

# LEAD SCREWS

2004 Release

[www.ballscrews.com](http://www.ballscrews.com)



**THOMSON NEFF**

## High Performance Lead Screw Assemblies

- ActiveCAM Technology
- Bearing Grade Polymer Nuts
- Precision Accuracy

# Mechanical and Electro-Mechanical Product Solutions by Danaher Motion

## New Name, Established Brands

Danaher Motion's wide range of motion control systems and components offer customers an unprecedented choice in selecting the right solution for their particular application requirements. Our product innovations have been improving the efficiency and productivity of complex manufacturing operations for over 60 years through trusted brand names such as Dover, Kollmorgen, Pacific Scientific, Portescap and Thomson in industries as diverse as semiconductor, aerospace and defence, mobile-off-highway, packaging, medical and robotics.

In addition, Danaher Motion, through Motion Engineering (MEI), offers powerful integrated motion control solutions with its industry-leading, multi-axis motion platforms and SynqNet® communications network for ultra-reliable machine performance. From software and controller, through the communications network to drives and I/O devices, to mechanical and electro-mechanical products, Danaher Motion differentiates itself in the marketplace by designing standard and custom solutions to satisfy the most demanding application requirements.

Our growing family of leading motion control products tells only half the story. With a worldwide service and support infrastructure, our field service engineers and support teams are available when you need them. It is part of the Danaher Corporation's unrelenting focus on you, our customer. That's why more and more design engineers are turning to Danaher Motion to meet their motion control requirements.



**KOLLMORGEN**™

## Danaher Motion Values

- Application Expertise
- Broad & Innovative Motion Control Products and Systems
- Customer Focus
- Customisable Products and Services
- Motion Control Pioneers with Global Staying Power
- Operational Excellence



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 **THOMSON**™



## Offering smooth, precise, cost effective positioning, lead screws are the ideal solution for your application.

Thomson Neff precision lead screws from Danaher Motion are an excellent economical solution for your linear motion requirements. For more than 25 years, Danaher Motion has designed and manufactured the highest quality lead screw assemblies in the industry. Our precision rolling process ensures accurate positioning to ,075mm/300mm and our PTFE coating process produces assemblies that have less drag torque and last longer.

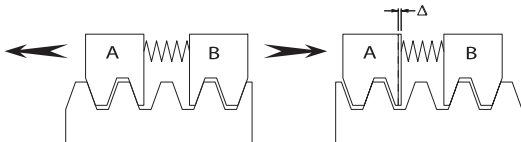
Danaher Motion provides a large array of standard plastic nut assemblies in anti-backlash or standard Supernut® designs. All of our standard plastic nut assemblies use an internally lubricated Acetal providing excellent lubricity and wear resistance with or without additional lubrication. With the introduction of our new unique patented zero backlash designs, Danaher Motion provides assemblies with high axial stiffness, zero backlash and the absolute minimum drag torque to reduce motor requirements. These designs produce products that cost less, perform better and last longer. Both designs automatically adjust for wear ensuring zero backlash for the life of the nut.

Danaher Motion also provides engineering design services to aid in your design requirements producing a lead screw assembly to your specifications. Call Danaher Motion today to discuss your application with one of our experienced application engineers.

### Danaher Motion Products Deliver Performance

To ensure precise positioning, the elimination of backlash is of primary concern. Several types of anti-backlash mechanisms are common in the market which utilise compliant preloads.

Because they are low in stiffness, a high preload is required to maintain position.



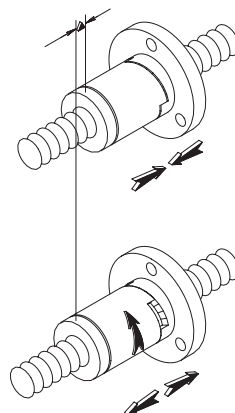
This results in high drag torque, shorter life and poor performance. System costs increase as a larger motor is required.

### The Solution is THOMSON NEFF

With the introduction of the Patented XC series nut with **ActiveCAM**, the highest axial stiffness with the absolute minimum drag torque is achieved. Utilising an extremely rigid stainless steel cam for biasing, axial stiffness is unsurpassed. Axial play is removed without the need for high preload, resulting in the lowest drag torque possible.

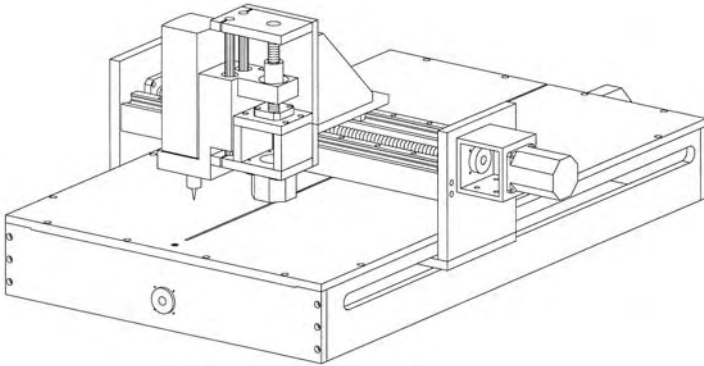
### Self-Compensating

As wear occurs over time, the unique **ActiveCAM** mechanism automatically compensates without compromising stiffness, positional accuracy or affecting drag torque at any time.



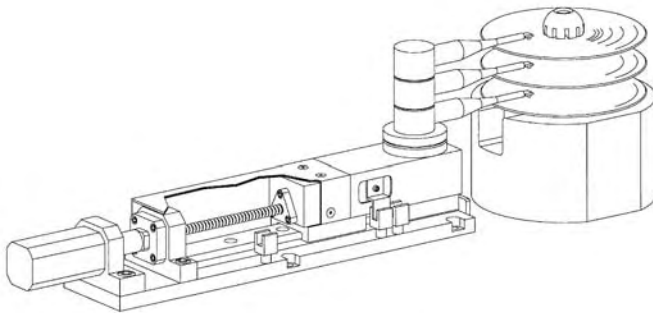
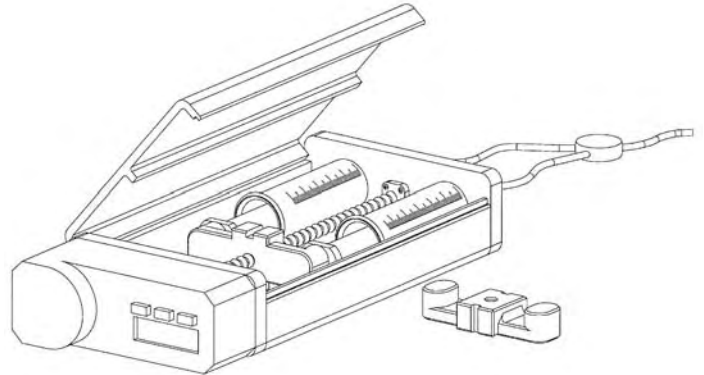
US Patent #5839321 and one or more foreign counterparts

## Lead Screw Applications



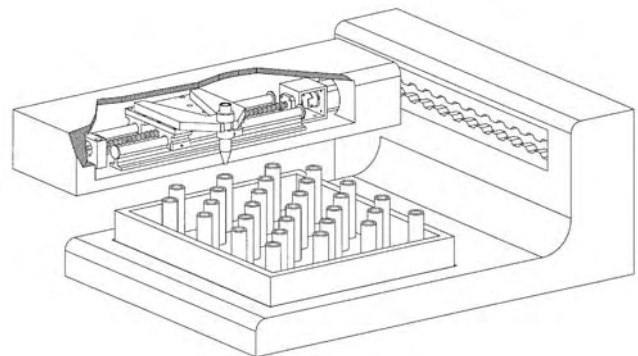
**ENGRAVING EQUIPMENT**

**MEDICAL EQUIPMENT**



**SEMICONDUCTOR  
MANUFACTURING EQUIPMENT**

**LABORATORY EQUIPMENT**



## Precision Lead Screws & Supernuts®

### Features/Advantages

#### Low Cost

Considerable savings when compared to ball screw assemblies.

#### Variety

Large range of leads and diameters to match your requirements.

#### Lubrication

Internally lubricated plastic nuts will operate without additional lubrication. However, TriGEL grease or dry film lubricant is recommended and will extend product life. See pages 13 and 14.

#### Vibration and Noise

No ball recirculation vibration and often less audible noise compared to ball screws.

### Design Considerations

#### Load

Supernuts provide a cost effective solution for moderate to light loads. For vertical applications, anti-backlash supernuts should be mounted with thread/flange on the bottom.

#### Cantilevered Loads

Cantilevered loads that might cause a moment on the nut will cause premature failure.

#### Critical Speed

Refer to critical speed chart on page 6.

#### Column Loading

Refer to column loading chart on page 7.

#### Self-Locking

Lead screws can be self locking at low leads. Generally, the lead of the screw should be more than 1/3 of the diameter to satisfactorily backdrive.

#### Custom Capability

Option of custom components to fit into your design envelope.

#### Non-Corrosive\*

Stainless Steel and internally lubricated acetal.

#### Environment

Less susceptible to particulate contamination compared to ball screws.

#### Lightweight

Less mass to move.

#### Temperature

Ambient and friction generated heat are the primary causes of premature plastic nut failure. Observe the temperature limits below and discuss your design with our application engineers for continuous duty, high load and high speed applications. Danaher Motion recommends bronze nuts for very high temperature environments or can aid in your selection of high temperature plastic for a custom assembly.

#### Efficiency

Except at very high leads, efficiency increases as lead increases. Although the internally lubricated acetal provides excellent lubricity, Ball Screw Assemblies remain significantly more efficient than most Lead Screw designs. See page 12 for actual efficiencies.

#### Length Limitations

Screw Diameter	Max Length
10 mm	1200 mm
12 - 16 mm	1800 mm
>16 mm	3600 mm

#### Lead Accuracy

Standard Grade (SRA)	250 µm/300 mm
Precision Grade (SPR)	75 µm/300 mm

Assembly		Screws	Nuts**			
Maximum Temperature	Friction Coefficient	Material	Material	Tensile Strength	Water Absorption (24 HRS %)	Thermal Expansion Coefficient
82°C	0,08 - 0,14	Stainless Steel*	Acetal with PTFE	55 MPa	0,15	9,7 x 10 <sup>-5</sup> m/m/°C

\* 1.4301 (AISI 304) & 1.4305 (AISI 303) \*\* Other materials available on a custom basis.

## Useful Formulas for Lead Screw Assemblies

### TORQUE, ROTARY TO LINEAR

Driving the screw to translate the nut, or driving the nut to translate the screw.

$$\text{Torque} = \frac{\text{Load (N)} \times \text{Lead (mm)}}{2\pi \times \text{efficiency}} \quad (\text{N-mm})$$

### TORQUE, LINEAR TO ROTARY

Loading the nut to rotate the screw

$$\text{Torque} = \frac{\text{Load} \times \text{Lead} \times \text{Efficiency}}{2\pi}$$

### EFFICIENCY

$$\% \text{ Efficiency} = \frac{\tan(\text{helix angle})}{\tan(\text{helix angle} + \arctan f)} \times 100$$

f = coefficient of friction

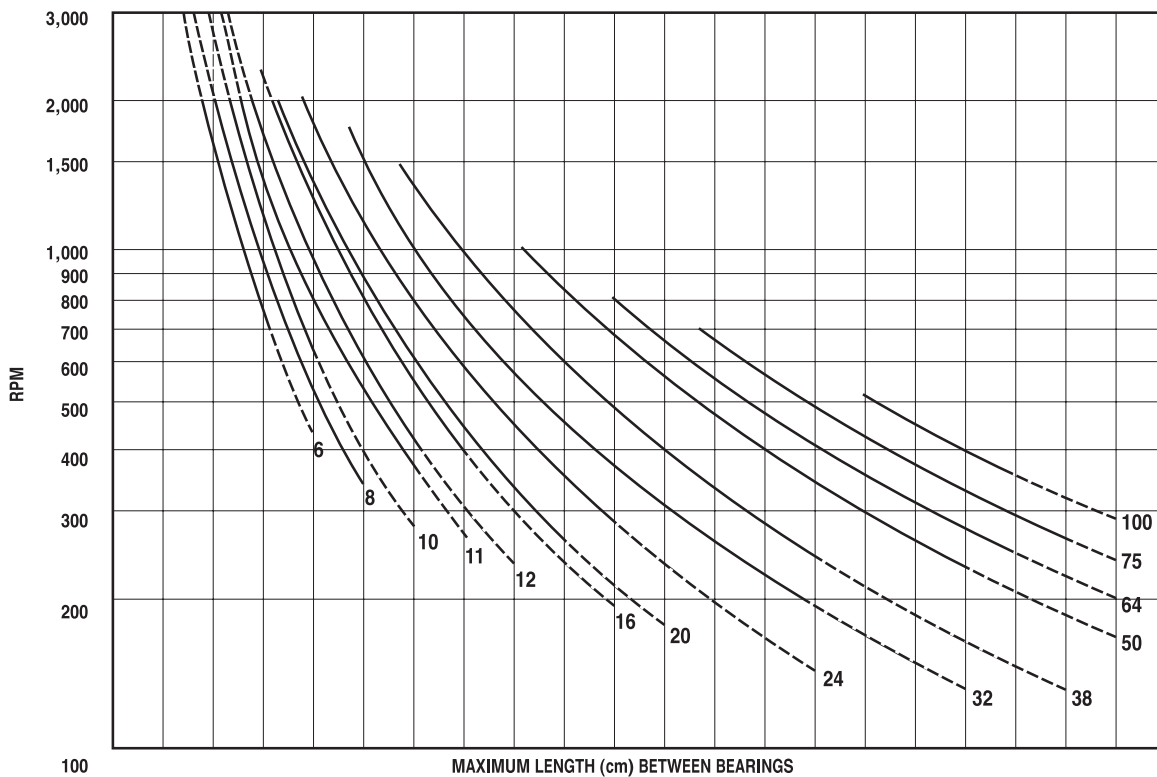
As a rule, assemblies that have an efficiency of 50% or more will backdrive. See page 12 for efficiencies. Efficiencies listed in catalogue computed at 0,1 friction coefficient.

## Critical Speed Limits Chart

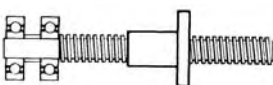
Every screw shaft has a rotational speed limit. That is the point at which the rotational speed sets up excessive vibration. This critical point is modified by the type of end bearing support used.

To use this chart, determine the required RPM and the maximum length between bearing supports. Next, select one of the four types of end support shown below. The critical speed limit can be found by locating the point at which the RPM (horizontal lines) intersects with the unsupported screw length (vertical lines) as modified by the type of supports select below. We recommend operating at no more than 80% of the critical speed limit.

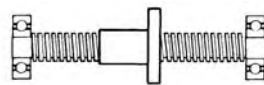
**Warning:** Curves for the screw diameters shown are based on the smallest root (minor) diameter of the standard screws within the nominal size range and truncated at the maximum ball nut rotational speed. **DO NOT EXCEED** this RPM regardless of screw length.



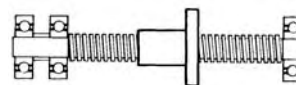
(A) Fixed Free	15	30	46	61	76	91	107	122	137	152	168	183	198	213	229	244	259	274	305	320
(B) Simple Simple	25	51	76	102	127	152	178	203	229	254	279	305	330	356	381	406	432	457	483	508
(C) Fixed Simple	30	61	91	122	155	185	216	246	277	307	338	391	401	432	462	493	523	554	584	615
(D) Fixed Fixed	38	76	114	152	191	229	267	302	340	378	417	455	493	531	569	607	645	683	721	757



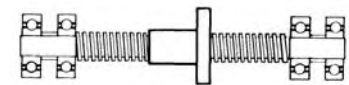
(A) Fixed-Free



(B) Simple-Simple



(C) Fixed-Simple

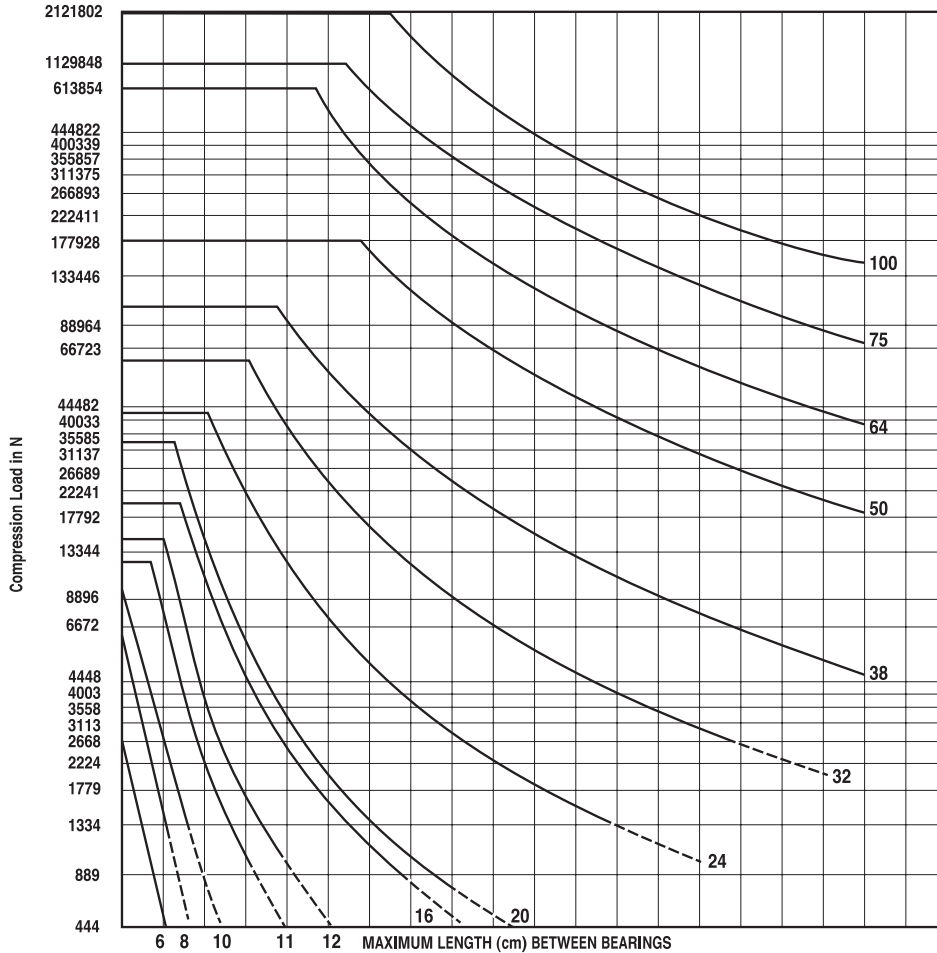


(D) Fixed-Fixed

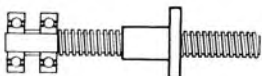
## Column Loading Capacities Chart

Use the chart below to determine the Maximum Compression Load for Screw Shaft. Usually, screws operated in tension can handle loads up to the rated capacity of the nut, providing the screw length is within standard lengths. End supports have an effect on the load capacity of screws. The four standard variations are shown below with corresponding rating adjustments. Find the point of intersecting lines of load (horizontal) and length (vertical) to determine the minimum safe diameter of screw. If loads fall into dotted lines, consult factory.

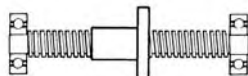
**Warning: DO NOT EXCEED nut capacity.** Curves for the screw diameters shown are based on the smallest root (minor) diameter of the standard screws within the nominal size range.



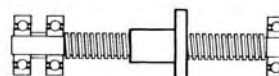
(A) Fixed Free	13	25	38	51	64	76	89	102	114	127	140	152	165	178	191	203	216	229	241
(B) Simple Simple	25	51	76	102	127	152	178	203	229	254	279	305	330	356	381	406	432	457	483
(C) Fixed Simple	36	71	107	145	180	216	251	287	323	358	396	432	467	503	538	574	610	648	686
(D) Fixed Fixed	51	102	152	203	254	305	356	406	457	508	559	610	660	711	762	813	864	914	965



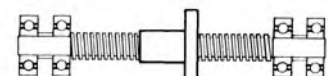
(A) Fixed-Free



(B) Simple-Simple



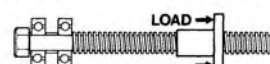
(C) Fixed-Simple



(D) Fixed-Fixed



Compression (Column) Load



Tension (Pulling) Load

## Lead Screw Product Summary

Series	Thomson Neff Precision Lead Screw
Lead accuracy	Standard - 250 µm/300 mm Precision - 75 µm/300 mm
Diameter	10 to 24 mm
Lead	2 to 45 mm
Backlash	,02 to ,25mm (standard nut) Zero backlash available
Dynamic Load	Up to 1550 N
Max. Static Load	Up to 6675 N
Catalogue Pages	10 to 12

## Lead Screw Product Availability

### Metric

	Lead (mm)													
	2	3	4	5	6	8	10	12	15	16	20	25	35	45
Dia. (mm)	10	•	•	•	•		•				•		•	
12		•	•	•	•		•		•			•		•
16			•	•		•				•		•	•	
20			•			•		•		•	•			•
24				•										

• = stocked size

### Inch

Also available are our inch series lead screws. Consult website for further details.

	Lead (in)													
	0,050	0,063	0,083	0,100	0,125	0,167	0,200	0,250	0,375	0,500	0,800	1,000	1,200	2,000
Dia. (in)	3/8	•	•	•	•	•	•	•	•	•		•	•	
7/16					•			•		•				
1/2		•		•			•	•		•	•	•		
5/8				•	•		•	•		•				
3/4				•	•	•	•			•		•		•
1				•	•		•	•		•		•		

Note: Miniature sizes also offered. Consult website. Custom diameters and leads per request.



## Ordering Information

Danaher Motion engineers its' lead screw thread to provide optimum performance. To ensure proper function, it is recommended that our nuts and screws be used only with mating Thomson Neff products manufactured by Danaher Motion. This is particularly important on our proprietary thread forms. If interchangeability is required, select a screw size from page 12 that conforms to the DIN standard.

It is recommended that you use a lubricant when operating a lead screw with a plastic nut. This will extend the life of the unit and increase the allowable operating load. (Note: load ratings in catalogue are calculated using a grease type lubricant.) See page 13 & 14 for lubrication options.

**Nut Part Number (See pages 10 and 11)**

<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Nut model number prefix (Letters only - 2 or 3 characters)			Screw size from table on page 12. (Do not include accuracy prefix)

**Example**

X	C	B	10x2M
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Note: Make sure the nut you have selected is offered for use with the screw diameter you select. See the "Screw Series" column on pages 10 and 11 to verify.

**Screw Part Number (See page 12)**

<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	-	<input type="text"/>
Accuracy Prefix (3 letter code for precision or standard accuracy)			Screw Size (specifies diameter and lead)		Screw Length (Please include units - mm preferred)

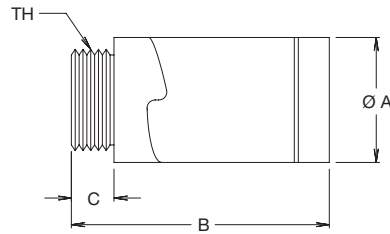
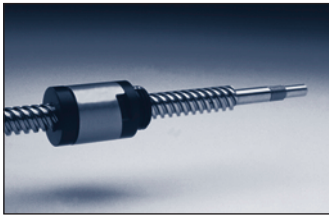
**Example**

S	P	T	10x2M	-	150mm
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Note that if the screw and nut have the same screw size suffix as shown in the examples above, the two components are properly specified to operate together.

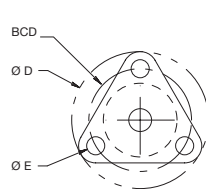


## XC Series - The Performance Leader

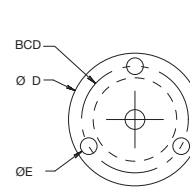


### Threaded Nut Type

Model #	Screw Series (mm)	Also Use w/Series (inch)	Dimensions				Design Load (N)	Drag Torque	
			A (mm)	B (mm) max	C (mm)	TH (mm)		Minimum (N-mm)	Maximum (N-mm)
XCB3700	10	5/16, 3/8	20,8	47,6	6,4	M16 x 1,5	100	7	21
XCB5000	12	7/16, 1/2	28,4	57,2	9,5	M25 x 1,5	550	7	21
XCB6200	16	5/8	35,6	66,0	12,7	M30 x 1,5	775	14	42
XCB7500	20	3/4	41,4	73,7	12,7	M35 x 1,5	1100	21	71
XCB10000	24	1	47,8	76,2	15,2	M40 x 1,5	1550	35	71



XCF3700 size only

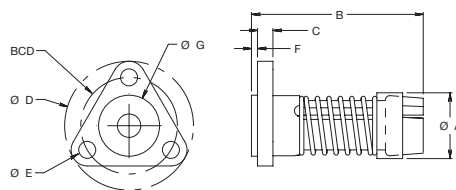


XCF5000, XCF6200

### Flange Nut Type

Model #	Screw Series (mm)	Also Use w/Series (inch)	Dimensions						Design Load (N)	Drag Torque	
			A (mm)	B (mm) max	D (mm)	E (mm)	F (mm)	BCD (mm)		Minimum (N-mm)	Maximum (N-mm)
XCF3700	10	5/16, 3/8	20,8	47,6	38,1	5,1	5,1	28,6	100	7	21
XCF5000	12	7/16, 1/2	28,4	57,2	44,5	5,6	7,6	35,5	550	7	21
XCF6200	16	5/8	35,6	66,0	54,1	5,6	12,7	42,9	775	14	42

## AFT3700 - The OEM Solution

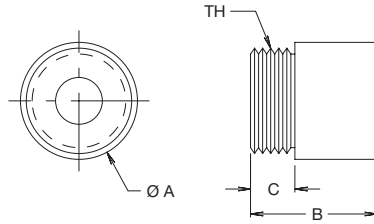
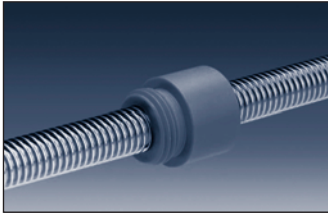


### Flange Nut Type

Model #	Screw Series (mm)	Also Use w/Series (inch)	Dimensions								Design Load (N)	Drag Torque	
			A (mm)	B (mm)	C (mm)	D (mm)	E (mm)	F (mm)	G (mm)	BCD (mm)		Minimum (N-mm)	Maximum (N-mm)
AFT3700	10	3/8, 7/16	19,6	50,8	5,1	38,1	5,1	1,5	18,0	28,6	45	14	35

See page 9 for ordering instructions

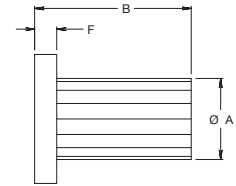
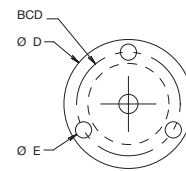
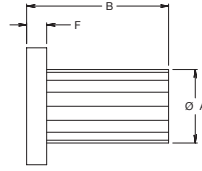
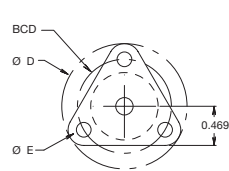
## SB Series - Compact Thread Mount Style



### Threaded Nut Type

Model #	Screw Series (mm)	Also Use w/Series (inch)	Dimensions				Design Load (N)	Max Static Load (N)	Drag Torque
			A (mm)	B (mm)	C (mm)	TH (mm)			
SB3700	10	5/16, 3/8	19,1	19,1	6,4	M16 x 1,5	310	1550	No Preload
SB5000	12, 16	7/16, 1/2	25,4	25,4	9,5	M22 x 1,5	445	2225	
SB1000	20, 24	3/4, 1	38,1	38,1	12,7	M35 x 1,5	1335	6675	

## MTS Series - Easy Mount Flange Style



### Flange Nut Type

MTS3700 only

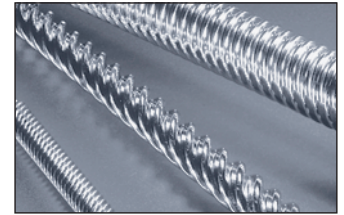
MTS5000, MTS6200, MTS7500

Model #	Screw Series (mm)	Also Use w/Series (inch)	Dimensions						Design Load (N)	Drag Torque
			A (mm)	B (mm)	D (mm)	E (mm)	F (mm)	BCD (mm)		
MTS3700	10	3/8, 7/16	18,0	38,1	38,1	5,1	5,1	28,6	325	No Preload
MTS5000	12	1/2	19,1	38,1	38,1	5,1	6,4	28,6	550	
MTS6200	16	5/8	22,4	41,4	38,1	5,1	7,6	30,2	775	
MTS7500	20	3/4	28,6	44,5	50,8	5,1	7,6	36,5	1200	

See page 9 for ordering instructions

Note: Design load is the recommended maximum operating load with lubrication at room temperature, 50% duty cycle, and 500 RPM. Increasing the RPM will decrease the maximum allowable operating load. At 1,000 RPM, the operating load is approximately 1/2 of the rated design load.

Precision rolled lead screws offer a burnished finish for maximum efficiency and lowest wear. All screws are stainless steel to provide corrosion resistance and a bright finish. SPT and SRT screws conform to DIN 103 while SPR and SRA screws have optimised thread forms for maximum performance.



Shaft Diameter (mm)	Lead (mm)	Part Number			Root Diameter (mm)	Efficiency @ .1 Friction Coefficient (%)
		Precision Accuracy Prefix	Standard Accuracy Prefix	Size		
10	2*	SPT	SRT	10 x 2M	7,4	42
	3^	SPT	SRT	10 x 3M	6,4	53
	5	SPR	SRA	2-10 x 2,5M	7,1	64
	6	SPR	SRA	4-10 x 1,5M	8,2	66
	10	SPR	SRA	5-10 x 2M	7,5	76
	20	-	SRA	6-10 x 3,3M	8,4	81
	35	-	SRA	10-10 x 3,5M	7,4	81
12	3*	SPT	SRT	12 x 3M	8,0	48
	4	SPR	SRA	2-12 x 2M	9,2	54
	5^	SPT	SRT	2-12 x 2,5M	8,9	59
	6	SPR	SRA	3-12 x 2M	9,1	63
	10^	SPT	SRT	4-12 x 2,5M	8,9	73
	15	SPR	SRA	6-12 x 2,5M	8,7	78
	25	-	SRA	10-12 x 2,5M	9,2	82
	45	-	SRA	15-12 x 3M	9,6	81
16	4*	SPT	SRT	16 x 4M	11,3	48
	5	SPR	SRA	2-16 x 2,5M	12,2	52
	8	SPR	SRA	4-16 x 2M	13,0	63
	16	SPR	SRA	7-16 x 2,3M	12,6	75
	25	-	SRA	5-16 x 5M	11,5	80
	35	-	SRA	7-16 x 5M	12,2	82
20	4*	SPT	SRT	20 x 4M	15,3	42
	8	SPR	SRA	2-20 x 4M	14,8	59
	12	SPR	SRA	3-20 x 4M	15,0	67
	16	SPR	SRA	4-20 x 4M	15,0	72
	20	-	SRA	5-20 x 4M	15,0	76
	45	-	SRA	9-20 x 5M	15,8	82
24	5*	SPT	SRT	24 x 5M	18,5	42

\*Conforms to DIN 103 parts 1 & 2. Tolerance grade 7e.

^Conforms to DIN 103 part 1, not defined in parts 2 & 3

See page 5 for maximum available screw lengths

See page 9 for ordering instructions



## Lubrication



### Overview

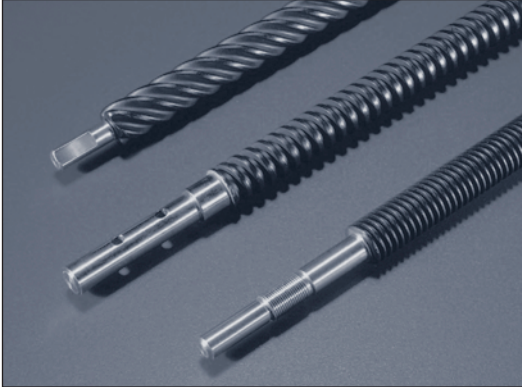
We offer a full complement of lubricants including our low vapour pressure greases for clean room and vacuum application. The TriGel line is specifically formulated to offer a lubrication solution for a wide range of linear motion applications. Choose the appropriate gel for your requirements and get the utmost performance out of your Danaher Motion products.

## Lubrication Selection Chart for Ball & Lead Screw Assemblies

Thomson Neff	TriGel-300S	TriGel-450R	TriGel-600SM	TriGel-1200SC	TriGel-1800RC
Application	Lead Screws Supernuts, Plastic Nuts	Ball Screws, Linear Bearings	Bronze Nuts	Lead Screws, Plastic Nuts, Clean Room, High Vacuum	Ball Screws, Linear Bearings, Bronze Nuts, Clean Room, Vacuum
Maximum Temperature	200° C (392°F)	125°C (257°F)	125°C (257°F)	250°C (482°F)	125°C (257°F)
Mechanism Materials	Plastic on Plastic or Metal	Metal on Metal	Metal on Metal Bronze on Steel	Plastic or Metals, Combination	Metal on Metal
Mechanical Load	Light	Moderate	Moderate to Heavy	Light to Moderate	Moderate
Very Low Torque Variation over Temperature	Yes	—	—	Yes	—
Very Low Starting Torque	Yes	Yes	—	Yes	Yes
Compatibility with Reactive Chemicals	Not recommended w/o OEM testing	Not recommended w/o OEM testing	Not recommended w/o OEM testing	Usually OK	Not recommended w/o OEM testing
Compatibility with Plastics and Elastomers	May cause silicon rubber seals to swell	May cause EPDM seals to swell	May cause EPDM seals to swell	Usually OK	May cause EPDM seals to swell
Clean Room Use	Not recommended	Not recommended	Not recommended	Usually OK	Usually OK
High Vacuum Use	Not recommended	Not recommended	Not recommended	Usually OK	Usually OK
Vapor Pressure (25°C)	Varies with lot	Varies with lot	Varies with lot	1 x 10 <sup>-6</sup> Pa	0,5 x 10 <sup>-6</sup> Pa
Packaging 10cc Syringe ,45kg Tube	TriGel-300S TriGel-300S-1	7832867/TriGel-450R 7832868/TriGel-450R-1	,1kg tube/TriGel-600SM	TriGel-1200SC NA	7832869/TriGel-1800RC

\* Maximum temperature for continuous exposure. Higher surge temperatures may be permissible but should be validated in the actual end use by the OEM. Low temperature limits are -15°C or lower. Consult Danaher Motion for specifics.

## Formulated for plastic on metal lead screw applications



PTFE coating is a dry film which creates a lubrication barrier between a metal substrate and a polymer bushing or lead nut. It can in some cases eliminate the need for an additional gel type lubricant which must be re-applied. It is well suited for use with our SuperNut line of plastic nuts and stainless steel lead screws. Lubrication maintenance intervals can be eliminated and the coating does not attract particulate like a gel lubricant. Gel lubricants can provide lower friction coefficients than dry film lubricants but must be maintained to prevent performance degradation. PTFE coating provides an attractive and clean\* alternative to gels and oils.

### Typical Properties

Type:	Bonded Solid Film Lubricant
Purpose:	Increased Lubricity, Decreased Friction & Wear
Appearance:	Black Coating
Thickness:	Approx. 13 – 25 micron
Active Lubricant:	Polytetrafluoroethylene
Friction Coefficient:	0,06 to 0,12
Temperature Operating Range:	-250° to 290° C
Resistance to Acids:	Excellent
Resistance to Bases:	Very Good
Resistance to Solvents:	Excellent

\*Some particulate will be generated as a result of wear between nut and screw. Screw may begin to show signs of "polishing" over time. This does not necessarily indicate failure.

## Application Data Information Sheet

Name: \_\_\_\_\_

Title/Dept: \_\_\_\_\_

Company Name: \_\_\_\_\_

Address: \_\_\_\_\_

Country: \_\_\_\_\_

Phone: \_\_\_\_\_ Fax: \_\_\_\_\_

E-mail: \_\_\_\_\_

1. What is your LOAD? \_\_\_\_\_  
 Newtons    Kilograms    Pounds  
 Other \_\_\_\_\_  
 (please describe)
2. Is your MOTION    Horizontal   or    Vertical
3. What is the length of STROKE? \_\_\_\_\_  
 m    mm    in  
 Other \_\_\_\_\_  
 (please describe )
4. What is the SPEED? \_\_\_\_\_  
 m    mm    in   per    second    minute  
 Other \_\_\_\_\_  
 (please describe)
5. ACCURACY requirements :  
 ,25mm / 300mm  
 ,075mm / 300mm    Other \_\_\_\_\_  
 (please describe)
6. BACKLASH requirements:  
 0    ,25mm  
 ,05mm    Other \_\_\_\_\_  
 (please describe)
7. BEARING SUPPORT requirements:  
 (see page 6)  
 Fixed/Simple    Fixed Free  
 Fixed/Fixed    Other \_\_\_\_\_  
 (please describe)
8. Quantity required \_\_\_\_\_ per  
 Month    Year    Other

Additional information/comments (describe environment and whether grease lubricant is allowed):

