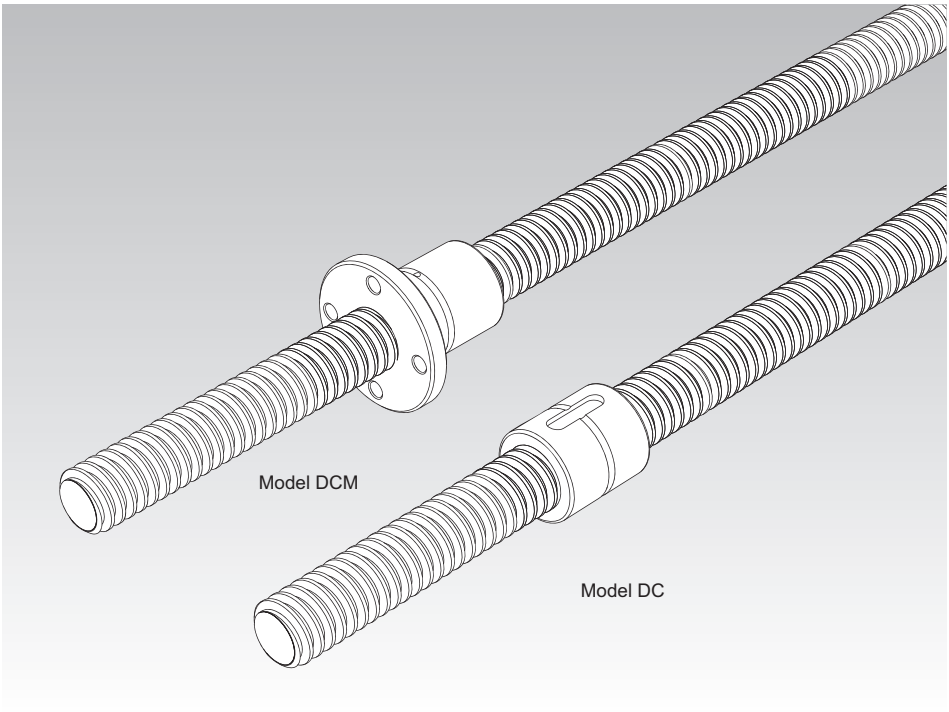
Features of the Lead Screw Nut



Structure and Features

The lead Screw Nut models DCM and DC are manufactured to meet the standards for the 30° trapezoidal threads. They use a special alloy (see **A16-3**) for the nuts and have a precision male thread, formed through die casting, as the core. As a result, these bearings achieve less unevenness in accuracy and higher accuracy and wear resistance than the machined lead screw nuts.
For the screw shafts to be used with this product, the rolled shafts are available as the standard.
In addition, cut screw shafts are also available according to the application. Contact THK for details.

Features of the Special Rolled Shafts

The dedicated rolled shafts with the standardized lengths are available for the Lead Screw Nut.

[Increased Wear Resistance]
The shaft teeth are formed by cold gear rolling, and the tooth surface is hardened to over 250 HV and is mirror-finished. As a result, the shafts are highly wear-resistant and achieve significantly smooth motion when used in combination with screw nuts.

[Improved Mechanical Properties]
Inside the teeth of the rolled shaft, a fiber flow occurs along the contour of the tooth surface of the shaft, making the structure around the teeth roots dense. As a result, the fatigue strength is increased.

[Additional Machining of the Shaft End Support]
Since each shaft is rolled, additional machining of the support bearing of the shaft end can easily be performed by lathing or milling.

High Strength Zinc Alloy

The high strength zinc alloy used in the lead screw nuts is a material that is highly resistant to seizure and the wear and has a high load carrying capacity. Information on mechanical properties, physical properties, and wear resistance is presented below.

[Mechanical Properties]

Table1

Item	Description
Tensile strength	275 N/mm^2 to 314 N/mm^2
Tensile yield strength (0.2%)	216 N/mm^2 to 245 N/mm^2
Compressive strength	539 N/mm^2 to 686 N/mm^2
Compressive yield strength (0.2%)	294 N/mm^2 to 343 N/mm^2
Fatigue strength	132 $N/mm^2 \times 10^7$ (Schenk bending test)
Charpy impact	0.098 $N{\cdot}m/mm^2$ to 0.49 $N{\cdot}m/mm^2$
Elongation	1 % to 5 %
Hardness	120 HV to 145 HV

Note: The figures shown in the table are target values—these figures are not guaranteed.

[Physical Properties]

Table2

Item	Description
Specific gravity	6.8
Specific heat	460 J/ (kg·K)
Melting point	390 ℃
Thermal expansion coefficient	24×10^{-6}

[Wear Resistance]

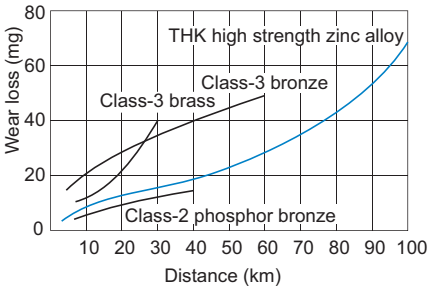


Fig.1 Wear Resistance of the High Strength Zinc Alloy

Table3 [Test conditions: Amsler wear-tester]

Item	Description
Test piece rotational speed	185 min^{-1}
Load	392 N
Lubricant	Dynamo oil

Selecting a Lead Screw Nut

[Permissible Dynamic Thrust]

The permissible dynamic thrust (F) is the level of thrust at which the contact surface pressure exerted by the bearing on the screw tooth surface is 9.8 N/mm^2. This value indicates the strength of the Screw Nut.

● f_S : Safety Factor

To calculate a load applied to the lead screw nut, it is necessary to accurately obtain the effect of the inertia that changes with the weight and dynamic speed of an object. In general, with the reciprocating or the rotating machines, it is not easy to accurately obtain all the factors such as the effect of the start and stop, which are always repeated. Therefore, if the actual load cannot be obtained, it is necessary to select a bearing while taking into account the empirically obtained safety factors (f_S) shown in Table1.

Table1 Safety Factor (f_S)

Type of load	Lower limit of f_S
For a static load less frequently used	1 to 2
For an ordinary single-directional load	2 to 3
For a load accompanied by vibrations/impact	4 or greater

● f_T : Temperature Factor

If the temperature of the screw nut exceeds the normal temperature range, the seizure resistance of the nut and the strength of the material will decrease. Therefore, it is necessary to multiply the dynamic permissible thrust (F) by the corresponding temperature factor indicated in Fig.1.

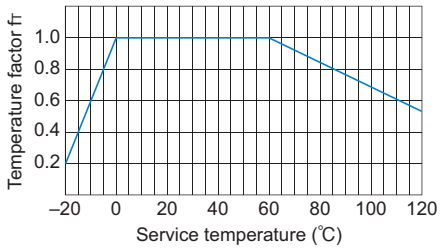


Fig.1 Temperature Factor

Accordingly, when selecting a lead screw nut, the following equations need to be met in terms of its strength.

$$f_S \leqq \frac{f_T \cdot F}{P_F}$$

f_S : Safety factor (see Table1)
f_T : Temperature factor (see Fig.1)
F : Dynamic permissible thrust (N)
P_F : Axial load (N)

● Hardness of the Surface and the Wear Resistance

The hardness of the shaft significantly affects the wear resistance of the lead screw nut. If the hardness is equal to or less than 250 HV, the abrasion loss increases as indicated in Fig.2. The roughness of the surface should preferably be Ra0.80 or less.

A special rolled shaft achieves the surface hardness of 250 HV or greater, through hardening as a result of rolling, and surface roughness of Ra0.20 or less. Thererfore, the dedicated rolled shaft is highly wear resistant.

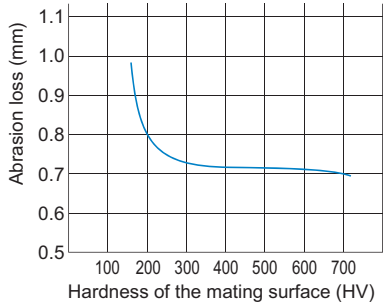


Fig.2 Hardness of the Surface and the Wear Resistance

[pV Value]

With a sliding bearing, a pV value, which is the product of the contact surface pressure (p) and the sliding speed (V), is used as a measuring stick to judge whether the assumed model can be used. Use the corresponding pV value indicated in Fig.3 as a guide for selecting a lead screw nut. The pV value varies also according to the lubrication conditions.

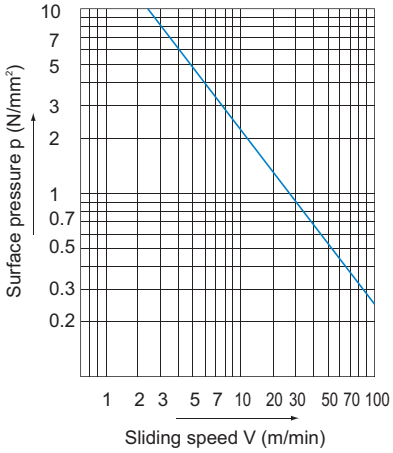


Fig.3 pV Value

[Calculating the Contact Surface Pressure p]

The value of “p” is obtained as followed.

$$p = \frac{P_F}{F} \times 9.8$$

p : Contact surface pressure on the tooth from an axial load (P_F) (N/mm²)
F : Dynamic permissible thrust (N)
P_F : Axial load (N)

[Calculating the Sliding Speed V on the Teeth]
The value of "V" is obtained as followed.

$$V = \frac{\pi \cdot Do \cdot n}{\cos\alpha \times 10^3}$$

V : Sliding speed (m/min)
Do : Effective diameter (see specification table) (mm)
n : Revolutions per minute (min^{-1})

$$n = \frac{S}{R \times 10^{-3}}$$

S : Feeding speed (m/min)
R : Lead (mm)
α : Lead angle (see specification table) (°)

Efficiency and Thrust

The efficiency (η) at which the screw transfers a torque into thrust is obtained from the following equation.

$$\eta = \frac{1 - \mu\tan\alpha}{1 + \mu/\tan\alpha}$$

η : Efficiency
α : Lead angle
μ : Frictional resistance

Fig.4 shows the result of the above equation.
The thrust generated when a torque is applied is obtained from the following equation.

$$Fa = \frac{2 \cdot \pi \cdot \eta \cdot T}{R \times 10^{-3}}$$

Fa	: Thrust generated	(N)
T	: Torque (input)	(N·m)
R	: Lead	(mm)

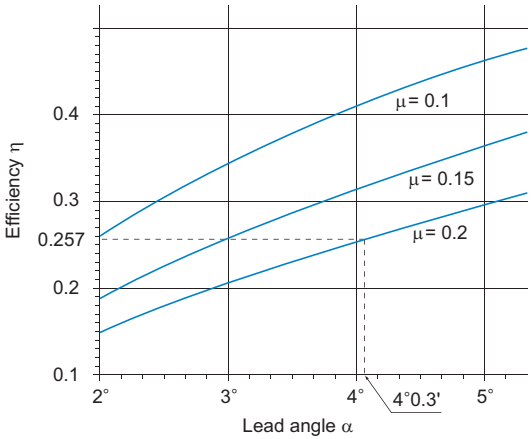


Fig.4 Efficiency

Accuracy Standards

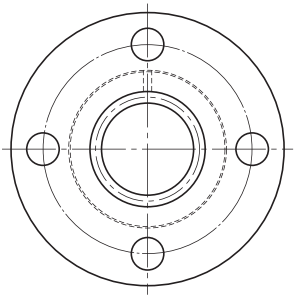
Table2 Accuracy of the Screw Shaft of Models DCM and DC

Unit: mm

Shaft symbol	Rolled shaft	Cut shaft
Accuracy	T[1]	K[1]
Single pitch error (max)	±0.020	±0.015
Accumulated pitch error (max)	±0.15/300	±0.05/300

[1] Symbols T and K indicate machining methods for the screw shaft.
Note: Cut shafts are made to order. For the maximum shaft lengths of cut shafts, contact THK.

Model DCM



Lead Screw Nut Model No.	Outer dimensions			Lead screw nut dimensions						
	Outer diameter									
	D	Tolerance h9	Length L	Flange diameter D_1	H	B	PCD	r	F	d
DCM 12	22	0 –0.052	30	44	6	5.4	31	1.5	7	1.5
DCM 14	22		30	44	6	5.4	31	1.5	7	1.5
DCM 16	28		35	51	7	6.6	38	1.5	8	1.5
DCM 18	32	0 –0.062	40	56	7	6.6	42	1.5	10.5	2
DCM 20	32		40	56	7	6.6	42	1.5	10.5	2
DCM 22	36		50	61	8	6.6	47	2	14	2.5
DCM 25	36		50	61	8	6.6	47	2	14	2.5
DCM 28	44		56	76	10	9	58	2	15	2.5
DCM 32	44		56	76	10	9	58	2	15	2.5
DCM 36	52	0 –0.074	60	84	10	9	66	2.5	17	3
DCM 40	58		70	98	12	11	76	2.5	19	3
DCM 45	64		75	104	12	11	80	2.5	21.5	4
DCM 50	68		80	109	12	11	85	2.5	24	4

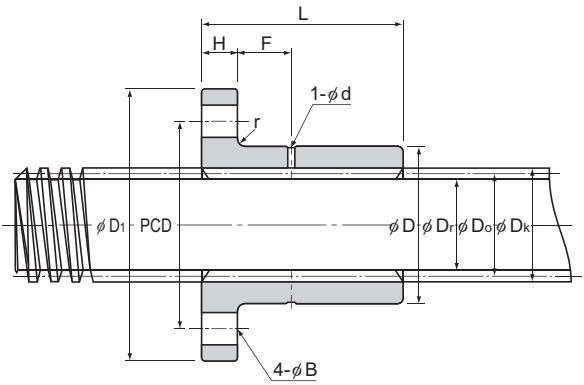
[1] In the dimensional table, standard shaft length and maximum shaft length are values for rolled shafts (T).
[2] The dynamic permissible thrust (F) indicates the torque at which the contact surface pressure on the screw tooth surface is 9.8 N/mm^2. The maximum axial load (both when stopped and during operation) is set to the dynamic permissible thrust or below, and it must be selected while taking into consideration the safety factors of Table1 on **A16-5**.
[3] The static permissible load (P) of the flange indicates the strength of the flange against the load as shown in the figure on the right.
Note: Cut shafts (K) are made to order. For maximum shaft lengths of cut shafts (K), contact THK.

Model number coding

Combination of lead screw nut and screw shaft

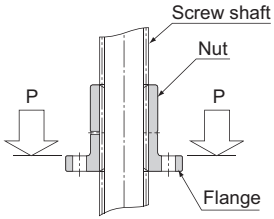
2 DCM20 +1500L T

- **2**: Number of lead screw nuts used on the same shaft
- **DCM20**: Model number of lead screw nut
- **+1500L**: Overall screw shaft length (in mm)
- **T**: How the screw shaft is processed (T: rolled shaft)



Unit: mm

Model No.	Screw shaft details					Standard shaft length[1]	Maximum shaft length[1]	Dynamic permissible thrust	Static permissible load of the flange	Mass	
	Outer diameter D_k	Effective diameter D_0	Thread minor diameter D_r	Lead R	Lead angle α			F^2 N	P^3 N	Screw nut g	Screw shaft kg/m
CS 12	12	11	9.5	2	3°19′	1000	1500	3920	20200	100	0.8
CS 14	14	12.5	10.5	3	4°22′	1000	1500	4900	16900	85	1
CS 16	16	14.5	12.5	3	3°46′	1000	1500	6670	31500	160	1.3
CS 18	18	16	13.5	4	4°33′	1000	2000	8730	42000	230	1.6
CS 20	20	18	15.5	4	4°03′	1500	2000	9800	37200	210	2
CS 22	22	19.5	16.5	5	4°40′	1500	2500	12400	48600	320	2.3
CS 25	25	22.5	19.5	5	4°03′	1500	3000	14200	39800	290	3.1
CS 28	28	25.5	22.5	5	3°34′	2000	3000	17900	69200	550	4
CS 32	32	29	25.5	6	3°46′	2000	4000	21100	54200	490	5.2
CS 36	36	33	29.5	6	3°19′	2000	4000	25800	84500	670	6.7
CS 40	40	37	33.5	6	2°57′	2000	4000	33800	106000	980	8.4
CS 45	45	41	36.5	8	3°33′	3000	5000	42100	125000	1310	10.4
CS 50	50	46	41.5	8	3°10′	3000	5000	50100	128000	1430	13



Model number coding

- Lead screw nut only

DCM20

Model number of lead screw nut

- Screw shaft

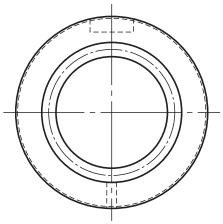
CS20 T +1500L

Model number of screw shaft

How the screw shaft is processed (T: rolled shaft)

Overall screw shaft length (in mm)

Model DC



Lead Screw Nut Model No.	Outer dimensions			Lead screw nut dimensions					
	Outer diameter		L	Keyway dimensions					
	D	Tolerance h9	0 −0.3	b	Tolerance N9	t	ℓ	d	r
DC 12	22	0 −0.052	22	4	0 −0.030	2	16	1.5	1
DC 14	22		22	4		2	16	1.5	1
DC 16	28		26	5		2.5	18	1.5	1
DC 18	32	0 −0.062	31	7	0 −0.036	2.5	22	2	1
DC 20	32		31	7		2.5	22	2	1
DC 22	36		40	7		2.5	26	2.5	1
DC 25	36		40	7		2.5	26	2.5	1
DC 28	44		45	10		4	32	2.5	1.5
DC 32	44		45	10		4	32	2.5	1.5
DC 36	52	0 −0.074	49	12	0 −0.043	4.5	40	3	1.5
DC 40	58		57	15		5	42	3	1.5
DC 45	64		62	15		5	48	4	1.5
DC 50	68		67	15		5	52	4	1.5

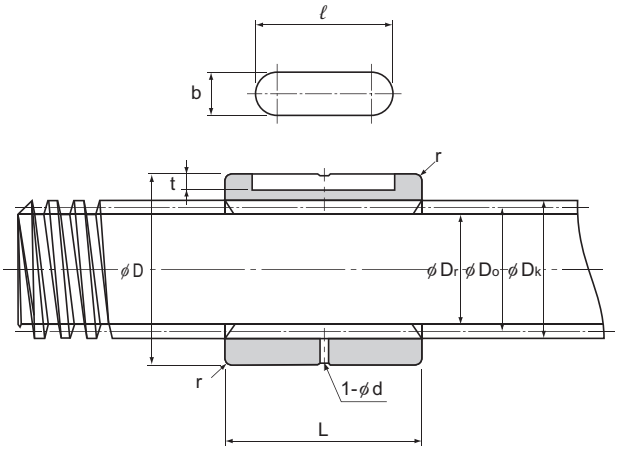
[1] In the dimensional table, standard shaft length and maximum shaft length are values for rolled shafts (T).
[2] The dynamic permissible thrust (F) indicates the torque at which the contact surface pressure on the screw tooth surface is 9.8 N/mm^2. The maximum axial load (both when stopped and during operation) is set to the dynamic permissible thrust or below, and it must be selected while taking into consideration the safety factors of Table1 on A16-5.
Note: Cut shafts (K) are made to order. For maximum shaft lengths of cut shafts (K), contact THK.

Model number coding

Combination of lead screw nut and screw shaft

2 DC20 +1500L T

- 2: Number of lead screw nuts used on the same shaft
- DC20: Model number of lead screw nut
- +1500L: Overall screw shaft length (in mm)
- T: How the screw shaft is processed (T: rolled shaft)



Unit: mm

Model No.	Screw shaft details					Standard shaft length[1]	Maximum shaft length[1]	Dynamic permissible thrust	Mass	
	Outer diameter D_k	Effective diameter D_0	Thread minor diameter D_r	Lead R	Lead angle α			F^2 N	Screw nut g	Screw shaft kg/m
CS 12	12	11	9.5	2	3°19′	1000	1500	2840	40	0.8
CS 14	14	12.5	10.5	3	4°22′	1000	1500	3630	45	1
CS 16	16	14.5	12.5	3	3°46′	1000	1500	4900	75	1.3
CS 18	18	16	13.5	4	4°33′	1000	2000	6860	120	1.6
CS 20	20	18	15.5	4	4°03′	1500	2000	7650	110	2
CS 22	22	19.5	16.5	5	4°40′	1500	2500	9900	180	2.3
CS 25	25	22.5	19.5	5	4°03′	1500	3000	11400	155	3.1
CS 28	28	25.5	22.5	5	3°34′	2000	3000	14400	280	4
CS 32	32	29	25.5	6	3°46′	2000	4000	17100	230	5.2
CS 36	36	33	29.5	6	3°19′	2000	4000	21200	380	6.7
CS 40	40	37	33.5	6	2°57′	2000	4000	27500	520	8.4
CS 45	45	41	36.5	8	3°33′	3000	5000	34900	730	10.4
CS 50	50	46	41.5	8	3°10′	3000	5000	42100	810	13

Model number coding

- Lead screw nut only

DC20

Model number of lead screw nut

- Screw shaft

CS20 T +1500L

Model number of screw shaft

How the screw shaft is processed (T: rolled shaft)

Overall screw shaft length (in mm)

Fit

For the fitting between the screw nut outer diameter and the housing, we recommend a loose fit.
Housing inner-diameter tolerance: G7

Installation

[About Chamfer of the Housing's Mouth]

To increase the strength of the root of the flange of the lead screw nut, the corner is machined to have an R shape. Therefore, it is necessary to chamfer the inner edge of the housing's mouth.

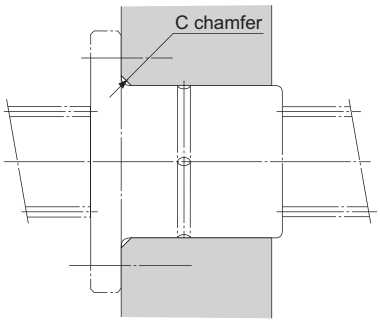


Fig.1

Table1 Chamfer of the Housing's Mouth

Unit: mm

Model No. DCM	Chamfer of the mouth C (Min.)
12	2
14	
16	
18	
20	
22	2.5
25	
28	
32	
36	3
40	
45	
50	

[Example of Installation]
Fig.2 shows examples of mounting the lead screw nuts. When mounting a lead screw nut, secure sufficient tightening strength in the axial direction. For the housing inner-diameter tolerance, see the section concerning fitting on A16-14.

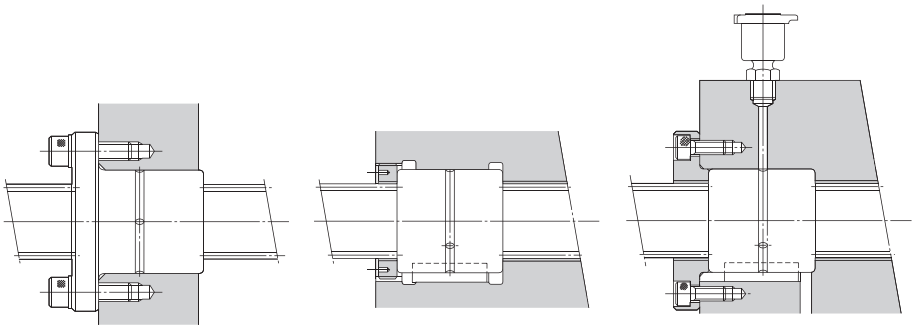


Fig.2 Examples of Installing the Lead Screw Nut

Lubrication

The Screw Nut is not lubricated when delivered. Once the bearing has been mounted, the Screw Nut must be treated with an appropriate volume of grease or lubricant. The lubrication method should be determined based on usage conditions.

[Lubricating with oil]
THK recommends lubricating the Lead Screw Nut with oil. Oil-bath lubrication or drip-feed lubrication are both effective. The most effective method is oil-bath lubrication, which is suitable for high-speed operation, heavy loads, high external temperatures, and other demanding conditions, and helps cools the Lead Screw Nut. Drip-feed lubrication is suitable for low and medium speeds and light and medium loads. Criteria for selecting the appropriate lubricant are shown in Table2.

Table2 Selection of a Lubricant

Condition	Types of Lubricants
Low speed, high load, high temperature	High-viscosity sliding surface oil or turbine oil
High speed, light load, low temperature	Low-viscosity sliding surface oil or turbine oil

[Lubricating with Grease]
For usage in lower-speed operations, which is a less common scenario, the user can lubricate the slide system by periodically applying grease to the shaft by hand, or use the oil hole on the Lead Screw Nut. THK recommends using lithium grease no. 2.

Model Number Coding

Model number configurations differ depending on the model features. Refer to the corresponding sample model number configuration.

[Lead Screw Nut]

● **Models DCM, DC and CS**

• Lead screw nut only

DC20

Model No. of lead screw nut

• Screw shaft

CS20 T +1500L

Model number of screw shaft

How the screw shaft is processed (T: rolled shaft)

Overall screw shaft length (in mm)

• Combination of lead screw nutand screw shaft

2 DC20 +1500L T

Number of lead screw nuts used on the same shaft

Model No. of lead screw nut

Overall screw shaft length (in mm)

How the screw shaft is processed (T: rolled shaft)

Note: Screw shafts will be shipped fully threaded. Shaft lengths will be longer than specified in the model number at time of delivery with the expectation that the customer will machine the shaft ends.