B-3-3.9 ND Series for Nut-Rotatable Drives

• This product is patented by NSK.

A nut rotatable ball screw is developed as a unit into which angular contact support ball bearings are integrated. It is best suited for an application that requires rotation of the ball nut while the screw shaft is fixed.

NDT model

1. Structure

Balls are installed between the assembly housing and the ball nut. The outer bearing rings are integrated into the assembly housing and thus, compact design are attained.
A timing pulley (prepared by the user) is directly secured to the end face of the nut.

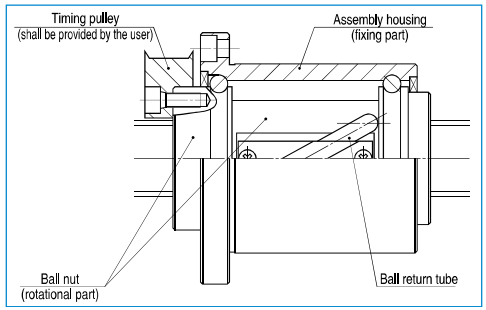


Fig. 1 Ball nut structure

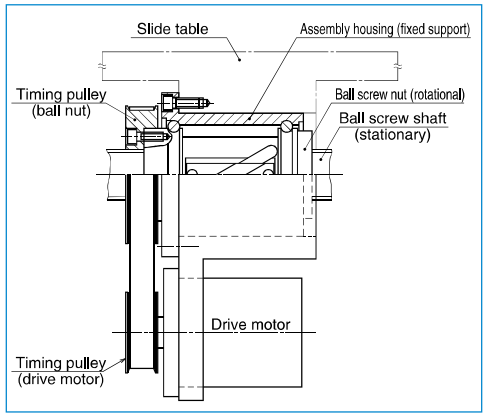


Fig. 2 Example of installation to the table

2. Features

● Multi-nut drive
Two or more nut units can be installed in a single ball screw shaft. They can be operated by respective motors.

● High operation speed
High feeding speed operation, but yet low rotational speed, is feasible by means of medium to high-helix lead ball screws.

● Easy installation
Merely install a mount housing to the table of the machine to take advantage of this multi-nut rotation system.

● Simple shaft end configuration
Shaft end configuration is simple because this unit does not need support bearings.

● Shaft diameter/lead combination
There are 10 types of "shaft diameter/lead" combinations.
Selections are: Shaft diameters -- 32, 40, 50 mm; Leads – 20, 25, 32, 40, 50 mm.

● Low inertia
Compared to the NSK current product (end cap ball recirculation system), rotational inertia was reduced by 16% at most.

3. Specifications

(1) Ball recirculation system
The structure of return tube recirculation system is shown below.

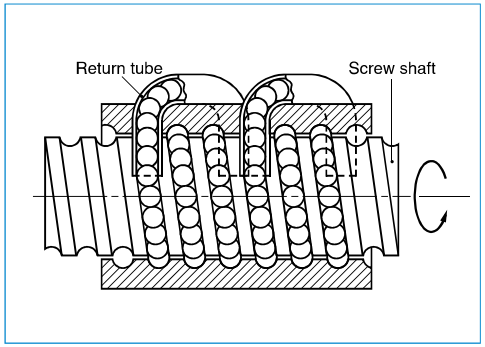


Fig. 3 Structure of ball return tube recirculation system

(2) Accuracy grade and axial play
The available standard accuracy grade and axial play are as follows. Please consult NSK for other grades.

Table 1 Axial play

Axial play code	Z	T	S
Axial play	0	0.005 mm or less	0.020 mm or less

Table 2 Combination of accuracy grades and axial play

Accuracy grade	C3	C5	Ct7
Axial play code	Z, T, S	Z, T, S	S

4. Allowable d·n value and the criterion of maximum rotational speed

Allowable d·n value and the criterion of maximum rotational speed are shown below. Please consult NSK if the rotational speed exceeds the permissible range below.
Note: The basic concept is the same as that of general ball screws. Refer to "Technical Description: Permissible Rotational Speed" (page B47).

Table 3 Allowable d·n value and the criterion of maximum rotational speed

Allowable d·n value	Standard specification	70 000 or less
	High-speed specification	100 000 or less
Criterion of maximum rotational speed	3 000 min^{-1}	

d·n value: shaft dia. d [mm] × rotational speed n [min^{-1}]

● Critical speed n_c
As shown **Fig. 4**, calculate unsupported length (mm) of L_1, L_2, and L_3 (assumed that the nut section is a fixed support.) **Table 4** shows the coefficients "f" of each shaft end mounting condition.

$$n_c = f \cdot \frac{d_r}{L_i^2} \times 10^7 \ (min^{-1}) \qquad (Ⅲ\text{-}1)$$

d_r: Screw shaft root diameter (See the dimension table.)
L_i: Unsupported length (mm) (See **Fig. 4**)
f : Factor determined by the ball screw shaft end mounting condition

Table 4

Shaft end mounting condition	f
Fixed – Fixed support	21.9
Fixed – Simple support	15.1
Fixed – Free support	3.4

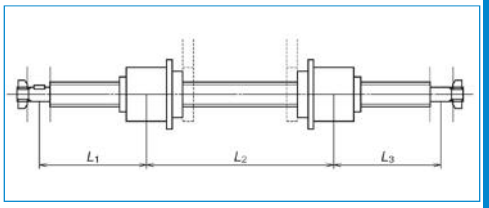


Fig. 4 Installation example

5. Design precautions

One end of the screw thread should be cut-through to the end. Also, if the nut must be removed from the screw shaft, the user should have an arbor to prevent the balls from falling out during this process. (NSK manufactures arbors on request.)
For general precautions regarding ball screws, refer to "Design Precautions" (page B83) and "Handling Precautions" (page B103).

NDD Type: (Incorporating vibration damper)

An increase in stroke length may restrict required rotational speed of a ball screw due to the issue of critical speed even if there is no problem on d·n limitation.

In such a case, we recommend using NDD Type nut rotatable ball screws equipped with vibration damper.

It will make it possible to operate a ball screw exceeding the critical speed, which is conventionally considered being impossible.

Notes: 1) However, NDD Type cannot be used exceeding the d·n limitation. Please consult with NSK in such a case.

2) You cannot rotate the screw shaft of NDD Series.

1. Structure

Hollow ball screw shaft has a mechanism to absorb vibration energy (vibration damper). This increases dynamic rigidity of the screw shaft and lowers vibration when exceeding the critical speed.

Construction of the ball nuts are the same as those of NDT Type.

2. Features

● No need for measures against critical speed.

Conventionally, an increase in screw shaft diameter or use of intermediate support is the measure against the issue of critical speed. NDD Type ball screw will make these measures needless.

● Dimensional interchageability with NDT Type ball screws

The vibration damper is set inside a ball screw shaft, and therefore, there is no difference with existing series in regards to external dimensions. The ball nuts of NDD Type are interchangeable with those of NDT Type.

● Others

Benefits in multiple ball nut on a screw shaft, high feeding speed for long stroke, easy in installation, and low inertia of the ball nuts are the same as NDT Type.

3. Specification

Recirculation system, accuracy grade, axial play and preload system are the same as NDT Type.

4. Design precautions

They are the same as NDT Type.

5. Permissible rotational speed

The d•n value is the same as NDT Type.

You don't need to consider the critical speed.

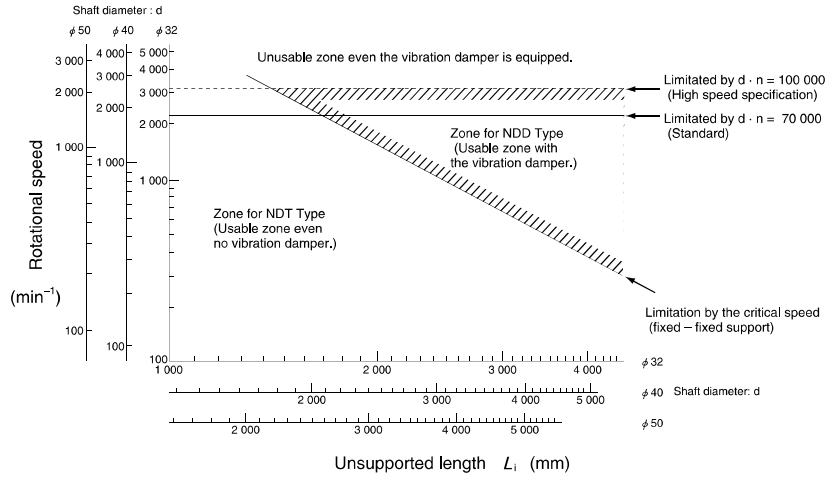


Fig. 5 Compartmentalization between NDT and NDD types to rotational speed and unsupported length

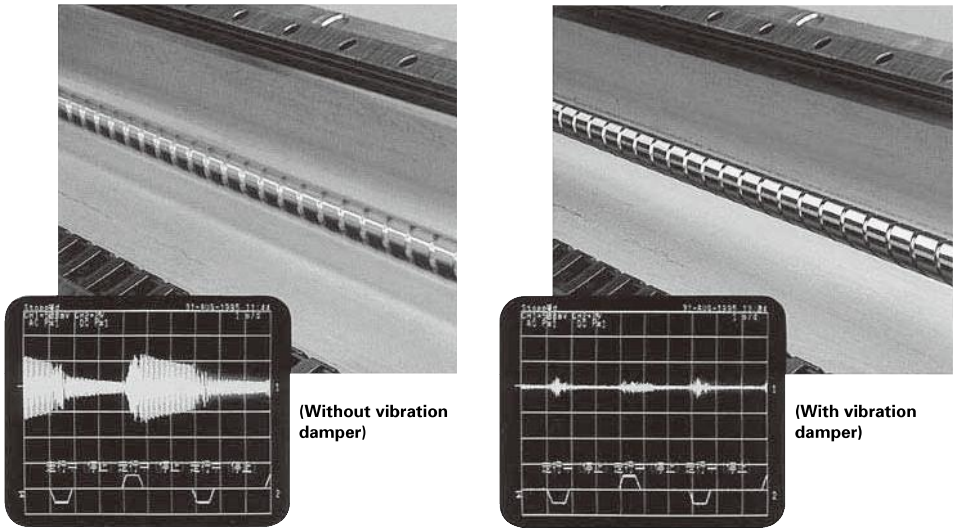


Fig. 6 Vibration of screw shaft when nut is rotating

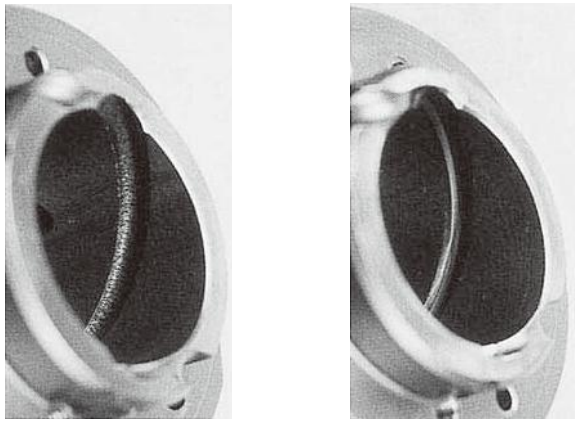


Fig. 7 Effect of vibration damper (results of endurance test)

Calculation example of permissible rotational speed

[Calculation example]
Assume a system which moves two nuts on a shaft as shown below.
Does this system operate appropriately if: both ends of the ball screw (shaft diameter 40 mm/ lead 40 mm) are fixed, and the travel speed is at 60 m/min?

[Answer]
The rotational speed n (min^{-1}) when the lead of the ball screw is 40 mm, and the travel speed is at 60 m/min is:

$$n = \frac{60 \times 10^3}{40} = 1\,500\ (min^{-1})$$

● Calculate d • n value
As the d • n value of standard specification is 7 000, therefore, the permissible rotational speed is;

$$n \leq \frac{70\,000}{40} = 1\,750\ (min^{-1})$$

● Calculate critical speed
The maximum unsupported length comes between Nut A and B.

$L_2 = 3\,300$ (mm)
$f = 21.9$ (Fixed-Fixed)
Root diameter: $d_r = 35.1$ (mm)

Therefore, the permissible rotational speed is;

$$n \leq \frac{21.9 \times 35.1}{3\,300^2} \times 10^7 = 706\ (min^{-1})$$

The calculation indicates that the d • n value is at the safe level. But the critical speed exceeds the limitation. However, with a vibration damper, the system can be operated at 1 500 min^{-1}.

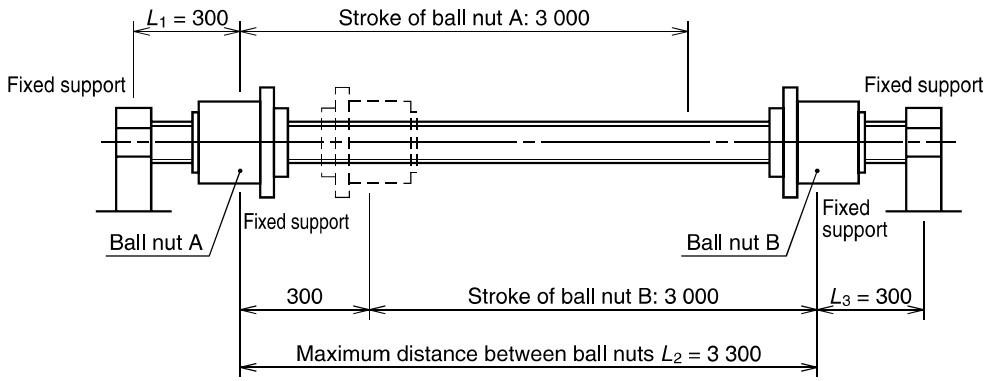


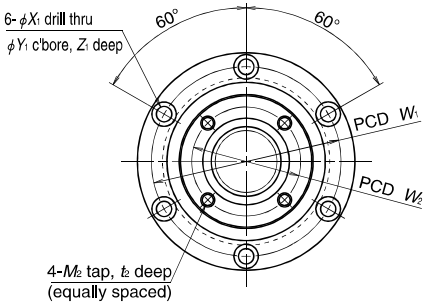
Fig. 8 Calculation example of permissible rotational speed

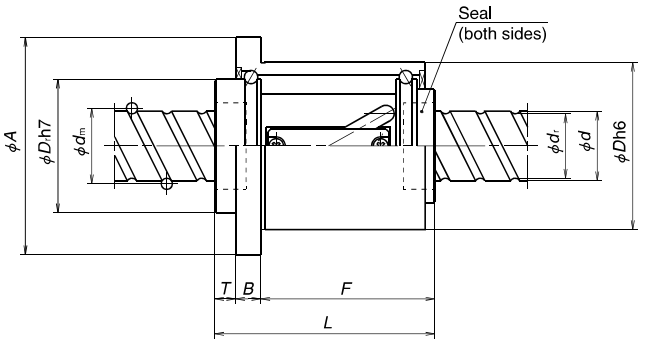
Structure of reference number
The followings describe the structure of "Reference number for ball screw".

◇Reference number for ball screw

W 40 15 - ** P XU - C5 Z 40

- Product code: W
- Screw shaft diameter (mm): 40
- Effective threaded length (in the unit of 100 mm): 15
- Design serial number: **
- Preload code: No code, Non-preload; P, P-preload (page B5): P
- Appearance/specification code ("T" is added for NDD Type.): XU
- Accuracy grade: C3, C5, C7 (Ct7) (page B37 to B42): C5
- Axial play code: Z, T, S (page B20): Z
- Lead (mm): 40





Unit: mm

Model No.	Shaft dia. d	Lead l	Ball dia. D_w	Ball circle dia. d_m	Root dia. d_r	Effective turns of balls Turns × Circuits	Basic load rating (N) Dynamic C_a	Basic load rating (N) Static C_{0a}	Moment of inertia, ball nut J (kg·cm²)	Ball nut mass W (kg)
NDT 3220-2.5 NDD 3220-2.5	32	20	4.762	33.25	28.3	2.5×1	17 900	41 800	6.2	2.9
NDT 3225-2.5 NDD 3225-2.5		25	4.762	33.25	28.3	2.5×1	17 900	41 800	6.7	3.2
NDT 3232-1.5 NDD 3232-1.5 NDT 3232-3 NDD 3232-3		32	4.762	33.25	28.3	1.5×1 1.5×2	11 500 18 900	24 800 44 600	6.2	2.9
NDT 4025-2.5 NDD 4025-2.5	40	25	6.35	41.75	35.1	2.5×1	28 500	70 000	19.3	6.0
NDT 4032-1.5 NDD 4032-1.5 NDT 4032-3 NDD 4032-3		32	6.35	41.75	35.1	1.5×1 1.5×2	18 400 30 100	41 200 74 100	18.0	5.5
NDT 4040-1.5 NDD 4040-1.5 NDT 4040-3 NDD 4040-3		40	6.35	41.75	35.1	1.5×1 1.5×2	18 400 30 100	41 200 74 100	19.2	6.0
NDT 5025-2.5 NDD 5025-2.5	50	25	7.938	52.25	44.0	2.5×1	42 700	109 000	45.7	8.5
NDT 5032-2.5 NDD 5032-2.5		32	7.938	52.25	40.0	2.5×1	42 700	109 000	48.9	9.4
NDT 5040-1.5 NDD 5040-1.5 NDT 5040-3 NDD 5040-3		40	7.938	52.25	44.0	1.5×1 1.5×2	27 500 44 900	66 500 120 000	45.5	8.5
NDT 5050-1.5 NDD 5050-1.5 NDT 5050-3 NDD 5050-3		50	7.938	52.25	44.0	1.5×1 1.5×2	27 500 44 900	66 500 120 000	48.7	9.4

Ball nut dimensions													Tap hole PCD
Nut entire length L	Nut outside diameter D	Flange outside diameter A	Flange width B	Nut length F	Projection tube dimensions D_r	Projection tube dimensions T	Bolt hole dimensions X_1	Bolt hole dimensions Y_1	Bolt hole dimensions Z_1	Bolt hole PCD W_1	Tap hole dimensions M_2	Tap hole dimensions t_2	W_2
107	78	105	12	83	60	12	6.6	11	6.5	91	M6	12	50
120	78	105	12	96	60	12	6.6	11	6.5	91	M6	12	50
107	78	105	12	83	60	12	6.6	11	6.5	91	M6	12	50
136	100	133	15	106	76	15	9	14	8.5	116	M8	16	62
122	100	133	15	92	76	15	9	14	8.5	116	M8	16	62
136	100	133	15	106	76	15	9	14	8.5	116	M8	16	62
140	120	156	18	107	96	15	11	17.5	11	136	M10	18	78
158	120	156	18	125	96	15	11	17.5	11	136	M10	18	78
140	120	156	18	107	96	15	11	17.5	11	136	M10	18	78
158	120	156	18	125	96	15	11	17.5	11	136	M10	18	78

Notes: 1. The right hand screw is the standard. Consult NSK for the left hand screws.
2. Seals are standard equipment.