution for Use

- As precision positioning table is a precision machine, excessive load or shock may impair accuracy and damage the parts. Take extra care when handling it.
- Check that the table mounting surface is free from dust and harmful projection.
- Use it in a clean environment where it is not exposed to water, oil and dust particles.
- As grease is applied to the linear motion rolling guide integrated with precision positioning table and ball screws, take dust protection measures to prevent dust and other foreign matters from entering into the unit. If foreign matters get mixed, thoroughly eliminate the contaminated grease and apply clean grease again.
- Though lubrication frequency for precision positioning table varies depending on usage conditions, wipe off old grease and apply clean grease again biannually for normal cases or every three months for applications with constant reciprocating motions in long distance. In addition, the Precision Positioning Table in which C-Lube is built delivers long-term maintenance free performance. This reduces the need for the lubrication mechanism and workload which used to be necessary for linear motion rolling guides and ball screws, allowing large-scale reduction of maintenance cost.
- As precision positioning table is assembled through precise processing and adjustments, do not disassemble or alter it.
- Linear motor drive products have strong magnets inside. Note that any magnetic object around such product may be attracted. For use around any device vulnerable to magnetism, please contact IKO.
- Linear motor drive products require parameter settings of programmable control unit or driver for driving. Securely configure parameter settings suitable for the drive motor.
- For Linear Motor Table LT series, motor cord, etc. is connected to moving table, so a space for wiring of cord must be ensured in addition to the installation space for the main body. In addition, arrange cord wiring with sufficient curvature so that the running resistance does not increase or no excessive force is applied.

◎ The external appearance / specifications of this product can be modified for improvements without notices.

1N=0.102kgf=0.2248lbs.
1mm=0.03937inch