# SLIDE SCREW

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**The NB slide screw converts rotational motion into linear motion by utilizing the friction between radial ball bearings and a shaft. This simple mechanism eases maintenance and installation cost. The slide screw is most commonly used as transport devices in many types of machines, and is not intended for accurate positioning requirements.**

## STRUCTURE AND ADVANTAGES

The NB slide screw consists of two aluminum blocks, each with three radial bearings with a fixed angle between them. A round shaft is inserted between the two blocks, and its rotation produces linear motion determined by the contact angle between the shaft and bearings. For variable loads, the thrust is adjusted by turning the spring loaded hexagonal bolts.

### Linear Motion on a Round-shaft:

The NB Slide Screw is suitable for long-stroke applications using a standard linear shaft.

### High Machine Efficiency:

The slide screw utilizes the rotational motion of the bearings and shaft to achieve machine efficiency as high as 90%.

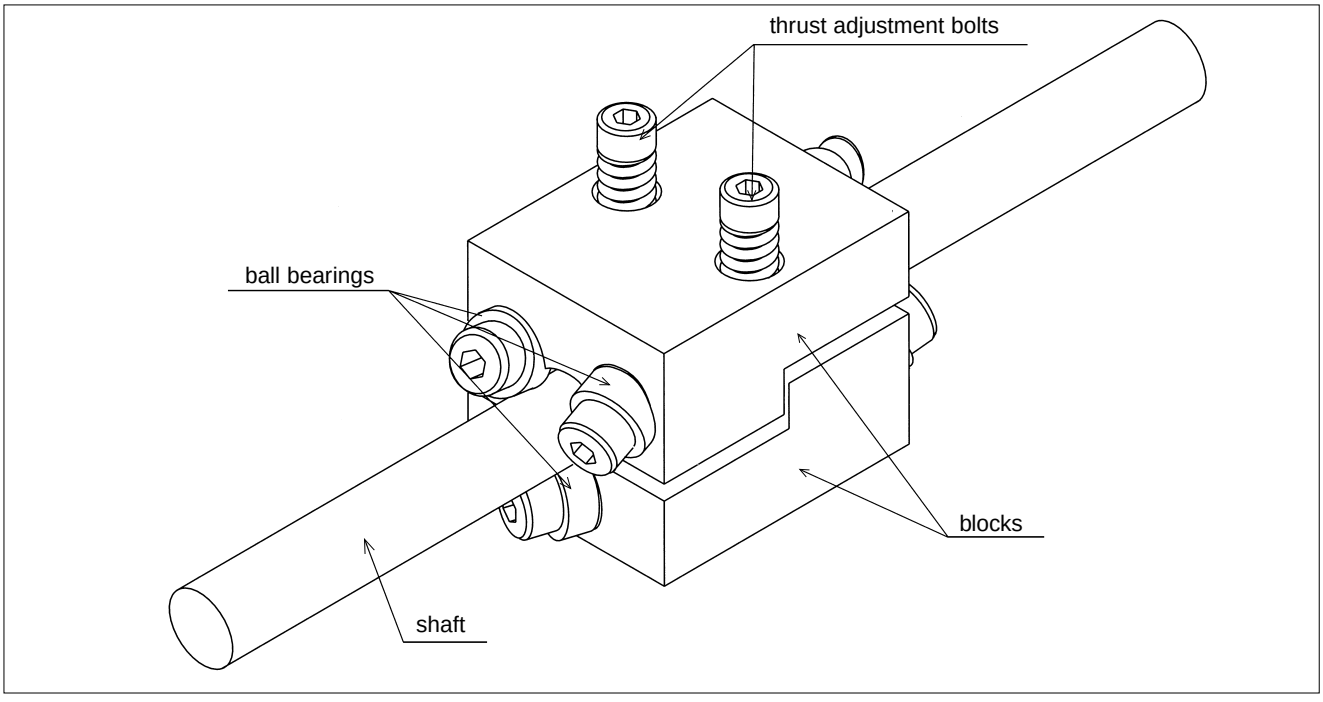
### No Lubrication Required:

The bearings are pre-lubricated with grease prior to shipment, so there is no need to apply lubrication other than to the drive shaft to prevent corrosion.

### Excessive Load Prevention Mechanism:

When an excessive load is applied, the screw will stop due to slippage, thereby preventing accidents.

Figure J-1 Structure of NB Slide Screw



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# SELECTION METHOD

## Required Thrust:

Tightening of the bolts creates a thrust force that pushes the bearings against the shaft. This results in a constant force being applied to the bearings regardless of the load. The thrust should not be greater than required force in the application.

$$F_1 = \mu \cdot g \cdot W \quad \cdots\cdots(1)$$

$F_1$: frictional resistance (N) $\mu$: friction coefficient W: mass of work (kg)
g: gravitational acceleration (9.8 m/sec$^2$)

A sufficient safety margin should be achieved at $\mu$ = 0.01. Also, the inertia at starting and stopping should be taken into consideration.

$$F_2 = W \frac{dv}{dt} \quad \cdots\cdots(2)$$

$F_2$: inertia (N) W: mass of work (kg) dv/dt: acceleration (9.8m/sec$^2$)

Therefore, the required thrust is its maximum limit at starting point due to the combination of frictional resistance and inertia.

$$F = F_1 + F_2 \quad \cdots\cdots(3)$$

F: thrust (N) $F_1$: frictional resistance (N) $F_2$: inertia (N)

## Torque:

After deciding the thrust required, decide the driving torque corresponding to that thrust. The torque is calculated as follows:

$$T = \frac{Fa\,\ell}{2\pi\eta} \quad \cdots\cdots(4)$$

T: driving torque (N.cm) Fa: axial load (N)
$\ell$: lead (cm) $\eta$: efficiency (0.9) Fa=Fo

## Life:

The rated life is expressed in terms of the number of revolutions of the drive shaft: Equation (5). The corresponding total distance traveled and life time are given in Equations (6) and (7) respectively.

Rated life

$$L = \left(\frac{C}{F}\right)^3 10^6 \quad \cdots\cdots(5)$$

Total travel distance

$$Ls = \frac{L \cdot \ell}{10^6} \quad \cdots\cdots(6)$$

Life time

$$Lh = \frac{L}{60 \cdot n} \quad \cdots\cdots(7)$$

L: rated life (rev) C: basic dynamic load rating (N)
F: thrust (N) Ls: travel life (km)
l: lead (mm) Lh: life time (hr)
n: revolutions per min (rpm)

Table J-1 Basic Dynamic Load Rating

| part number | basic dynamic load rating (N) |
|---|---|
| SS 6 | 98 |
| SS 8 | 294 |
| SS10 | 441 |
| SS12 | 588 |
| SS13 | 588 |
| SS16 | 784 |
| SS20 | 1,080 |
| SS25 | 1,470 |
| SS30 | 2,160 |



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## Allowable Rotational Speed:

When the rotational speed is increased and approaches the shaft resonant frequency, the shaft is disabled from further operation. This speed is called the critical speed and can be obtained by the following equation. In order to leave a sufficient safety margin, the maximum operating speed should be set at about 80% of the calculated value.

$$Nc = \frac{60\lambda^2}{2\pi L^2} \cdot \sqrt{\frac{EI \times 10^3}{\gamma A}} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (8)$$

Nc : critical speed (rpm)  E : modulus of directe elasticity (N/mm$^2$)
$\gamma$ : density (kg/mm$^3$)  $\lambda$ : installation coefficient (refer to Figure J-3)
L : support distance (mm)  I : geometrical moment of inertia (mm$^4$)
A : cross-sectional area of the shaft (mm$^2$)

If modulus of direct elasticity is 2.06 x $10^5$ N/mm$^2$ and density is 7.85x$10^{-6}$ kg/mm$^3$, the critical speed for a solid shaft is:

$$Nc = 12.2 \cdot \frac{\lambda^2}{L^2} D \times 10^6 \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (9)$$

Nc : critical speed (rpm)
$\lambda$ : installation coefficient (refer to Figure J-3)
L : support distance (mm)  D : shaft diameter (mm)

Figure J-2 Critical Speed and Support Distance

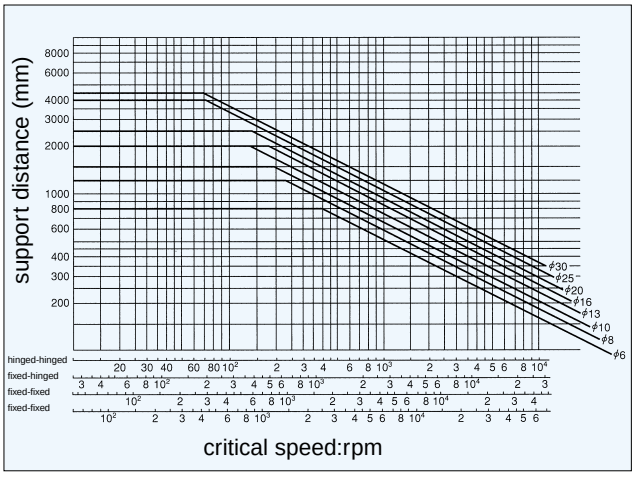
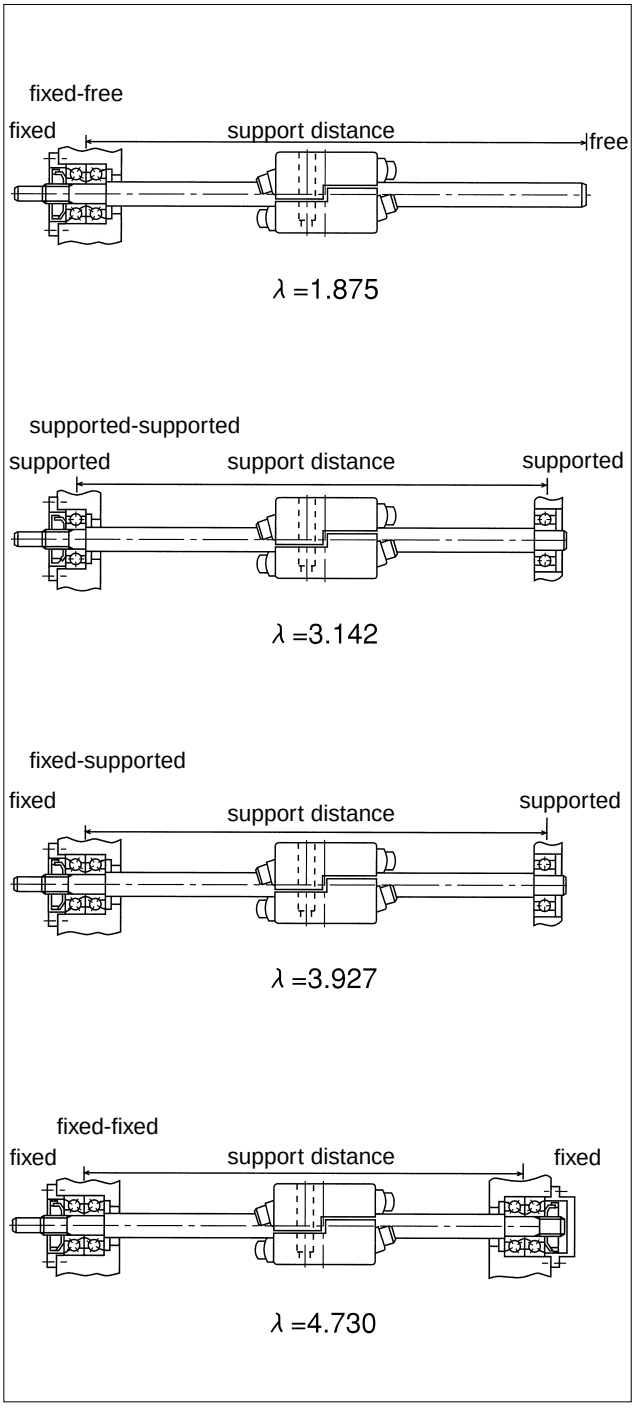



Figure J-3 Mounting of Slide Screw



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## Sample Calculation:

1. Selecting a slide screw that satisfies the following conditions:
Support method: fixed-supported
Support distance: 1,500 mm
External force: 98 N
Table mass: 50 kg
Stroke distance: 1,200 mm
Friction coefficient: 0.01
Maximum speed of movement: 12 m/min
Strokes per minute: 4

● Determination of required thrust:
$F = 98+(0.01\times50\times9.8)=102.9N$
Therefore, based on the maximum thrust required, at least SS10 is required in size.

● Allowable rotational speed:
From Equation (9)
According to the conditions, the critical speed Nc is.

$$Nc = 12.2\cdot\frac{\lambda^2}{L^2}\cdot D\times10^6 \quad \left[\begin{array}{l}\lambda=3.927\\ L=1500mm\end{array}\right]$$

$= 83.6D$ rev
Applying a safety factor of 0.8, the maximum velocity is given by:

$$Vmax = \frac{0.8\cdot Nc\cdot \ell}{1000}\ m/min$$

($\ell$ : lead mm)
The following table summarizes the results of the calculations above for SS10 to SS16.

Table J-2

| part number | shaft diameter D mm | lead $\ell$ mm | critical speed Nc rpm | maximum speed Vmax m/min |
|---|---|---|---|---|
| SS10-10 | 10 | 10 | 836 | 6.68 |
| SS10-15 | | 15 | | 10.0 |
| SS13-13 | 13 | 13 | 1086 | 11.2 |
| SS13-15 | | 15 | | 13.0 |
| SS16-16 | 16 | 16 | 1337 | 17.1 |

Therefore, the SS13-15 and SS16-16 slide screws satisfy the given conditions.

● Life Calculation:
The life for the SS13-15 slide screw is calculated as follows. The rated life is obtained using Equation (5).

$$L=\left[\frac{C}{F}\right]^3 10^6 = 186\times10^6 rev$$

The average number of rotations that satisfies the condition is:

$$n = \frac{1{,}200\times2\times4}{15} = 640rev$$

The life in terms of time is:

$$L_h = \frac{L}{60\times n} = 4{,}840hour$$

For the SS16-16 slide screw:
$L = 4.40\times10^6 rev$
$n = 600rev$
$L_h = 12{,}200hour$

2. Determining the maximum speed of movement under the following conditions:
Support method: fixed-supported
Support distance: 2,000mm
Slide screw used: SS16-16
The critical speed is obtained from Equation (9):

$$Nc = 12.2\cdot\frac{\lambda^2}{L^2}\cdot D\times10^6 \quad \left[\begin{array}{l}\lambda=3.927\\ L=1500mm\\ D=16mm\end{array}\right]$$

$= 752rpm$
Applying a safety factor of 0.8, the maximum speed of movement is:

$$Vmax = \frac{0.8\cdot Nc\cdot \ell}{1000}\ m/min \quad (\ell : \text{lead mm})$$

$= 9.6m/min$


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## INSTALLATION

1. Clean dust from drive shaft.

2. Place shaft between upper and lower blocks. Lightly tighten hexagonal bolts until the clearance between the shaft and the bearings diminishes.

3. Temporarily attach the slide screw to the table.

4. Adjust the parallelism between the slide screw and the linear motion guides by manually moving the table forward and backward. Fix the shaft accurately after the required parallelism is achieved.

5. Tighten the bolts evenly while appling a thrust force untill slippage disappears. Care should be required to avoid excessive tightning which results in shortening the rated life.

## NOTES ON OPERATION

● Use of a heat-treated ground shaft such as NB's slide shaft to prevent wear and obtain smooth motion is recommended.

● Since the slide screw utilizes the friction between the bearings and the shaft, the lead varies due to the effect of load variation, movement direction, and shaft conditions. Highly accurate positioning can be obtained by attaching a linear scale to the aluminum blocks.

● If the slide screw and shaft are not parallel, an unbalanced load will be applied to the slide screw. Exercise care in controlling the parallelism.

● The slide screw slips on the shaft if an excessive load is applied, in order to prevent damage. However, frequent slippage should be avoided not to shorten the travel life.

● Please transfer the radial load to linear motion guides since the radial load on the slide screw shortens the rated life.

## SPECIAL REQUIREMENTS

NB can fabricate slide screws to meet special requirements, including screws with a special lead or a even reverse lead. Contact NB for further information.



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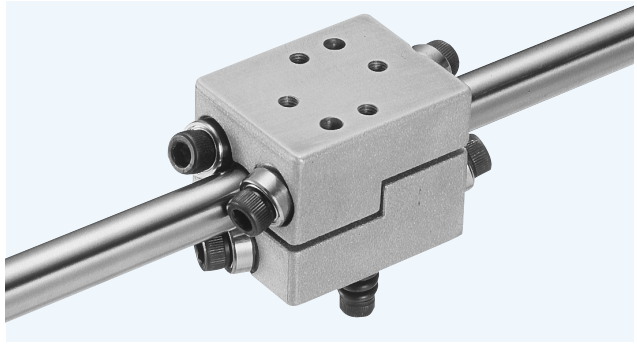
# SS TYPE

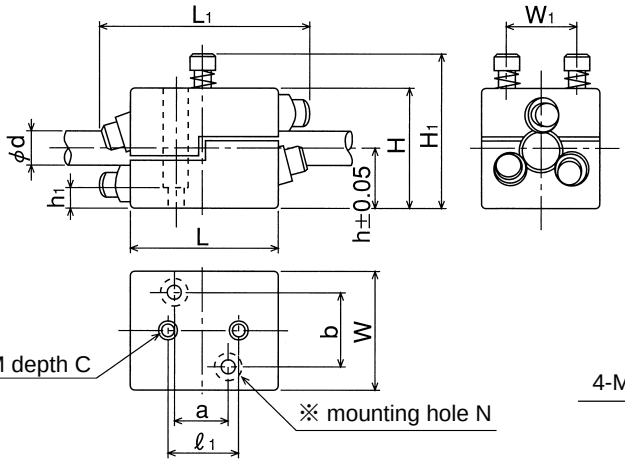


part number structure example

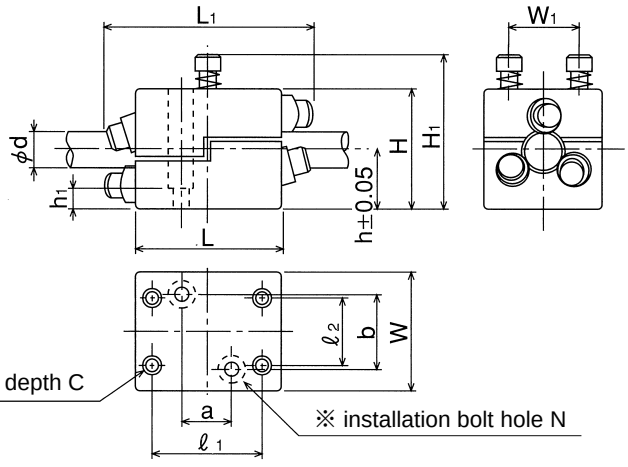
SS 16 - 16 - N

- SS: slide screw
- 16: shaft diameter
- 16: lead
- N: additional mounting holes

SS6～SS16 TYPE




SS20～SS30 TYPE




※ The mounting holes are machined on request.

| Part number | shaft diameter d mm | major dimensions H mm | W mm | L mm | h mm | $H_1$ mm | $L_1$ mm | $W_1$ mm | $\ell_1$ mm | $\ell_2$ mm | a mm | b mm | M mm | C mm | N mm | $h_1$ mm | standard lead mm | maximum thrust N | maximum tightening torque N·m | mass kg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SS 6** | 6 | 20.5 | 20 | 25 | 10 | 28 | 36 | 12 | 10 | – | – | – | M3 | 6.5 | – | – | 6, 9 | 24.5 | 0.03 | 0.03 |
| **SS 8** | 8 | 28.5 | 28 | 40 | 14 | 40 | 56 | 18 | 18 | – | – | – | M4 | 9 | – | – | 8,12 | 73.5 | 0.14 | 0.09 |
| **SS10** | 10 | 36.5 | 36 | 45 | 18 | 51 | 62 | 24 | 20 | – | 20 | 24 | M4 | 12 | M4 | 8 | 10,15 | 118 | 0.25 | 0.17 |
| **SS12** | 12 | 40.5 | 40 | 50 | 20 | 54 | 72 | 25 | 25 | – | 20 | 25 | M5 | 12.5 | M4 | 10 | 12,18 | 147 | 0.31 | 0.22 |
| **SS13** | 13 | 40.5 | 40 | 50 | 20 | 54 | 72 | 25 | 25 | – | 20 | 25 | M5 | 12.5 | M4 | 10 | 13,15 | 147 | 0.31 | 0.22 |
| **SS16** | 16 | 50.5 | 50 | 60 | 25 | 62 | 86 | 32 | 30 | – | 25 | 32 | M5 | 16 | M5 | 10 | 16,24 | 196 | 0.41 | 0.39 |
| **SS20** | 20 | 60.5 | 60 | 70 | 30 | 71 | 97 | 40 | 50 | 40 | 30 | 40 | M6 | 12 | M6 | 10 | 20,30 | 265 | 0.56 | 0.57 |
| **SS25** | 25 | 76.5 | 76 | 80 | 38 | 87 | 110 | 50 | 60 | 50 | 32 | 50 | M8 | 12 | M8 | 15 | 25 | 392 | 1.1 | 1.05 |
| **SS30** | 30 | 89 | 90 | 88 | 44 | 92 | 127 | 60 | 60 | 70 | 36 | 60 | M8 | 15 | M8 | 15 | 30,45 | 539 | 1.4 | 1.65 |

1N≒0.102kgf　1N·m≒0.102kgf·m





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