# 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

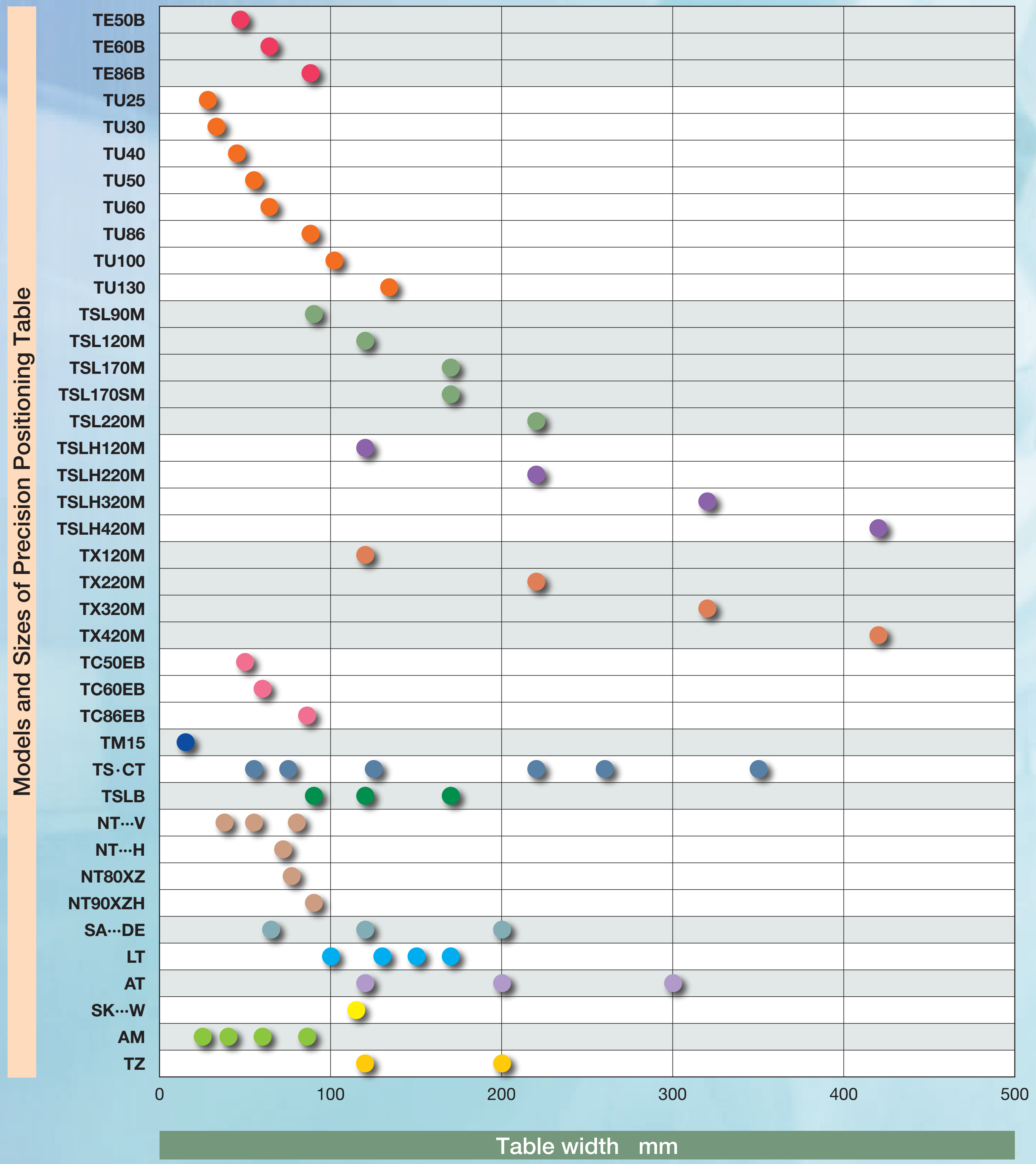
## IKO Characteristics of Precision Positioning Table

| 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 | AC servomotor/ Stepper motor | Selection | U-shaped Track Rail Linear Way | Assembler, Processing machine, Measuring equipment |
| C-Lube ball screw | AC servomotor/ Stepper motor | Provided as standard | C-Lube Linear Way (Parallel arrangement of 2 ways) | Assembler, Processing machine, Measuring equipment |
| C-Lube ball screw | AC servomotor/ Stepper motor | Provided as standard | C-Lube Linear Way (Parallel arrangement of 2 ways) | Precision processing machine, Precision measuring equipment<br>Machine tool, Assembler |
| C-Lube ball screw | AC servomotor | Provided as standard | C-Lube Linear Roller Way Super *MX* (Parallel arrangement of 2 ways) | Precision processing machine, Precision measuring equipment<br>Machine tool, Assembler |
| C-Lube ball screw | AC servomotor/ Stepper motor | Selection | U-shaped Track Rail Linear Way with C-Lube built in | Semiconductor related device, LCD related device |
| Ball screw | AC servomotor/ Stepper motor | Selection | Linear Way (Parallel arrangement of 2 ways) | Precision measuring equipment, Assembling machine |
| Ball screw | AC servomotor/ Stepper motor | Selection | Anti-Creep Cage Crossed Roller Way<br>Crossed Roller Way | Precision measuring equipment, Prober<br>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 | | Provided as standard | C-Lube Linear Way Linear Way (Parallel arrangement of 2 ways) | Semiconductor related device, Medical equipment |
| AC linear servomotor | | Provided as standard | Anti-Creep Cage Crossed Roller Way | Semiconductor related system, Precision measuring equipment |
| AC linear servomotor | | Provided as standard | C-Lube Linear Way (Parallel arrangement of 2 ways) | Semiconductor related device, Medical equipment |
| AC linear servomotor | | Provided as standard | C-Lube Linear Way (Parallel arrangement of 2 ways) | Semiconductor related device, High speed conveyor |
| Ball screw | AC servomotor/Stepper motor | Provided as standard | 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.

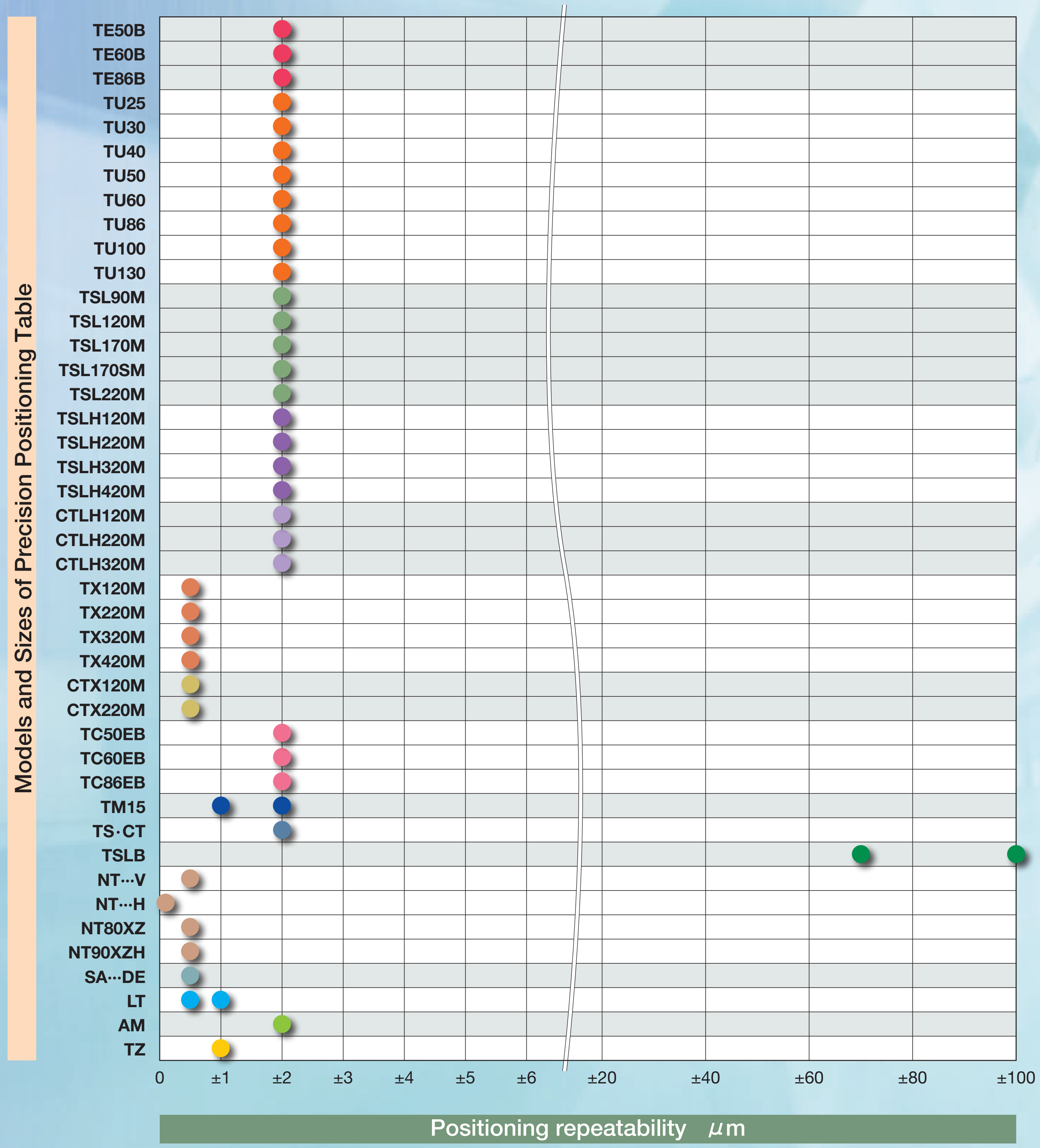
# Stroke Length of Precision Positioning Table


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.

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

# Positioning Repeatability of Precision Positioning Table

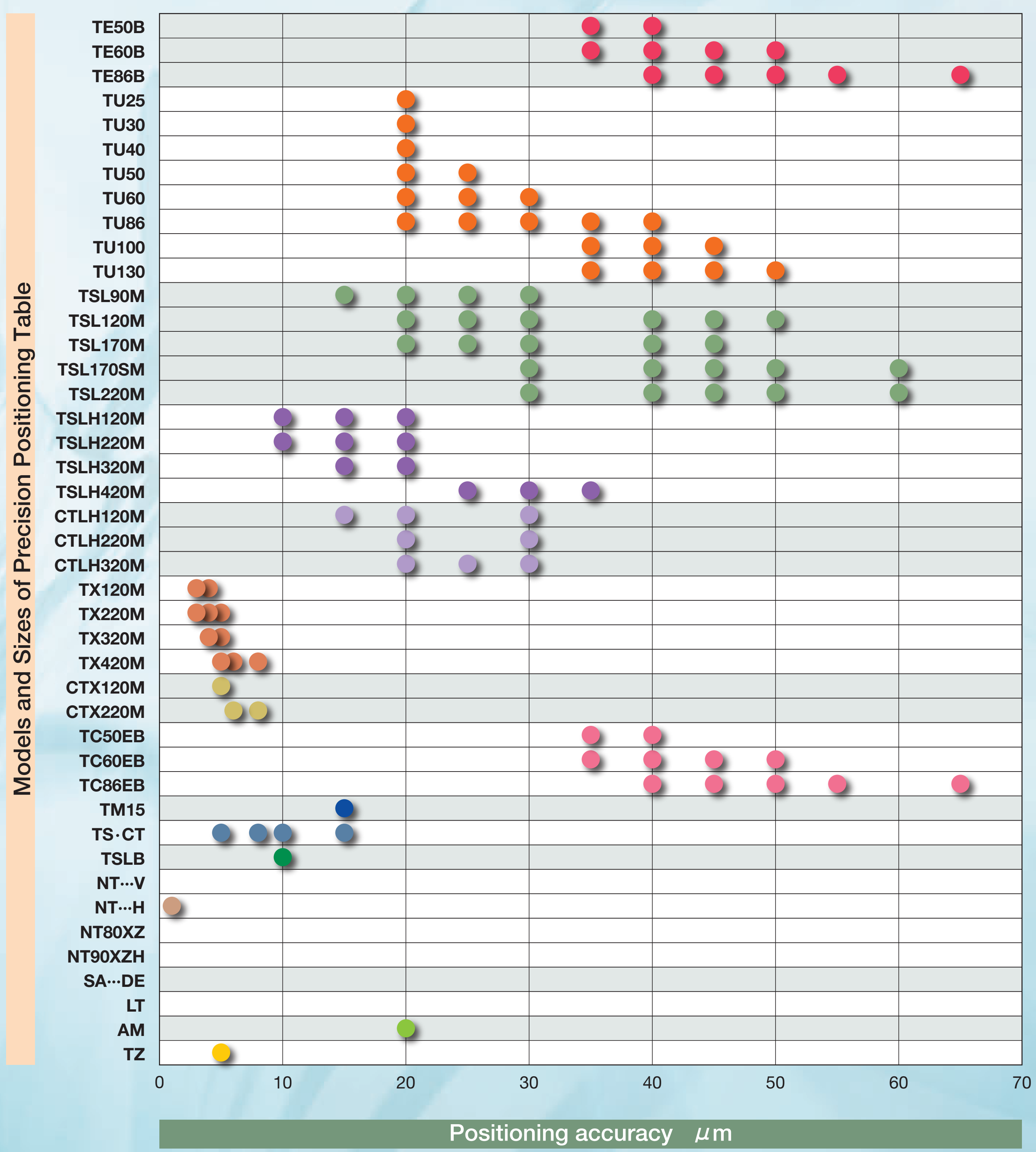



How to see the above graph

- 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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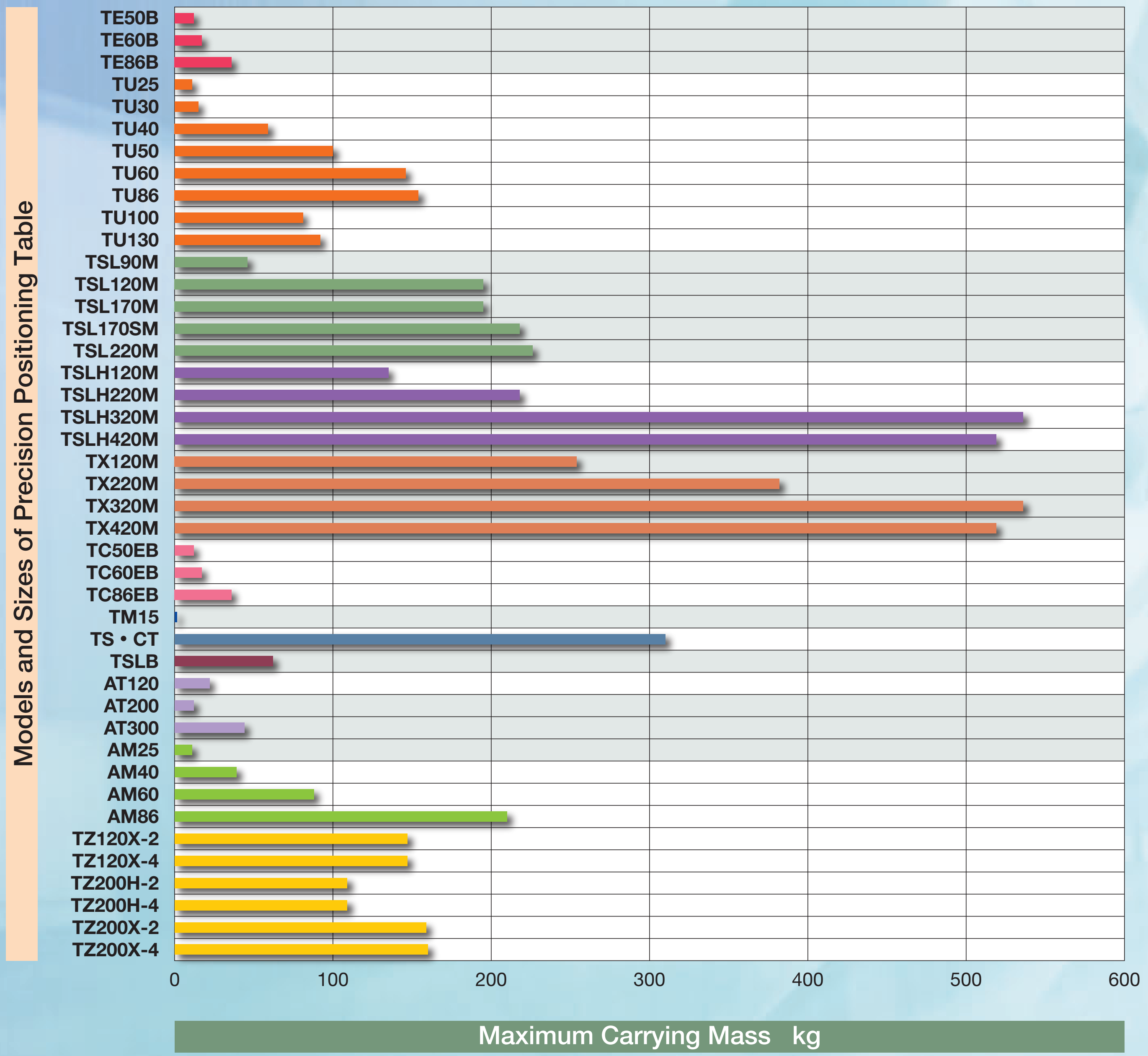
1mm=0.03937inch

# Maximum Carrying Mass of Precision Positioning Table

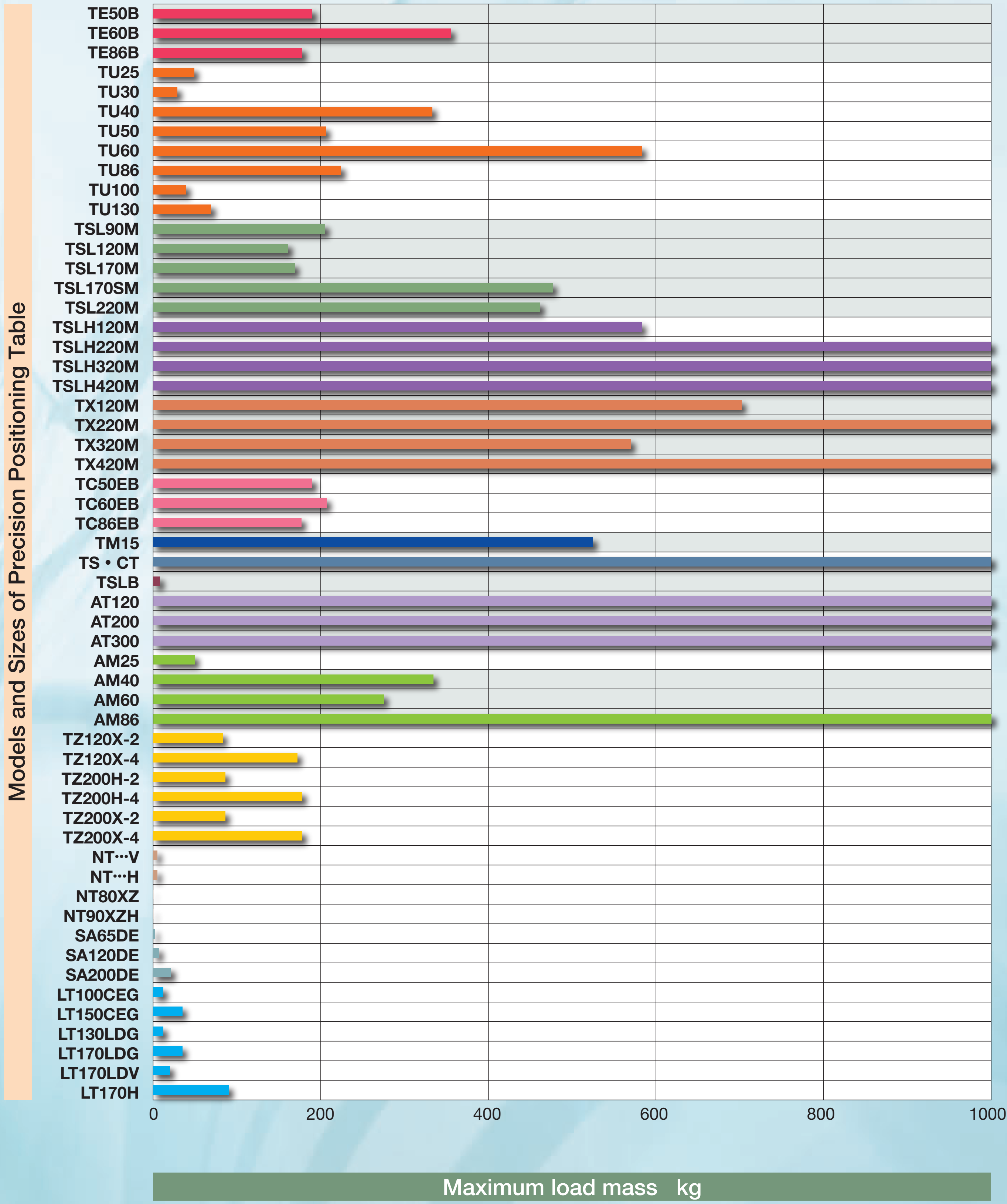



How to see the above graph

- The values shown in the graph are for reference. For details, see the explanation of each model.
- The values shown in the graph are for a position of the mass to load of 0mm (length) and 0mm (height).
- The maximum carrying mass values are for when the table is oriented horizontally.
- The values shown in the graph are for when the load's center of gravity is positioned at 0mm (length) and 0mm (height).



# Maximum load mass of Precision Positioning Table

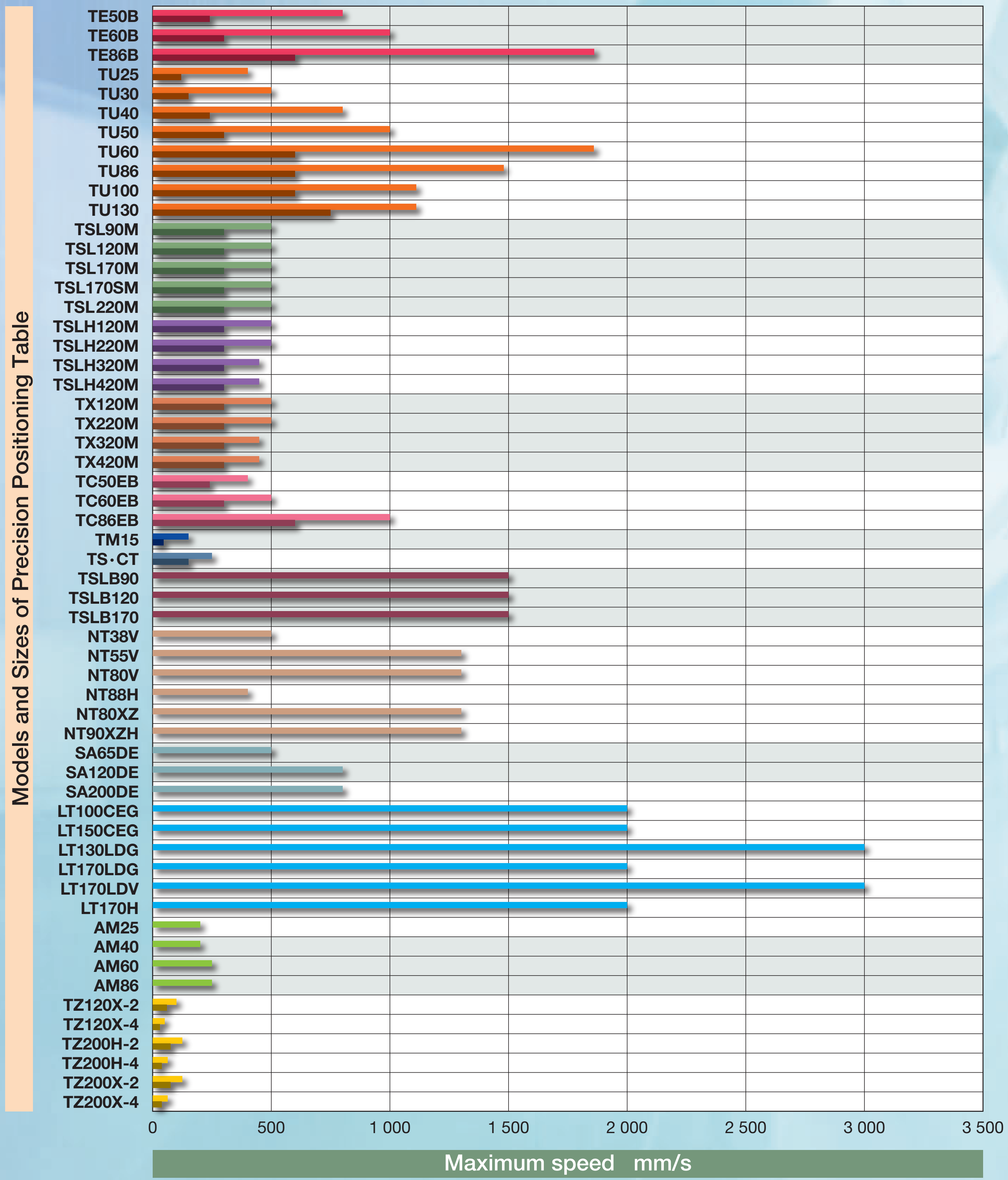



How to see the above graph

- The values shown in the graph are for reference. For details, see the explanation of each model.
- The maximum load mass values are for when the table is oriented horizontally.

1N=0.102kgf=0.2248lbs.
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.



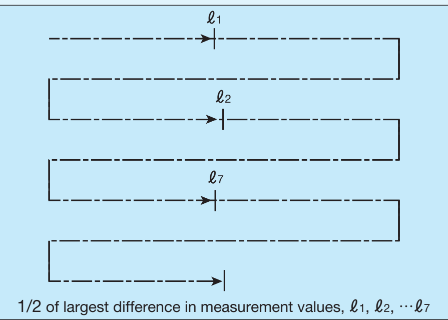
1N=0.102kgf=0.2248lbs.
1mm=0.03937inch

# 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

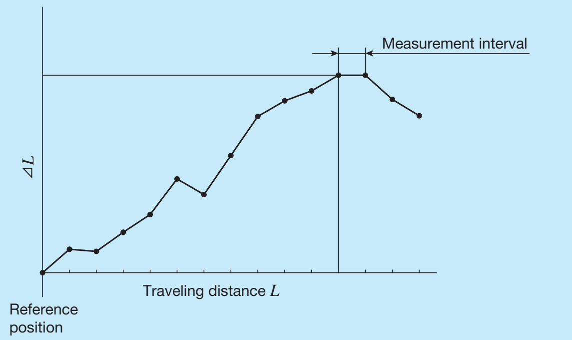
Repeat positioning to any one point from one direction 7 times to measure the stop position and obtain 1/2 of the maximum reading difference.
In principle, perform this measurement at the center and each end of the stroke length and take the maximum obtained value as the measurement value. Indicate the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




1/2 of largest difference in measurement values, $\ell_1, \ell_2, \cdots \ell_7$

## 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.



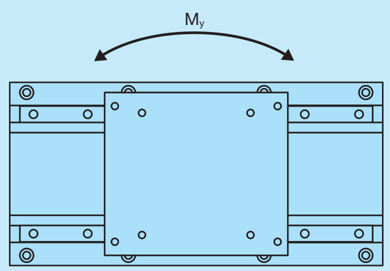

$\Delta L$ = (Distance actually traveled) − (Command value for traveling distance)

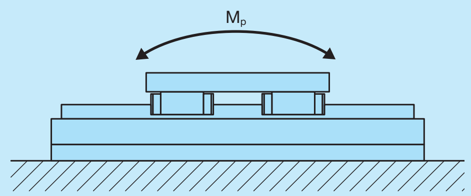
## Attitude accuracy (pitching and yawing)

The tilt angles for pitching direction(Mp) and yawing direction(My) of the table within the stroke range are measured with a laser angle measurement system, and the measured value is the value of the maximum reading error.

● Pitching ($M_p$)
Vertical angle change on table travel axis

● Yawing ($M_y$)
Horizontal angle change on table travel axis

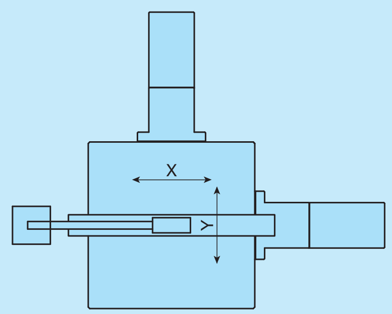


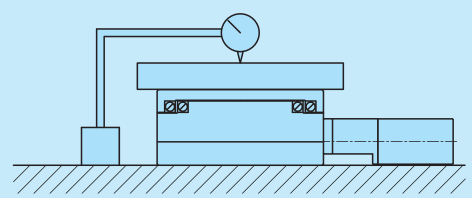

## Parallelism in table motion A

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.

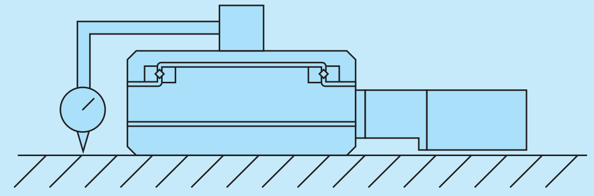



● When the stroke is longer than the slide table length
Fix the test indicator on the stool on which the precision positioning table is mounted, place the straight-edge on the slide table, and apply the test indicator at the center of the slide table. Make a measurement across almost whole area of the 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.

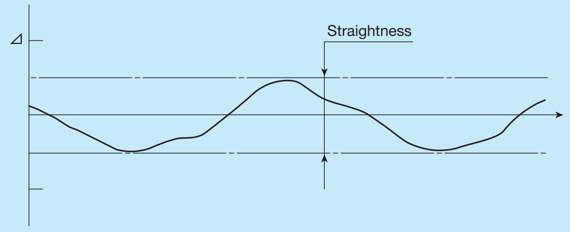


## Straightness

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

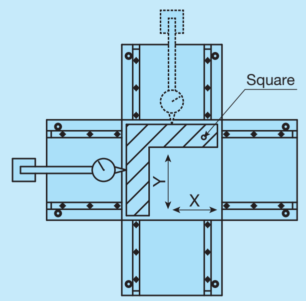
・Straightness in horizontal: Motion of the slide table travel axis in left and right (horizontal) direction.
・Straightness in vertical: Motion of the slide table travel axis in up and down (vertical) direction.

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.



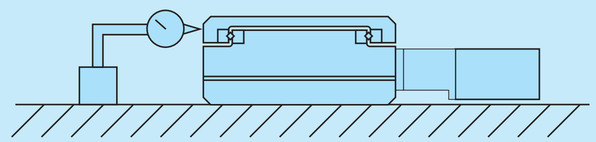

## Squareness of XY motion

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.



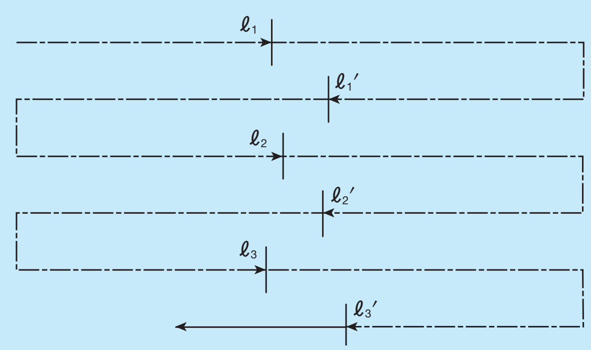

## Backlash

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 ($\ell_1$ 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 ($\ell_1'$ 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 ($\ell_2$ 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

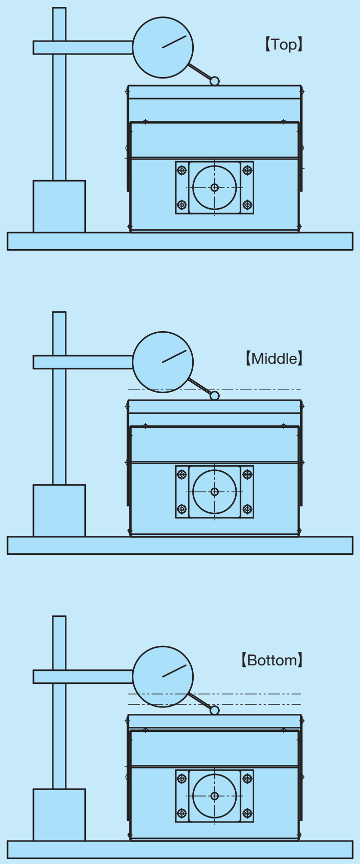
## Measurement of parallelism during table elevating

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.

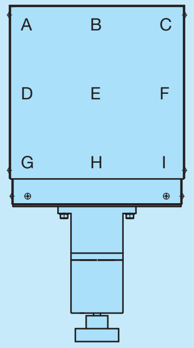
*[Sample calculation of parallelism during table elevating]*

| 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]

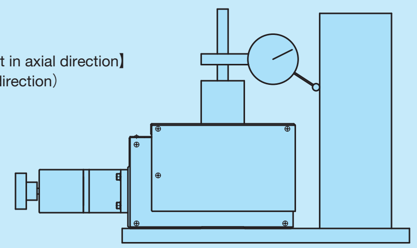


[Measuring point]

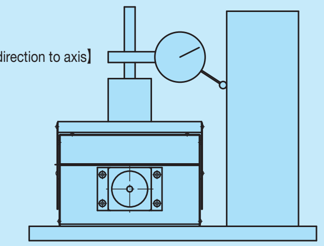
## Measurement of squareness during table elevating

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)



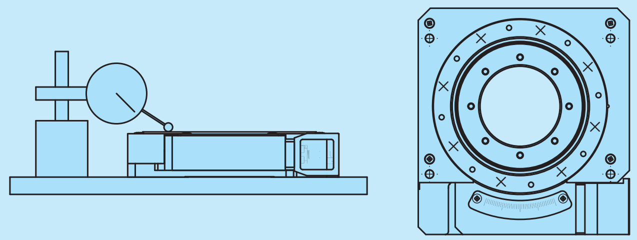
[Measurement in perpendicular direction to axis]
(Y direction)





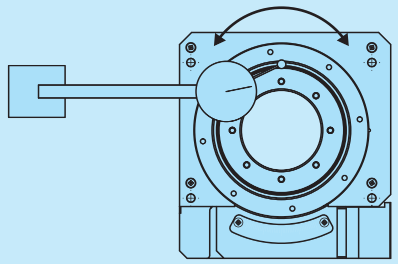
## Parallelism of the table to the mounting surface

Using the table mounting surface as a reference, the entire height of the upper surface of the table is measured with an indicator. The maximum reading difference is taken as the measurement value.


[X: Measuring point]

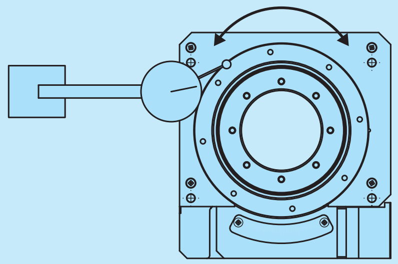
## Radial runout of the table diameter

An indicator is placed against the radial surface of the table while the table is rotated a full revolution. The maximum reading difference is taken as the measurement value.



## Deflection on the upper surface of the table

An indicator is placed against the upper surface of the table while the table is rotated a full revolution. The maximum reading difference is taken as the measurement value.



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# Carrying Mass, Allowable Load

## ■ Maximum carrying mass

The maximum carrying mass is the mass satisfying conditions ① and ② below, and is a reference maximum mass that can be loaded when the precision positioning table is used horizontally or vertically. The size varies depending on the center of gravity of the mass to be carried (height: H, length: L).

①The mass when the rating life of the linear motion rolling guide, ball screws, or bearings is 18,000 hours during continuous operation at a number of revolutions of the motor of 3000min$^{-1}$ (900min$^{-1}$ for TSLB) and an acceleration/deceleration time of 0.2s.

②The mass calculated is based upon the basic static load rating of the linear motion rolling guide you are using.

It is set for TE···B, TU, TSL···M, TSLH···M, TX···M, TC···EB, TM, TS/CT, TSLB, AT, AM, and TZ.

For the maximum carrying mass of each model, please refer to pages Ⅱ-10 to Ⅱ-362. When considering maximum carrying mass, please also refer to maximum load mass values on page Ⅲ-18.

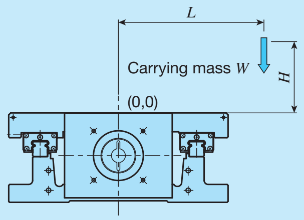



*Fig. 1.1 Carrying mass center of gravity (horizontal direction)*

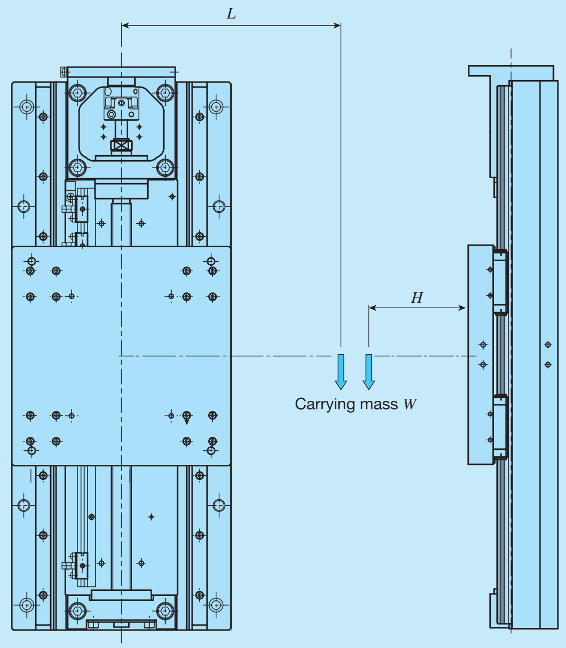



*Fig. 1.2 Carrying mass center of gravity (vertical direction)*

## ■ Allowable load

Allowable load refers to the maximum static load that can be applied without affecting functions or performance when used horizontally. It is set for SK···W.



# Load Mass

## ■ Maximum load mass

Maximum load mass is based on the thrust force (torque) characteristics of the motor used and refers to the maximum mass with which the necessary acceleration rate or acceleration time can be still be achieved.

For ball screw drives and timing belt drives, this is the maximum mass that under which it is possible to achieve continuous operation with 3000 motor revolutions·min$^{-1}$ (900 rev·min$^{-1}$ for TSLB) and an acceleration/deceleration time of 0.2s. For the maximum load mass of each model, please refer to pages Ⅱ-18 to Ⅱ-21.

It is set for TE...B, TU, TSL...M, TSLH...M, TX...M, TC...EB, TM, TS/CT, TSLB, AT, AM, and TZ.

When considering the maximum load mass of ball screw drives and timing belt drives, please also refer to maximum carrying mass values on page Ⅲ-17.

For linear motor drive, this will be the maximum mass that ensures an acceleration of 0.5G (for linear motor) or a peripheral acceleration of 0.5G (for rotary 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, 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.

*Table 1.1 Maximum load mass of TE···B(1)*

| Model and size | Ball screw lead mm | Maximum load mass kg | |
|---|---|---|---|
| | | Horizontal direction | Vertical direction |
| TE50B | 4 | 190 | 18 |
| | 8 | 47 | 9 |
| TE60B | 5 | 355 | 32 |
| | 10 | 88 | 15 |
| | 20 | 21 | 7 |
| TE86B | 10 | 178 | 32 |
| | 20 | 44 | 14 |

Note(1) The values shown in this table were calculated with the motor with the highest rated torque installed, selected from the AC servomotor models listed in Table 2.1 on page II-8.

*Table 1.2 Maximum load mass of TU(1)*

| Model and size | Ball screw lead mm | Length of slide table | Maximum load mass kg | |
|---|---|---|---|---|
| | | | Horizontal direction | Vertical direction |
| TU 25 | 4 | Standard | 49 | 13 |
| TU 30 | 5 | Standard | 29 | 10 |
| TU 40 | 4 | Short | 333 | 41 |
| | | Standard | 333 | 41 |
| | | Long | 332 | 41 |
| | 8 | Short | 83 | 19 |
| | | Standard | 83 | 19 |
| | | Long | 82 | 19 |
| TU 50 | 5 | Short | 206 | 31 |
| | | Standard | 206 | 31 |
| | | Long | 206 | 31 |
| | 10 | Short | 51 | 14 |
| | | Standard | 51 | 14 |
| | | Long | 51 | 14 |
| TU 60 | 5 | Short | 583 | 60 |
| | | Standard | 583 | 60 |
| | | Long | 583 | 59 |
| | 10 | Short | 145 | 29 |
| | | Standard | 145 | 29 |
| | | Long | 144 | 28 |
| | 20 | Short | 36 | 13 |
| | | Standard | 36 | 13 |
| | | Long | 35 | 12 |
| TU 86 | 10 | Short | 224 | 100 |
| | | Standard | 223 | 99 |
| | | Long | 223 | 98 |
| | 20 | Short | 41 | 40 |
| | | Standard | 40 | 39 |
| | | Long | 39 | 38 |
| TU100 | 20 | Standard | 39 | 39 |
| TU130 | 25 | Standard | 69 | 26 |

Note(1) The values shown in this table were calculated with the motor with the highest rated torque installed, selected from the AC servomotor models listed in Table 6.1 on page II-41.

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

*Table 1.3 Maximum load mass of TSL···M(1)*

| Model and size | Ball screw lead mm | Maximum load mass kg | |
|---|---|---|---|
| | | Horizontal direction | Vertical direction |
| TSL 90 M | 5 | 205 | 30 |
| | 10 | 50 | 14 |
| TSL120 M | 5 | 161 | 27 |
| | 10 | 38 | 12 |
| TSL170 M | 5 | 169 | 27 |
| | 10 | 40 | 12 |
| TSL170 SM | 5 | 477 | 55 |
| | 10 | 116 | 25 |
| TSL220 M | 5 | 462 | 50 |
| | 10 | 112 | 21 |

Note(1) The values shown in this table were calculated with the motor with the highest rated torque installed, selected from the AC servomotor models listed in Table 2 on page II-106.

*Table 1.4 Maximum load mass of TSLH···M(1)*

| Model and size | Ball screw lead mm | Maximum load mass kg | |
|---|---|---|---|
| | | Horizontal direction | Vertical direction |
| TSLH120M | 5 | 583 | 61 |
| | 10 | 143 | 28 |
| TSLH220M | 5 | 1000 | 120 |
| | 10 | 327 | 52 |
| TSLH320M | 5 | 1000 | 201 |
| | 10 | 542 | 79 |
| TSLH420M | 5 | 1000 | 171 |
| | 10 | 478 | 50 |

Note(1) The values shown in this table were calculated with the motor with the highest rated torque installed, selected from the AC servomotor models listed in Table 3 on page II-129.

*Table 1.5 Maximum load mass of TX···M(1)*

| Model and size | Ball screw lead mm | Maximum load mass kg | |
|---|---|---|---|
| | | Horizontal direction | Vertical direction |
| TX120M | 5 | 702 | 61 |
| | 10 | 174 | 28 |
| TX220M | 5 | 1000 | 121 |
| | 10 | 329 | 53 |
| TX320M | 5 | 570 | 149 |
| | 10 | 119 | 55 |
| TX420M | 5 | 1000 | 165 |
| | 10 | 480 | 48 |

Note(1) The values shown in this table were calculated with the motor with the highest rated torque installed, selected from the AC servomotor models listed in Table 3 on page II-155.

*Table 1.6 Maximum load mass of TC···EB(1)*

| Model and size | Ball screw lead mm | Maximum load mass kg | |
|---|---|---|---|
| | | Horizontal direction | Vertical direction |
| TC50EB | 4 | 190 | 18 |
| | 8 | 47 | 8 |
| TC60EB | 5 | 207 | 32 |
| | 10 | 51 | 15 |
| TC86EB | 10 | 177 | 31 |
| | 20 | 43 | 13 |

Note(1) The values shown in this table were calculated with the motor with the highest rated torque installed, selected from the AC servomotor models listed in Table 2 on page II-179.

*Table 1.7 Maximum load mass of TM(1)*

| Model and size | Ball screw lead mm | Maximum load mass kg | |
|---|---|---|---|
| | | Horizontal direction | Vertical direction |
| TM15 | 0.5 | 525 | 6 |
| | 1 | 393 | 7 |
| | 1.5 | 194 | 4.7 |
| TM15G | 0.5 | 525 | 6 |
| | 1 | 393 | 7 |
| | 1.5 | 194 | 4.7 |

Note(1) The values shown in this table were calculated with the motor with the highest rated torque installed, selected from the AC servomotor models listed in Table 10 on page II-201.

*Table 1.8 Maximum load mass of TS(2)*

| Model and size | Ball screw lead mm | Maximum load mass kg | |
|---|---|---|---|
| | | Horizontal direction | Vertical direction |
| TS 55/ 55(1) | 1 | – | – |
| TS 75/ 75(1) | 1 | – | – |
| TS125/125 | 1 | 1000 | 141 |
| | 2 | 1000 | 69 |
| | 5 | 196 | 26 |
| TS125/220 | 2 | 1000 | 68 |
| | 5 | 190 | 24 |
| TS220/220 | 2 | 1000 | 58 |
| | 5 | 188 | 18 |
| TS220/310 | 2 | 1000 | 53 |
| | 5 | 172 | 13 |
| TS260/350 | 2 | 1000 | 126 |
| | 5 | 595 | 37 |

Note(1) For information on the maximum load mass for stepper motors, please contact IKO.
(2) The values shown in this table were calculated with the motor with the highest rated torque installed, selected from the AC servomotor models listed in Table 2 on page II-236.

*Table 1.9 Maximum load mass of CT(2)*

| Model and size | Ball screw lead mm | Maximum load mass kg | |
|---|---|---|---|
| | | Horizontal direction | Vertical direction |
| CT 55/ 55(1) | 1 | – | – |
| CT 75/ 75(1) | 1 | – | – |
| CT125/125 | 1 | 1000 | 141 |
| | 2 | 1000 | 69 |
| | 5 | 192 | 26 |
| CT220/220 | 2 | 1000 | 58 |
| | 5 | 175 | 18 |
| CT260/350 | 2 | 1000 | 126 |
| | 5 | 576 | 38 |
| CT350/350 | 2 | 1000 | 121 |
| | 5 | 558 | 32 |

Note(1) For information on the maximum load mass for stepper motors, please contact IKO.
(2) The values shown in this table were calculated with the motor with the highest rated torque installed, selected from the AC servomotor models listed in Table 2 on page II-208.

*Table 1.10 Maximum load mass of TSLB(1)*

| Model and size | Horizontal direction Maximum load mass kg |
|---|---|
| TSLB 90 | 8 |
| TSLB120 | 6 |
| TSLB170 | 3.5 |

Note(1) The values shown in this table were calculated with the motor with the highest pull-out torque installed, selected from the stepper motor models listed in Table 2 on page II-236.

*Table 1.11 Maximum load mass of AT(1)*

| Model and size | Ball screw lead mm | Maximum load mass kg | |
|---|---|---|---|
| | | Horizontal direction | Vertical direction |
| AT120 | 1 | 1000 | 243 |
| AT200 | 1 | | 201 |
| AT300 | 2 | | 93 |

Note(1) The values shown in this table were calculated with the motor with the highest rated torque installed, selected from the AC servomotor models listed in Table 1 on page II-325.

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

*Table 1.12 Maximum load mass of AM*[1]

| Model and size | Ball screw lead mm | Maximum load mass kg | |
|---|---|---|---|
| | | Horizontal direction | Vertical direction |
| AM25 | 4 | 49 | 11 |
| AM40 | 4 | 334 | 39 |
| AM60 | 5 | 275 | 38 |
| AM86 | 5 | 1000 | 124 |

Note[1] The values shown in this table were calculated with the motor with the highest rated torque installed, selected from the AC servomotor models listed in Table 1 on page II-346.

*Table 1.13 Maximum load mass of TZ*[1]

| Model and size | Wedge reduction ratio | Maximum load mass kg | |
|---|---|---|---|
| | | Horizontal direction | Vertical direction |
| TZ120X-2 | 1:2 | 83 | 1000 |
| TZ120X-4 | 1:4 | 172 | |
| TZ200H-2 | 1:2 | 86 | |
| TZ200H-4 | 1:4 | 178 | |
| TZ200X-2 | 1:2 | 86 | |
| TZ200X-4 | 1:4 | 178 | |

Note[1] The values shown in this table were calculated with the motor with the highest rated torque installed, selected from the AC servomotor models listed in Table 1 on page II-360.



# Maximum Speed and Resolution

## Maximum speed

The maximum speed of a 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 a fixed maximum speed. See the specifications of each model for more details.

**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 $\times \pi = 100$mm)

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

## Resolution

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

**Ball screw drive**

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

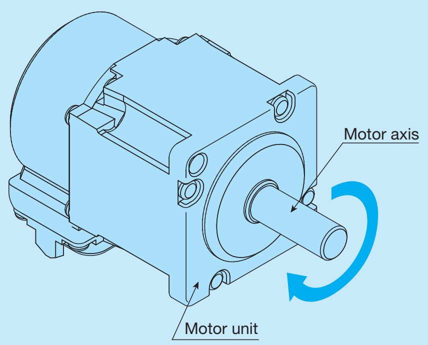
**Timing belt drive**

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

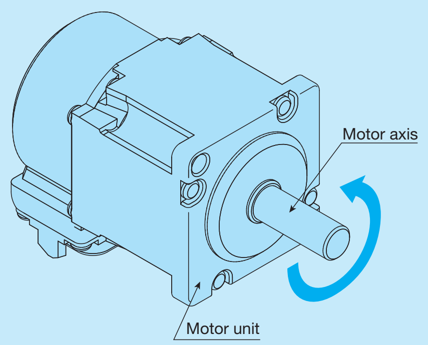
(Pulley pitch diameter $\times \pi = 100$mm)

# Motor Axis Rotation Directions

Motor axis (shaft) rotation directions are defined as shown below.
When a reducer is mounted to the motor, the rotation direction of the reducer output shaft may be the opposite of that shown for CW and CCW below.




CW




CCW

Motor axis rotation direction CW (Clockwise Rotation)
Rotates to the right (clockwise) when looking at the motor unit from the motor axis.

Motor axis rotation direction CCW (Counter Clockwise Rotation)
Rotates to the left (counter clockwise) when looking at the motor unit from the motor axis.

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

# Consideration of Operation Patterns

## ■ Calculation of positioning time

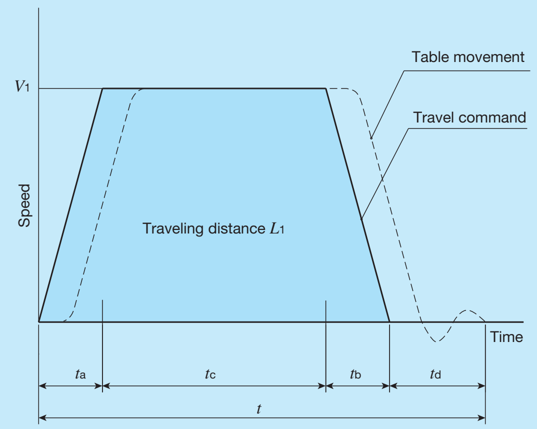
The positioning time taken when the precision positioning table actually moves can be obtained by the following equation. For applications requiring high precision positioning, the settling time from completion of command pulse input to full stop of the table at the positioning point and vibration damping 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 the distance for which there is enough constant speed traveling time when 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

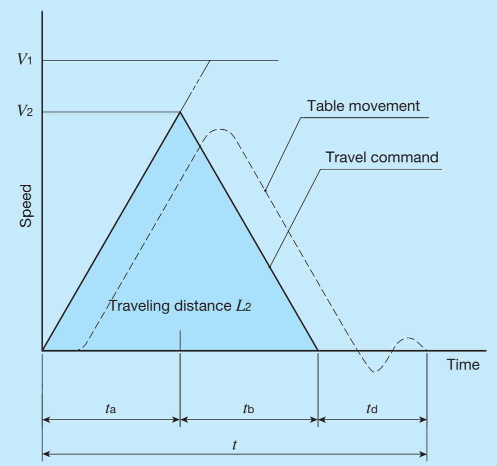



### Short-distance positioning

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

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

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




## ■ 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 $T_a$

$T_a=(J_T+J_M+J_C+J_L)\cdot\frac{2\pi N}{60t_a}$ [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 | $\ell$ [m] | $L$ [m] |
|---|---|---|
| AT120A | 0.001 | 0.100 |
| AT200A | 0.001 | 0.130 |
| AT300A | 0.002 | 0.186 |

$T_0$ : Starting torque N·m
$\mu$ : Friction coefficient of rolling guide (0.01)
$W$ : Carrying mass kg
$\ell$ : Ball screw lead m
$r$ : Pulley pitch radius (0.0159m)
$\eta$ : 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



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

## 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]

$\mu$ : 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.

## 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
In case of SA200DE/X 10.0N

● 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 0.3N·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]

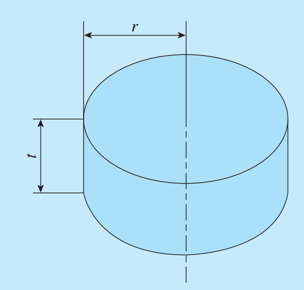
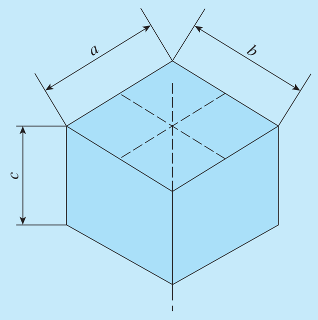
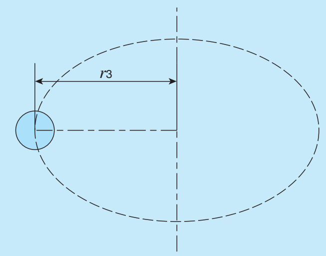
● Marginal acceleration time $t_a$
$t_a=\frac{(J_L+J_T)\cdot R\cdot k}{M_M-M_L}$ [s]

$J_L$ : Inertia moment of load kg·m²
$J_T$ : Inertia moment of moving table kg·m²
$M_c$ : 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 $\theta$-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 |
|---|---|---|
|  |  |  |
| $J_L=\frac{1}{2}\cdot\pi\cdot p\cdot t\cdot r^4$<br>$=\frac{1}{2}\cdot m\cdot r^2$ | $J_L=\frac{1}{12}\cdot p\cdot a\cdot b\cdot c\cdot(a^2+b^2)$<br>$=\frac{1}{12}\cdot m\cdot(a^2+b^2)$ | $J_L'=J_L+m\cdot r_3^2$<br>$J_L'$: Inertia moment from rotation center<br>$J_L$: Inertia moment when rotating around the center of gravity |



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

## ■ 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

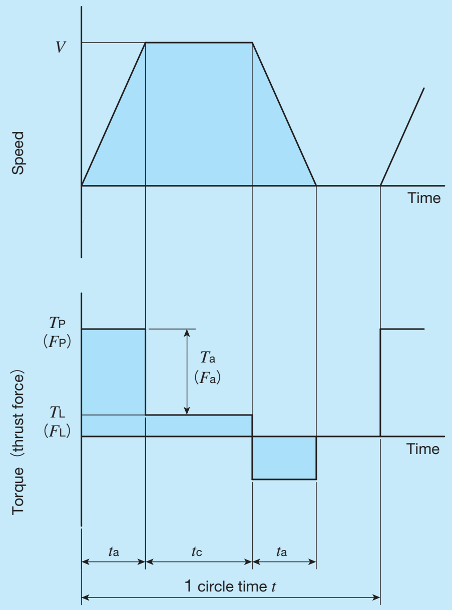
● Effective torque $T_{rms}$

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

### In case of linear motor drive

● Effective thrust force $F_{rms}$

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



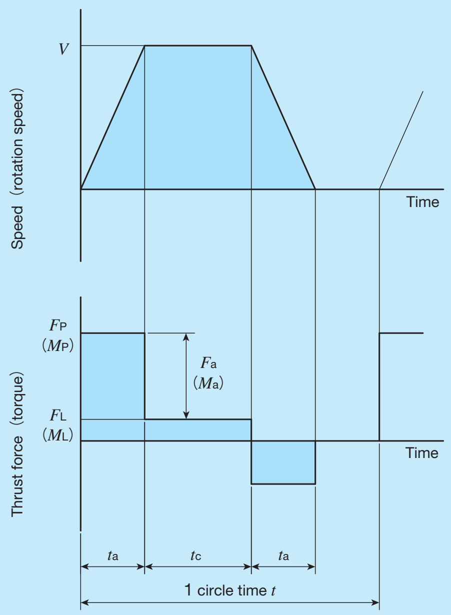

### In case of direct drive (SA···DE)

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

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

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

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



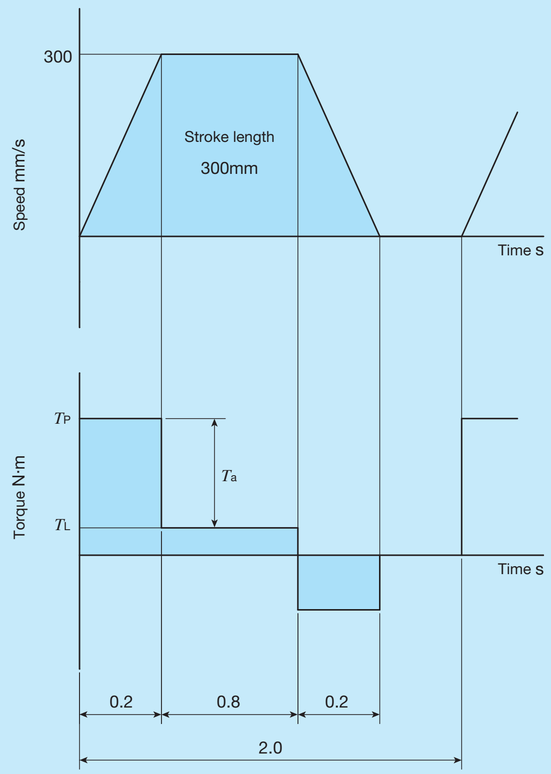



## ■ Consideration example of operation pattern

### 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 $\ell$ | 10mm |
| Stroke length | 300mm |
| Maximum speed | 500mm/s |
| Starting torque $T_s$ | 0.08N·m |
| Table inertia $J_T$ | $0.93\times10^{-5}$kg·m² |
| Coupling inertia $J_C$ | $0.290\times10^{-5}$kg·m² |

● Motor specification

| | |
|---|---|
| AC servomotor used | SGMAV-01A |
| Rated torque | 0.318N·m |
| Motor inertia $J_M$ | $0.380\times10^{-5}$kg·m² |

● Calculation of torque required for acceleration

· Applied torque $T_L$

$$T_L=T_s+\mu Wg\cdot\frac{\ell}{2\pi\eta}$$
$$=0.08+0.01\times30\times9.8\times\frac{0.01}{2\times\pi\times0.9}$$
$$\fallingdotseq0.09\mathrm{N\cdot m}$$

· Acceleration torque $T_a$

$$J_L=W\cdot\left(\frac{\ell}{2\pi}\right)^2$$
$$=30\times\left(\frac{0.01}{2\times\pi}\right)^2\fallingdotseq7.60\times10^{-5}\mathrm{kg\cdot m^2}$$
$$N=V\times\frac{60}{\ell}=0.3\times\frac{60}{0.01}=1800\mathrm{min^{-1}}$$
$$T_a=(J_T+J_M+J_C+J_L)\cdot\frac{2\pi N}{60t_a}$$
$$=(0.93+0.380+0.290+7.60)\times10^{-5}\times\frac{2\times\pi\times1800}{60\times0.2}$$
$$\fallingdotseq0.09\mathrm{N\cdot m}$$

· Torque required for acceleration $T_P$

$$T_P=T_L+T_a=0.09+0.09=0.18\mathrm{N\cdot m}$$

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.

$$T_M=0.318\times3\fallingdotseq0.95\mathrm{N\cdot m}$$
$$T_P\times k=0.18\times1.3=0.23\mathrm{N\cdot m}<T_M$$

● Consideration of effective torque

· Effective torque $T_{rms}$

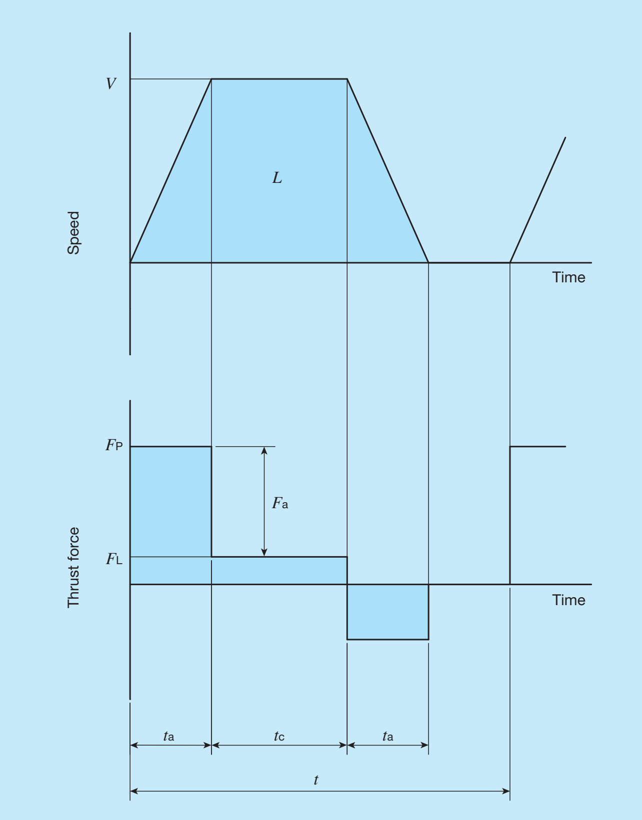
$$T_{rms}=\sqrt{\frac{T_P^2\times t_a+(T_P-2\times T_L)^2\times t_a+T_L^2\times t_c}{t}}$$
$$=\sqrt{\frac{0.23^2\times0.2+(0.23-2\times0.09)^2\times0.2+0.09^2\times0.8}{2.0}}$$
$$\fallingdotseq0.09\mathrm{N\cdot m}$$

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.

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

## 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-306.




Setting items

| | | | |
|---|---|---|---|
| Table specification | Model | | LT170HS (natural air cooling) |
| | Mass of moving table | $W_T$ | 4.0kg<br>See page Ⅱ-318 |
| | Maximum thrust at traveling speed $V$ | $F_M$ | About 550N<br>See page Ⅱ-306 |
| | 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<br>Expected value |
| Factor of safety | | $k$ | 1.3 |
| Ambient temperature | | | 30℃ |

STEP1 Calculation of thrust force required for acceleration

①Force from running resistance $F_L$

$F_L = f_V \times F_R + F_c = 2.25 \times 40 + 1 = 91\text{N}$

②Force from acceleration $F_a$

$F_a = (\text{WL}+\text{WT}) \cdot \dfrac{V}{t_a}$

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

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-306. 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
$F_P \times k = 261 \times 1.3 = 339.3\text{N} < F_M$

STEP2 Consideration of effective thrust force

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

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

$$= \sqrt{\frac{261^2 \times 0.3 + (261-2\times91)^2 \times 0.3 + 91^2 \times 0.5}{2.5}}$$

$≒ 103\text{N}$

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.

## 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 | | $J_L$ | $1.0\times10^{-2}$kg・m² |
| 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 | $J_T$ | $2.0\times10^{-3}$kg・m² |
| | Set operating angle | $L$ | 0.1πrad<br>18° |
| | Maximum speed | $R$ | πrad/s<br>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

①Force from running resistance $F_L$

$F_L = F_f + F_c = 3.0 + 1.0 = 4.0\text{N}$

②Force from acceleration $F_a$

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

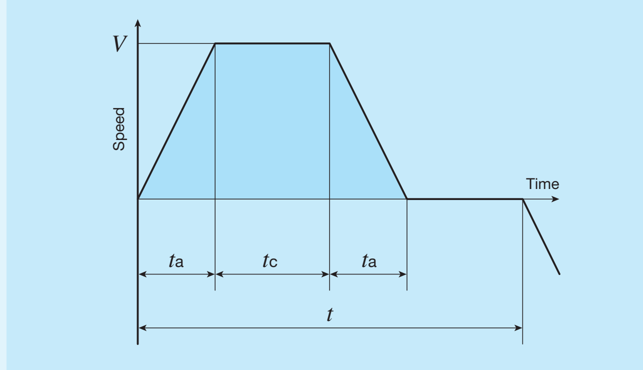
$= (5.0+5.9) \times \dfrac{0.1}{0.05} = 21.8\text{N}$

③Thrust force required for acceleration $F_P$

$F_P = F_a + F_L$

$= 21.8 + 4.0 = 25.8\text{N}$

At this point, check that the $F_P \times k$ (factor of safety) is below the maximum thrust in page Ⅱ-280. 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
$F_P \times k = 25.8 \times 1.3 = 33.54\text{N} < F_M$




STEP2 Consideration of effective thrust force

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

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

$$= \sqrt{\frac{25.8^2 \times 0.05 + (25.8-2\times4.0)^2 \times 0.05 + 4.0^2 \times 0.05}{0.4}}$$

$≒ 11.17\text{N}$

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. In the example pattern, it can be judged that continuous operation is possible.



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

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 $\theta$-axis acceleration

①Torque from rotation resistance $M_L$

$M_L = M_f + M_c$

$= 0.1 + 0.0 = 0.1\text{N·m}$

②Torque from acceleration $M_a$

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

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

③Torque required for acceleration $M_P$

$M_P = M_a + M_L$

$= 0.754 + 0.1 = 0.854\text{N·m}$

At this point, check that the $M_P \times k$ (factor of safety) is below the maximum torque in page Ⅱ-280. 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
$M_P \times k = 0.854 \times 1.3 \fallingdotseq 1.11\text{N·m} < M_M$

STEP5 Consideration of effective torque

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

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

$$= \sqrt{\frac{0.854^2 \times 0.05 + (0.854 - 2 \times 0.1)^2 \times 0.05 + 0.1^2 \times 0.05}{0.4}}$$

$\fallingdotseq 0.38\text{N·m}$

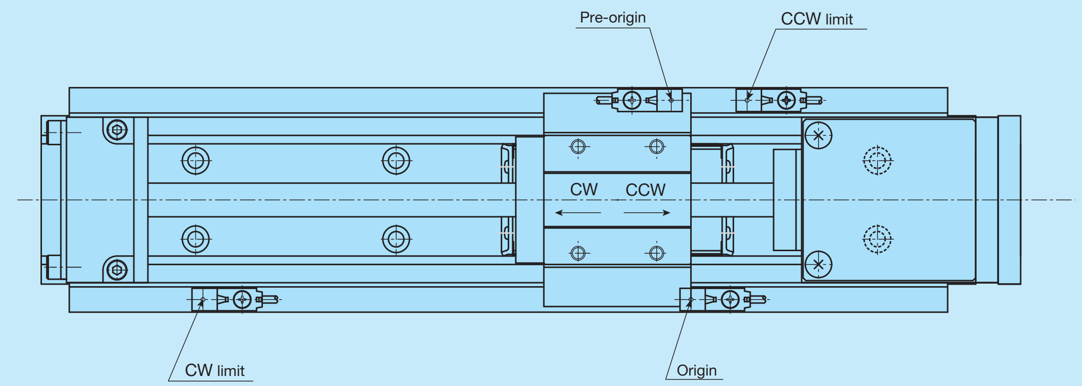
At this point, check that $M_{rms}$ is below the rated torque. If the rated torque is exceeded, review the maximum speed for operating pattern and acceleration / deceleration time. In the example pattern, it can be judged that continuous operation is possible.

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

# Sensor Specification

Precision positioning table is equipped with CW and CCW limit sensors for overrun prevention and pre-origin, origin and for 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, 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.

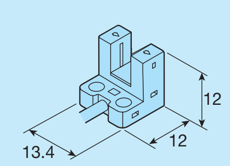
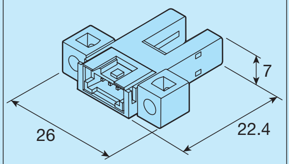
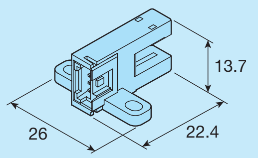
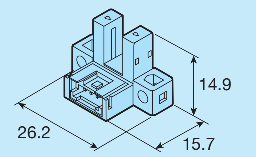
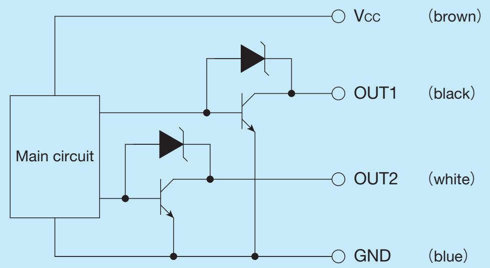
| Table model (Sensor) | | CW limit | CCW limit | Pre-origin (PORG) | Origin (ORG) | For origin (PORG) |
|---|---|---|---|---|---|---|
| TE…B (1) | | Proximity sensor | Proximity sensor | Proximity sensor | Proximity sensor | – |
| TU (1) | | Proximity sensor | Proximity sensor | Proximity sensor | Proximity 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) | – |
| NT…H | | Encoder (3) (5) | Encoder (3) (5) | – | Encoder (3) (5) | – |
| AT | | Proximity sensor (5) | Proximity sensor (5) | – | – | – |
| SK…W | | Proximity sensor | Proximity sensor | – | – | Proximity sensor |
| AM | | Proximity sensor | Proximity sensor | Proximity sensor | – (2) | – |
| SA…DE | SA200DE | 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.



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

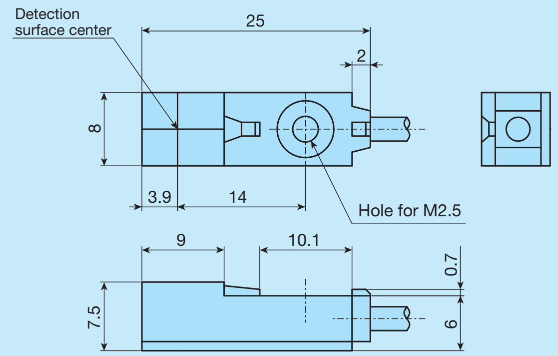
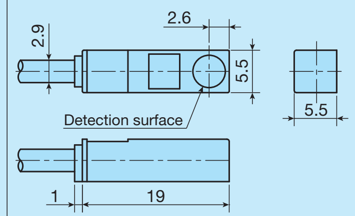
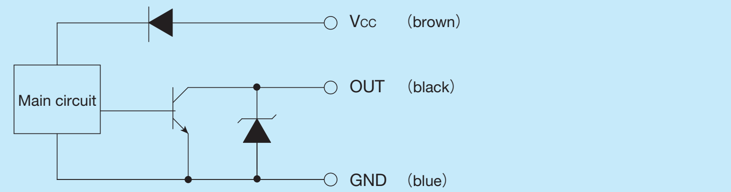
*Table 2 Photo sensor specifications*

| Item \ Sensor | Limit, pre-origin and origin | | | |
|---|---|---|---|---|
| | ① PM-L25 | ② PM-K65 | ③ PM-T65 | ④ PM-L65 |
| Manufacturer | Panasonic Industrial Devices SUNX Co., Ltd. | | | |
| Shape (mm) |   |   |   |   |
| Output connector models (1) | – | CN-14A-C1 (lead length: 1 m) or<br>CN-14A-C3 (lead length: 3 m) | | |
| Power supply voltage | DC5~24V ±10% | | | |
| Current consumption | 15mA or less | | | |
| Output | NPN transistor open collector<br>· Maximum input current : 50mA<br>· Applied voltage : 30VDC or less<br>· Residual voltage : 2V or less at input current of 50mA<br>1V or less at 16mA | | | |
| Output operation | ON/OFF upon light entrance; selective (2) | | | |
| Operation indication | Orange 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.

*Table 3 Specifications of proximity sensor*

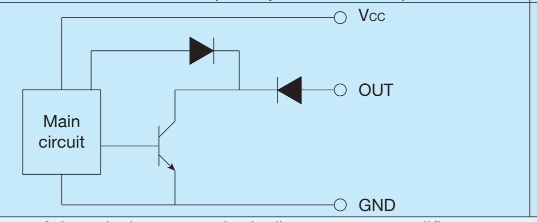
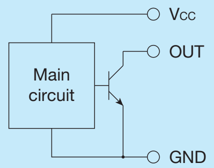
| Item \ Target model | | SA200DE/X | SA200DE/S | TZ200H and TZ200X | Other models | SK···W | TZ120X |
|---|---|---|---|---|---|---|---|
| Manufacturer | | Azbil Corporation | | | | OMRON Corporation | |
| Model | Pre-origin | APM-D3A1- (special) | APM-D3A1F- (special) | APM-D3B1F- (special) | APM-D3B1- (special)<br>APM-D3B1F- (special) | – | E2S-W14 1M |
| | CW limit | APM-D3A1- (special) | APM-D3A1- (special) | APM-D3B1- (special) | APM-D3B1- (special) | E2S−W14 1M | E2S-W14 1M |
| | CCW limit | APM-D3A1- (special) | | APM-D3B1F- (special) | | E2S−W14 1M | E2S-W14 1M |
| | Origin | Encoder | | APM-D3A1- (special) | APM-D3A1- (special) | – | E2S-W13B 1M |
| | For origin | – | – | – | – | E2S−W13B 1M | – |
| Shape mm | |   | | | |   | |
| Power supply voltage | | DC12~24V ±10% | | | | | |
| Current consumption | | 10mA or less | | | | 13mA or less | |
| Output | | NPN open collector<br>· Maximum input current: 30mA or less (resistance load)<br>· Applied voltage : DC26.4V or less<br>· Residual voltage : 1V or less at input current of 30mA | | | | NPN open collector<br>· Maximum input current: 50mA<br>· Applied voltage : DC30V or less<br>· 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/For 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/For origin | — | | Orange LED (ON upon detection) | | | |
| Circuit diagram | |   | | | | | |

Remarks: 1. Unbound wires for sensor cords or sensor extension cords must be wired by the customer.
2. Lead runs off by at least 200mm from the table end. Actual length varies depending on stroke length.
3. For information about PNP sensor options, please contact IKO.



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

*Table 4 Specifications of magnetic sensor*

| Item \ Sensor | | 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<br>· Maximum input current: 12mA<br>· Applied voltage : DC36V or less<br>· Residual voltage: 1.7V or less at input current of 12mA<br>: 1.1V or less at input current of 4mA | NPN open collector<br>· Maximum input current: 10mA<br>· Applied voltage: DC26.4V or less<br>· 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 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<br>Terminal 1855TL | Housing 1625-12P1<br>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<br>Terminal 43031-0010 | Housing 43025-0600<br>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.



# 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<br>TM | 8 |
| TS/CT<br>NT···V<br>NT···XZ<br>NT···XZH<br>SA···DE<br>SK···W | 10 |
| TSLH···M | 15 |
| TE···B<br>TU<br>TSL···M<br>TC···EB<br>LT<br>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 | Female thread component: Aluminum alloy | Female thread component: 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)

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

# 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.
- Rust prevention oil or grease is used on the linear motion rolling guide, bearings, and ball screws incorporated in mechatronics products. Therefore, oil may drip or spatter depending on the operating conditions. Consider installing a shielding plate if necessary.
- The stainless sheet and resin roller in the Cleanroom Precision Positioning Table TC series are consumable items. Please conduct daily inspections or other routine checks to verify that there is no damage or abrasion. If replacement items are necessary, please contact IKO.

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