Linear Motion Control

Ball bearing screws actuate and control linear motion in a most efficient way. They complement Warner Linear's other innovative products to comprise a total capability to control motion in industrial, agricultural, and commercial equipment.

Warner Linear's capability in ball bearing screws ranges from the standard off-the-shelf industrial models presented in this catalog to a complete spectrum of precision metric ball bearing screws designed for many unique applications requiring the ultimate in accuracy and performance. Contact the factory or your local Warner Linear sales representative for more information on the precision metric ball screws.

Outstanding product benefits of Warner Linear ball bearing screws are:

- Repeatable
- Efficient
- Simple
- Responsive
- Accurate
- Smooth
- Reliable
- Predictable
- Quiet & Clean Operation

Standard ball bearing screws are locally available from over 1000 Warner distributor locations throughout the United States, Canada and Mexico. Call the Warner distributor nearest you with your application requirements. He's a linear motion specialist with innovative solutions to motion control problems.

New!

*Ball Screw Express**

Warner Linear has made a commitment to new ball screw availability and shorter lead times for both standard products and specials.

Standard Products (cut and ship)
- Orders entered before 10AM central time will ship the same day (10 pc. max.)
- Orders entered after 10AM will ship the following business day
- Larger quantities will ship in five days or less

Standard Modified Products (end journals shown in catalog)
- Shipped in five days or less (10 pc. max.)

Express Modified Products
(custom end journals with clear print, no outside processes)
- Shipped in eight days or less (10 pc. max.)

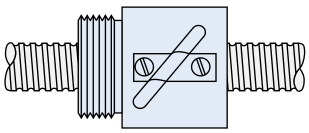
* Contact your local Warner Linear sales representative, authorized Warner Linear distributor or contact the factory for details.

Contents

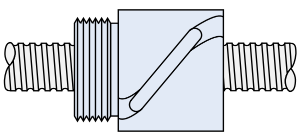
Product Selection
Industrial Grade Ball Bearing Screws

Series R

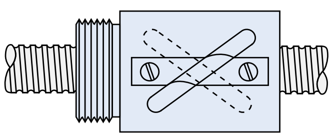
- 35 standard models
- Available in non-preload and preloaded/zero backlash ball nut assemblies
- Optional flanges available
- 5 left hand thread models
- 3 stainless steel models



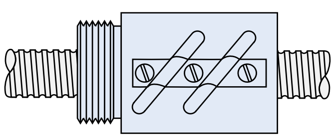
Single nut, non-preload, single circuit



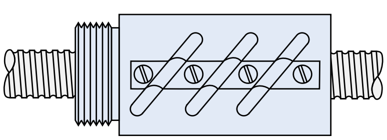
Single nut, non-preload, single circuit, recessed return tube



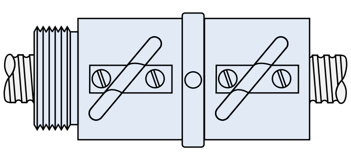
Single nut, non-preload, dual circuit



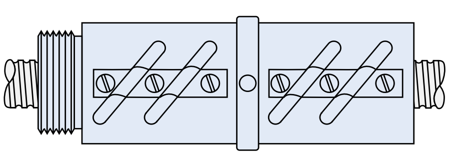
Single nut, non-preload, dual circuit



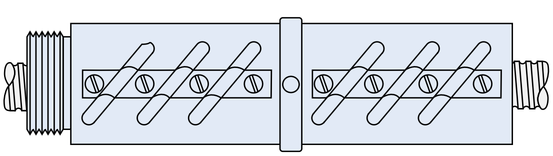
Single nut, non-preload, triple circuit



Double nut, preloaded, (2 single circuits)



Double nut, preloaded, (2 dual circuits)



Double nut, preloaded, (2 triple circuits)

							Preloaded/Zero Backlash Assemblies		
Model No.	Max. Major Screw Dia.	Lead	RH LH	Nom. Ball Dia.	Maximum Static Capacity (lbs.) Single Nut Non-Preloaded	RatedDynamic Load–Lbs@ 1,000,000" Travel Single Nut Non-Preloaded	Preload Model No.	Maximum Static Capacity (lbs.) Double Nut Preloaded	RatedDynamic Load–Lbs@ 1,000,000" Travel Double Nut Preloaded
R-0308	.375	.125	RH	.078	4,250	500	RP0308	4,200	450
RC0308	.375	.125	RH	.078	1,760	235	—	—	—
R-0505	.500	.200	RH	.125	9,400	1,200	RP0505	9,280	1,080
R-0502	.500	.500	RH	.125	13,350	2,200	RP0502	13,130	1,980
RS0502	.500	.500	RH	.125	1,950	380	—	—	—
RC0605	.625	.200	RH	.125	6,150	800	RD0605	6,070	720
RQ0605	.625	.200	RH	.125	6,150	800	—	—	—
RK0605	.625	.200	LH	.125	6,150	800	RE0605	6,070	720
R-0705	.750	.200	RH	.125	18,800	1,900	RP0705	18,610	1,710
RC0705	.750	.200	RH	.125	7,750	950	RD0705	—	—
R-0702	.750	.500	RH	.156	24,200	3,450	RP0702	23,855	3,150
RS0702	.750	.500	RH	.156	3,460	600	—	—	—
R-1004	1.000	.250	RH	.156	30,750	3,350	RPI004	30,415	3,015
RC1004	1.000	.250	RH	.156	12,700	1,600	RD1004*	—	—
RL1004	1.000	.250	LH	.156	30,750	3,350	RT1004	30,415	3,015
RK1004	1.000	.250	LH	.156	12,700	1,600	—	—	—
R-1002	1.000	.500	RH	.156	32,300	3,950	RP1002	31,905	3,555
R-1001	1.000	1.000	RH	.156	13,750	2,250	RP1001	13,525	2,025
RS1001	1.000	1.000	RH	.156	2,000	430	—	—	—
R-1105	1.125	.200	RH	.125	27,550	2,400	RP1105	27,310	2,160
R-1520	1.425	2.000	RH	.281	29,000	7,600	RP1520	—	6,840
RH1520	1.425	2.000	RH	.281	29,000	7,600	RJ1520	—	6,840
R-1547	1.410	.473	RH	.344	57,770	10,050	—	—	—
R-1504	1.500	.250	RH	.156	47,450	4,050	RP1504	47,045	3,645
R-1502	1.500	.500	RH	.312	102,300	12,900	RP1502	101,010	11,610
RL1502	1.500	.500	LH	.312	102,300	12,900	RT1502	101,010	11,610
R-1501	1.500	1.000	RH	.344	47,800	8,250	RP1501	46,975	7,425
RH1501	1.500	1.000	RH	.344	47,800	8,250	RP1501	46,975	7,425
R-2002	2.000	.500	RH	.375	143,400	18,500	RP2002	154,635	17,235
RL2002	2.000	.500	LH	.375	143,400	18,500	RT2002	154,635	17,235
R-2001	2.000	1.000	RH	.375	134,500	21,200	RP2001	152,605	19,755
R-2202	2.250	.500	RH	.375	161,150	19,300	RP2202	159,220	17,370
R-2502	2.500	.500	RH	.375	186,000	21,200	RP2502	183,880	19,080
R-2501	2.500	1.000	RH	.375	174,000	27,000	RP2501	199,910	24,210
R-3066	3.000	.660	RH	.500	323,950	38,000	RP3066	320,150	34,200

* REF: 8110-448-050

Prefix Designations for Series R Models

R- = right hand thread, dual circuit*
*R-3066 is a triple circuit

RL = left hand thread, dual circuit

RC = right hand thread, single circuit

RK = left hand thread, single circuit

RQ = right hand thread, single circuit, square nut

RS = right hand thread, dual circuit, stainless steel

RP = right hand thread, dual circuit, preload

RT = left hand thread, dual circuit, preload

RD = right hand thread, single circuit, preload

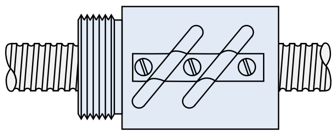
RE = left hand thread, single circuit, preload

RH = right hand thread, dual circuit with deflectors

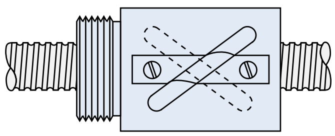
RJ = right hand thread, dual circuits with deflectors, preload

Series RM

- Metric leads
- 2 standard models
- Optional flanges available



Single nut, non-preload, dual circuit



Single nut, non-preload, dual circuit

Model No.	Major Screw Dia. mm	Lead mm	RH LH	Nom. Ball Dia. (in.)	Maximum Static Capacity (lbs.) Single Nut Non-Preloaded	Rated Dynamic Load Pounds at 1,000,000 inch travel Single Nut Non-Preloaded
RM2510	24.87	10	RH	.1378	30,000	3,500
RM2525	24.54	25	RH	.1560	15,000	2,500

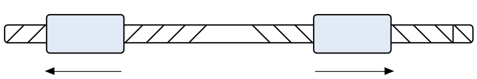
Note: Additional size metric units available on request.

Series A

- Ball bearing splines
- 3 standard models
- Predictable life-reliable
- Smooth axial movement even while transmitting torque

Model No.	Inner Raceway Pitch	Number of Circuits	Nominal Ball Diameter	Max. static torque (lb.in.)	Rated Dynamic Torque @ 1,000,000" travel (lb.in.)
A-250	.625	6	.188	1,170	3,540
A-350	1.000	6	.188	2,600	7,800
A-450	1.500	6	.250	8,400	23,176

Series RA



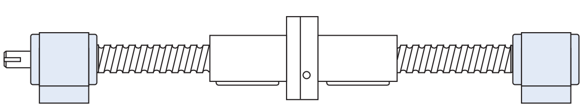
Four models of ball screws are available in combined right and left hand thread. The unit sizes, lead and load ratings are the same as the single thread versions in the same sizes. RA series screws incorporate two ball nuts and will allow for movement along the screw in opposite directions with a single motor input.

RLR 0605, RLR 1004, RLR 1502, RLR 2002

Ball Screw End Supports

- Base or flange mount
- Sizes 5/8" to 2"
- Predictable life-reliable
- Simple, duplex and rigid mount

Pre-engineered ball screw end supports are now available in base or flange mount design for screws 5/8" to 2" diameter. These end supports are easy to install and are designed specifically for Warner Linear ball screws. They can be ordered separately or installed on the ball screw at the factory. For technical information, features, and how to order, see pages 24–29.

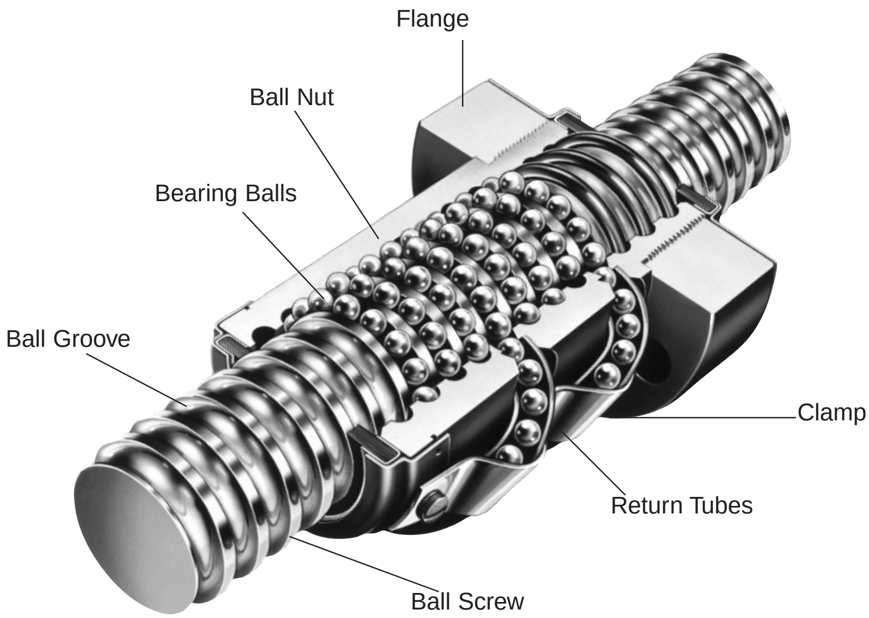


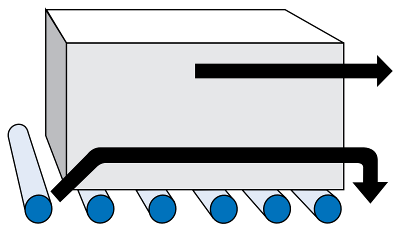
Design Advantages

A ball bearing screw is well described by its name; it is a screw that runs on bearing balls. The balls provide the only physical contact between screw and nut, replacing the sliding friction of the conventional screw with a free and smooth rolling motion

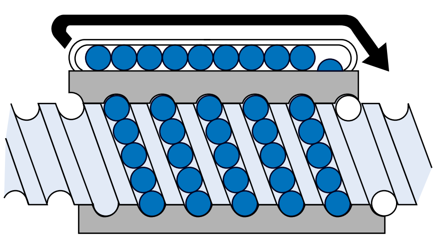
Although it may look quite complex, the principle is very simple and at least as old as the pyramids. Huge blocks of stone were rolled up the slopes of the pyramids on logs. As each block passed over the last log in line, that log was again moved to the front. Similarly, in a ball bearing screw the return tubes carry the bearing balls from the end of their travel, over the screw and back to the start of the circuit to form a continuously recirculating path

Just as in the case of the pyramids, where huge masses of stone were moved uphill by hand, the ball bearing screw is capable of moving a tremendous load with very little power.



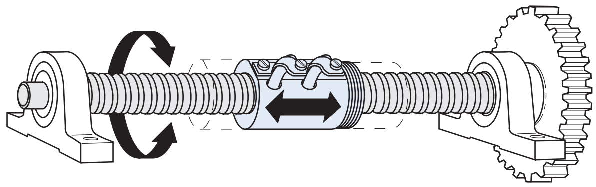


A ball bearing screw is energy efficient—three times more efficient than conventional screws. The benefit is smaller motors, smaller drive components and less power input. These benefits add up to a cost savings, both in component cost and energy consumption

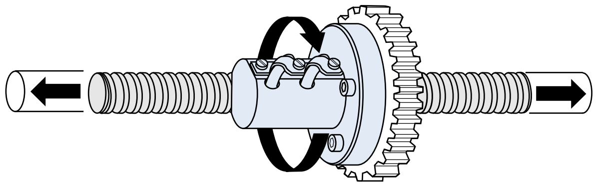


A ball bearing screw thread is actually a hardened ball race. The nut consists of a series of load carrying bearing balls circulating in a similar race. The bearing balls are transferred from one end of the nut to the other by return tubes. In a typical ball bearing screw, like the one shown, two complete bearing ball circuits are used to increase both the load carrying capacity of the screw and its operating life.

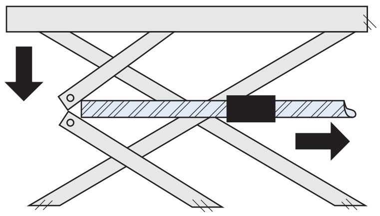
The primary function of a ball bearing screw is to convert rotary motion to linear motion—or torque to thrust.

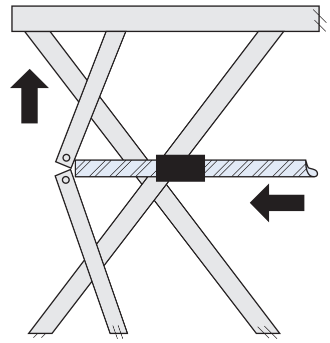


In the most common type of linear motion control, the screw rotates and the nut travels along the length of the screw.



Ball bearing screws can also convert thrust to torque. The screw travels through the nut, causing it to rotate.

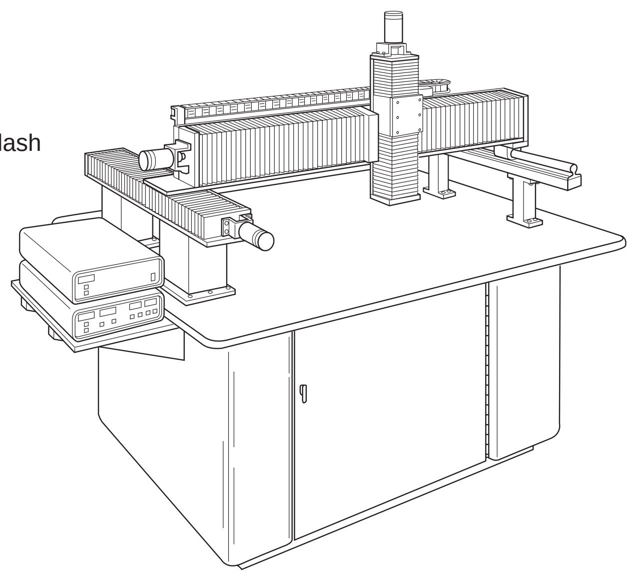




Ball bearing screws are used in lift tables, farm equipment, x-ray machines, vans for the handicapped, hospital beds, tire-making machines, saw mill carriages, general purpose machine tools and special machinery of all kinds.

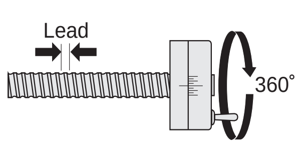
Ball bearing screws are reliable. There's no hydraulic fluid to leak out. Positive driving contact is made between bearing balls and a hardened steel screw. Ball bearing screw performance characteristics can be compared to ball bearings. Operating life is predictable. They don't wear, they fatigue. This means that throughout the life of the ball bearing screw, performance is accurate and consistent. Frequent adjustments are not required. The end result is reliability, efficiency, performance, consistency, predictability, and cleanliness.

In a ball bearing screw, backlash can be held to a minimum to provide the system stiffness required for accuracy and reliability. Precision ground ball bearing screws are standard equipment on N/C machine tools where accurate positioning of the work piece and cutting tool are imperative.



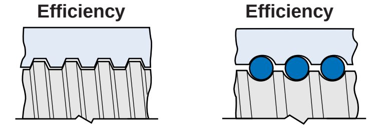
Accuracy

Lead variation of a ball bearing screw is defined as its total inaccuracy through 360° of screw rotation. Lead variation of Warner Linear R Series screws is .005 inch/foot anywhere on the screw. A 12 foot length of screw stock could have a total variation of .060 inch. A more accurate certified lead is available upon request. Contact the factory for details.



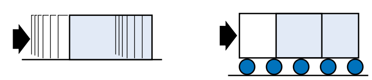
90% Efficiency

High mechanical efficiency of a Warner Linear ball bearing screw results from the rolling contact of a ball bearing as compared to the relatively inefficient sliding friction of a conventional Acme screw.



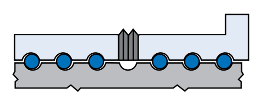
Low Starting Torque

The substitution of rolling contact for sliding metal to metal contact minimizes starting friction and eliminates the tendency to stop-start and stutter when a slow smooth linear motion is desired.



Zero Backlash

Zero backlash, which minimizes any looseness and endplay, is accomplished by preloading one ball nut against another. See pages 21–23 for standard preload assemblies.



Predictable Life— No Adjusting for Wear

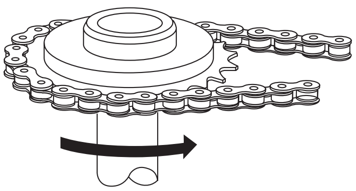
Like a conventional ball bearing, the life of a ball bearing screw is predictable. Due to the same ball bearing operating characteristics, very little dimensional change occurs over the life of a ball bearing screw, thus eliminating the need for frequent compensating adjustments.

Design Advantages

Advantages over other linear actuators

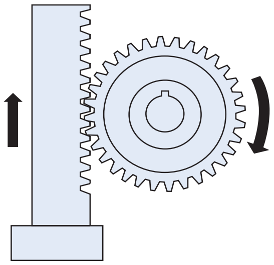
Chain and Sprocket

The chain and sprocket can provide linear motion control in very long lengths at relatively high speeds, but the inherent flexibility of chain can cause an unstable motion and undesirable noise. Load carrying capacity is limited and drive systems can become complex.



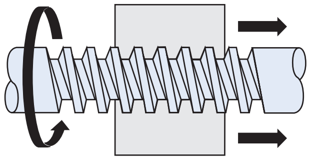
Rack and Pinion

The rack and pinion replaces the chain and sprocket with a rigid metal rack of teeth. It is a simple, efficient and economical mechanism for converting rotary to linear motion and is applicable to long or short strokes. The principal limitation of the rack and pinion is its low load capacity and low mechanical advantage. The entire force it produces must be supported by one pinion tooth at any given instant.



Acme Screw

The acme screw and nut is one of the most common linear actuators, but it is also one of the least efficient. 30% efficiency is a good rule of thumb unless the components are manufactured to precision ground tolerances. Since all motion between the two basic components takes place under pure sliding friction, frequent adjustment for wear is also required.



Hydraulics and Pneumatics

Smooth, predictable linear motion—no response delays in starting or stopping. In typical motor driven ball bearing screw applications, linear speed does not vary significantly with changes in load, a common problem with hydraulics and pneumatics. Inconsistent motion due to variations in line pressure or oil viscosity are also eliminated.

Quicker response—hydraulic and pneumatic systems require time to build pressure before actuation is possible. A ball bearing screw system is dependent only on the minimal start time of a motor or engagement time of a clutch.

Repeatability—ball bearing screw systems return consistently to predetermined locations without positive stops .

Simplified installation and maintenance—Elimination of auxiliary equipment, such as pumps, tanks, accumulators, valves, fittings and high pressure lines can add up to substantial savings in initial design and installation, besides dramatically reducing maintenance problems.

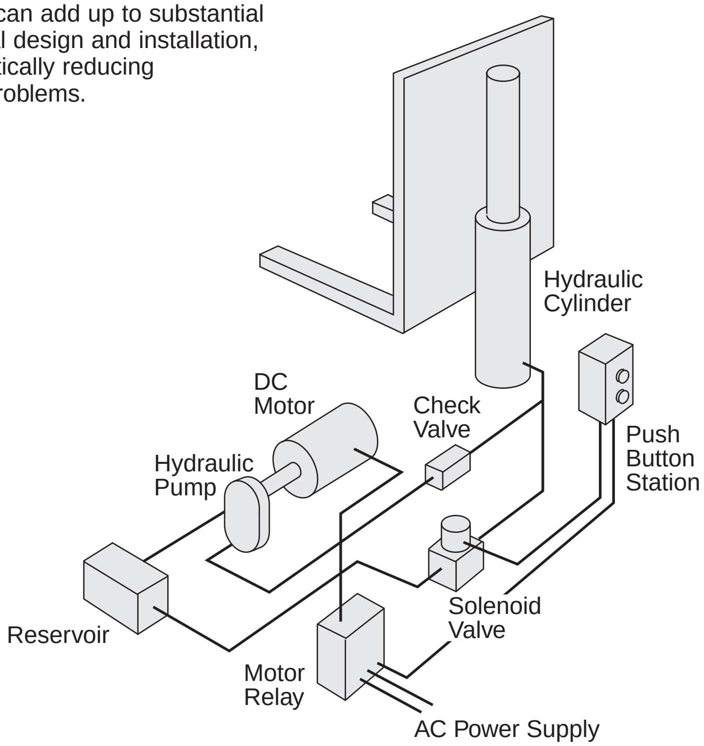
Quiet—no air exhausts to muffle. No pumps or compressors constantly whining.

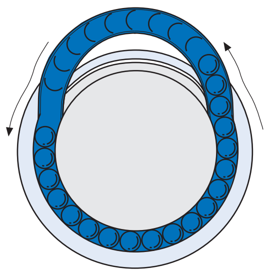
Energy Savings—power consumed only when motion is required; no power drain or continuously running pumps or compressors.

No fluid leakage problems—a continuing problem with hydraulics.

No filtering—moisture removal not necessary as required with pneumatics.

Easily interface—with step motors and servo motors for variable positioning, indexing and variable speed applications.





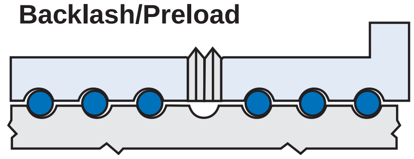
Tangential Ball Return

A unique Warner Linear feature which minimizes recirculated bearing ball deflection, for smoother and quieter operation. The tangential circuit consists of a pick-up deflector finger and modified return tube which allows the bearing balls to enter and exit the load carrying portion of the ball screw circuit in a straight path. Standard on ball bearing screws with up to 10,000 pound dynamic load capabilities

Lube Holes

A standard 1/8-27 NPT tapped hole on ball nuts with a dynamic load capacity of 10,000 pounds or more provides easy access for continuing lubrication.

Zero Backlash/Preload

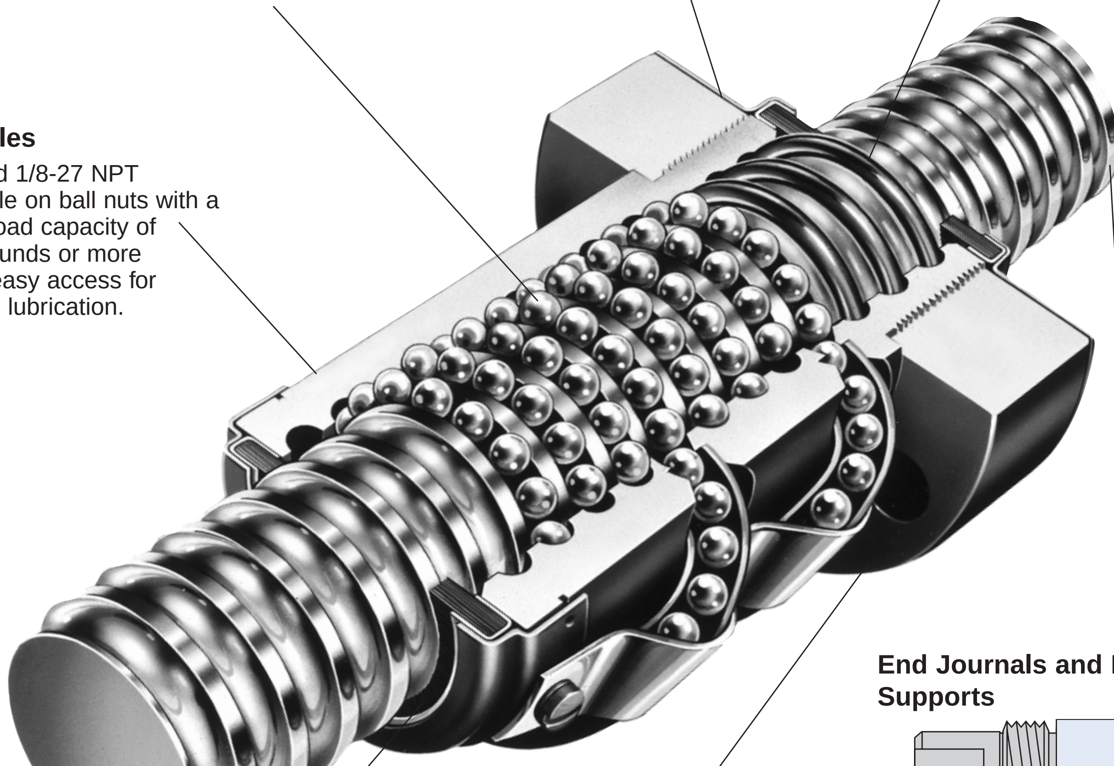


Packages

Warner Linear offers standard, off-the-shelf, preload nut designs for applications requiring minimal endplay. See pages 21–23 for details.

Load Locking Spring

The load locking spring is a coil turned into the inactive portion of the nut and conforms to the ball tract. In normal operation, the spring is inactive and not in contact with the screw. In the event the ball bearings are lost from the nut, the load locking spring will not allow the load carrying nut to free-fall down the screw.



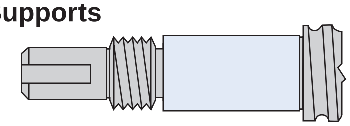
Wiper Kit

Wipers can increase the life and long-term performance of ball bearing screws by preventing most dirt and other foreign matter from entering the ball nut. See pages 32–33 for details. Telescoping metal or rubber covers are commercially available for applications requiring complete protection of ball bearing screw drives.

Flanges

Standard flanges are offered for all ball nuts. Flanges provide an easy, low cost method to mount the load square and concentric to the ball screw.

End Journals and Bearing Supports



To assist the designer, standard end journals and bearing supports are included in this catalog, pages 24–31. Ball bearing screws complete with end journals and supports may be ordered through a local Warner Linear distributor or directly from the factory. An end machining guide is available for customers who desire to machine their own end journals. Ask for Manual P–256.

Warner Linear welcomes the opportunity to custom machine end journals to unique customer designs.

Applications

The inherent efficiency and accuracy of Warner Linear ball bearing screws make them ideal for use in virtually every industry. The following basic application designs illustrate just a few of their possibilities for linear/rotary motion control.

With hundreds of product variations available, the range of Warner Linear ball bearing screw applications is almost limitless.

- Robot manipulator arms
- Hospital bed/dental chair elevation
- Palletizers/pallet platform lifts
- Servo drives
- Wheel chair lifts
- X-Y positioning tables/machine tool beds
- Vertical scanners/testing equipment
- Web tension unwind stands
- Foundry die positioners
- Belt tighteners
- Steering mechanisms
- Satellite antenna drives
- Floor sweepers
- Trenching machines
- Man lifts/vehicle hoists
- Automatic welders
- Railroad track switching

With proper design consideration a ball bearing screw can be used almost anywhere. The very nature of the product extends the application possibilities for linear motion control, rather than limiting it. They have successfully operated on the moon in the LEM, on hay balers, snowmobile trail grooming machines, even inside jet engines.

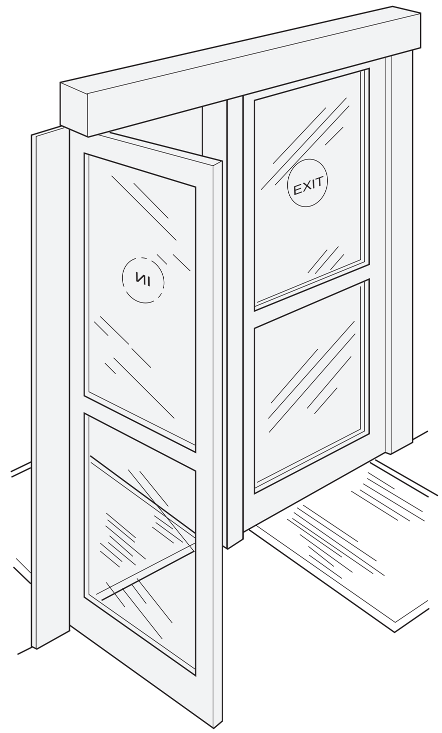
Back Driving

Automatic Door

A permanent magnet D.C. motor coupled with a ball bearing screw opens automatic doors with a minimal amount of energy. A helcial spring, compressed as the door opens, causes the highly efficient ball bearing screw to back drive, thus closing the door.

Advantages:

- 90% plus efficiency permits manual operation during emergency/power outage.
- Quick, responsive actuation
- No hydraulic oil leakage



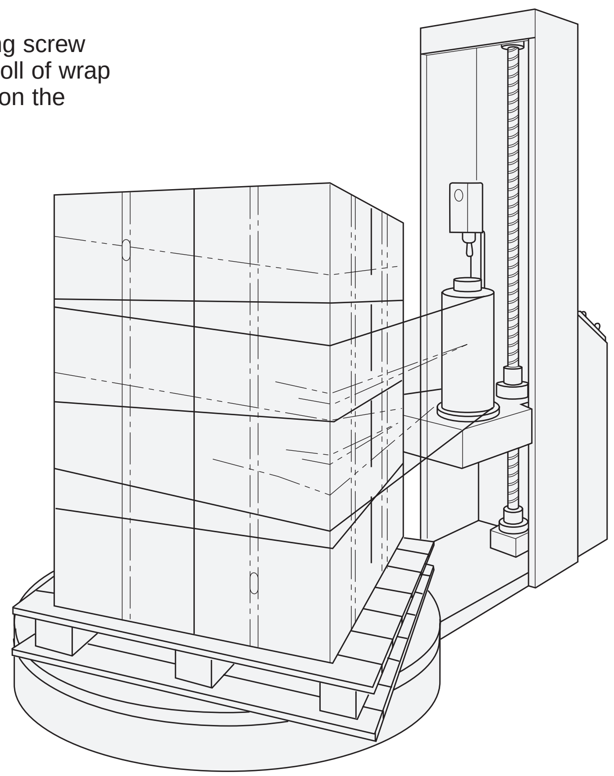
Efficiency

Pallet Stretch Wrapper

A Warner Linear ball bearing screw positions the height of the roll of wrap film as the pallet is rotated on the pallet platform.

Advantages:

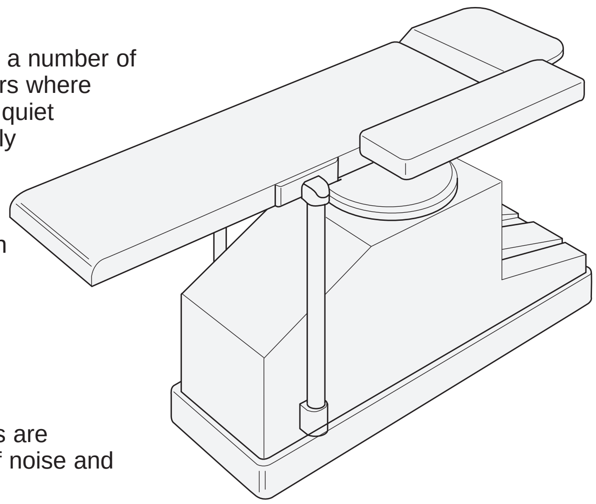
- Ball bearing screws simplify system design and installation since there are fewer components
- 90% plus efficiency enables use of smaller motors for design cost savings
- Smooth operation



Clean, Quiet Operation

Medical Equipment

Ball bearing screws are used by a number of medical equipment manufacturers where reliable performance and clean, quiet operation is essential. Completely mechanical ball bearing screws require a minimal amount of space—twelve inches of linear motion results from a fifteen inch package length.



Advantages:

- Accurate positioning
- Fluid power valves and pumps are eliminated—a major source of noise and contamination
- Long, predictable life without maintenance

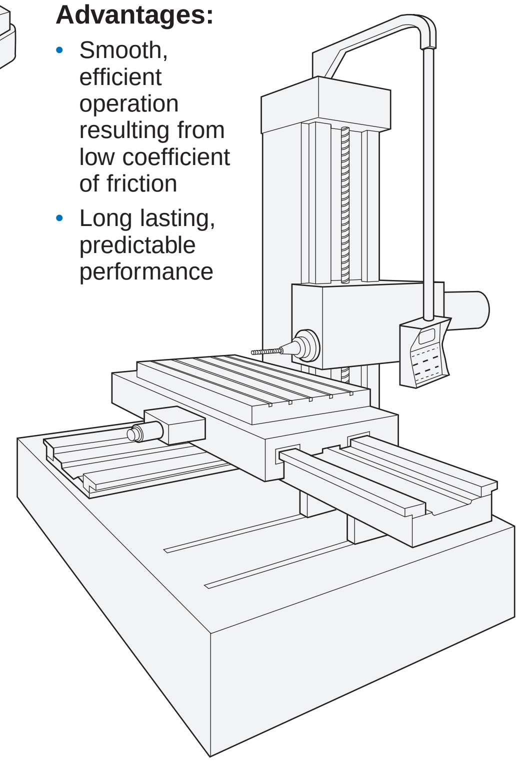
Accurate Positioning

Machine Tools

Warner Linear ball bearing screws provide efficient and effective feed, elevation and position control on milling machines, surface grinders, gun drills, lathes and punch presses.

Advantages:

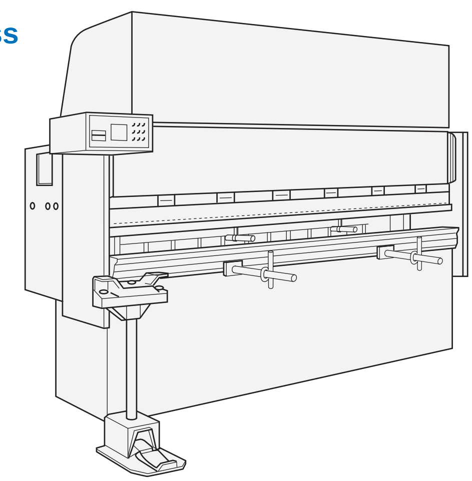
- Smooth, efficient operation resulting from low coefficient of friction
- Long lasting, predictable performance



Maximum System Stiffness

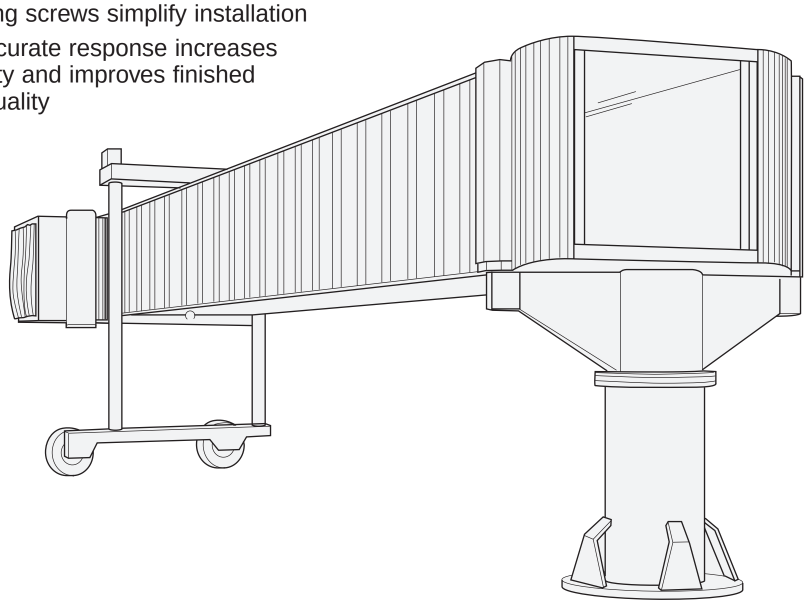
Press Brake

Two preloaded ball bearing screws precisely position the backstop against which sheet metal rests prior to bending. Utilizing CNC, the ball bearing screws provide bend accuracies of ±.003 inch.



Advantages:

- Preloaded ball bearing screws provide zero backlash and maximum system stiffness without positive stops
- Synchronized, completely mechanical ball bearing screws simplify installation
- Rapid, accurate response increases productivity and improves finished product quality



Synchronization

Aircraft Passenger Bridge

Two synchronized ball bearing screws adjust the height of the passenger bridge to the airplane in service. A Warner electrically released brake prevents the ball bearing screw from back driving

Advantages:

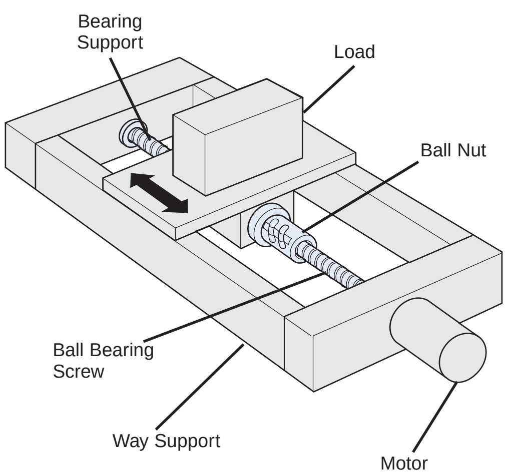
- Smooth and reliable
- System stiffness maintains position under significant load changes
- System efficiency

Ball Bearing Screw Selection Process

For the selection of ball bearing screws, Warner Linear has developed a simplified process. By applying the four steps which follow, the proper size ball bearing screw can readily be selected for most applications. This four step process includes:

Step 1. Determine the load
Step 2. Determine the design life objective
Step 3. Verify safe speed
Step 4. Verify safe compression load

If unique design considerations are encountered in your application, consult the factory for in-depth technical assistance.

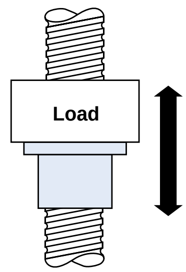


Typical systems elements in a ball bearing screw application.

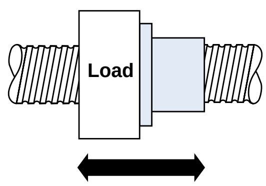
Step 1.
Determine the load

The first step is to determine what the load weighs.

Vertical application



Horizontal application



Next, determine whether the load is moving horizontally or vertically.

If the load is to move vertically, then the weight of the load is the value used.

If the load is moved horizontally, then the actual load can be de-rated by the coefficient of friction of the load supports.

All horizontally mounted ball screw applications will use supports of some type to carry the load. Common devices are linear bearings on a shaft or a bronze or plastic bearing on a shaft. Each of these devices will have a coefficient of friction that will make it easier to move the load than if the load were unsupported. For instance, a teflon bearing on steel shaft will have a coefficient of friction of .15. Therefore, a 100 pound load will appear to the ball screw to be 15 pounds.

The adjusted load can be determined by the following formula:

Load = Weight * coefficient of friction of load supports.

Common load supports and their coefficient of friction multipliers are:

Linear Bearing .005
Teflon on steel (lubricated) .15
Bronze on steel (lubricated) .20
Steel on steel (lubricated) .20

*Example: A machine tool head weighing 2700 pounds supported on teflon bearings would result in the following formula: Load = 2700 * .15. The load applied at the ball screw is 405 pounds.*

Step 2.
Determine the design life objective

The second step in selecting a ball screw is the life requirement. To determine this the following information is required:

1. Length of travel per stroke
2. Number of cycles per hour
3. Number of work hours per day
4. Number of work days per year
5. Number of years of life required

Multiply numbers 1 through 5 times each other to determine the unit life requirement.

For example, a machine with a 24 inch horizontal stroke. It will run 12 cycles per hour, 14 hours per day, 250 days per year and can be replaced after 3 years. Therefore we multiply 24x12x14x250x3 (stroke x cycles per minute x 60 minutes per hour x hours per day x days per year x years of life). Our life goal will therefore be: 3.024 million inches of life.

On the chart on page 12 the proper ball screw for a load of 405 pounds at 3.024 million inches of travel would be determined by finding the point where these two values meet. Any ball screw above that point will provide the life required.

On the chart these points meet at a point below the line showing RC0705, RC0605, RK0605, RQ0605. Any of these units will provide the life required.

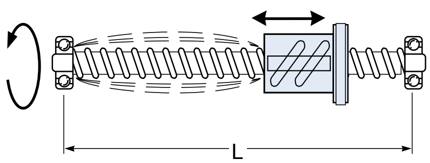
In a vertical application, the weight of the load is the weight that the screw must move. However, in a vertical application the load always rests on one side of the ball groove. Therefore the life requirement must be doubled to account for using just half of the ball groove. In our example above, the life would be 6.048 million inches of life.

The remainder of the steps remain the same. Using the chart on page 12, find the point where the 2700 pound load line crosses the 6 million inches of life line. This point is below the line including the R1501, RRH1501, R1520, RH1520 and R1547. Each of these can be selected.

Step 3.
Verify safe speed

The three factors that determine the safe speed of a ball bearing screw are:

A. Screw diameter
B. Screw length
C. Rigidity of end mountings



A small diameter, long length screw operating at very high speed could develop severe vibrations. Normally, this is not a problem, but should always be checked .

$$\text{RPM} = \frac{\text{travel rate (inches/minute)}}{\text{lead (inches/revolution)}}$$

If safe speed is a concern, first use the most rigid end mounting arrangement. Secondly, use a larger diameter screw.

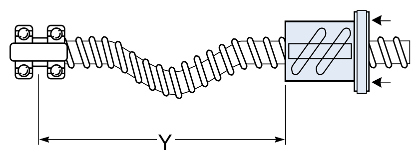
Engineering curves for critical speed comparisons of all models can be found on page 14–15.

Step 4.
Verify safe compression load

The three factors that determine the safe compression load of a given diameter ball bearing screw are:

A. Length between load point and end bearing
B. Load
C. Rigidity of end mountings

If a sufficiently heavy load is applied to a long ball bearing screw it could buckle. The easiest solution to this problem is to use the most rigid end mounting. The next step is to select a larger diameter screw.

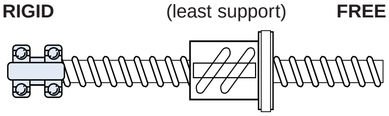


Engineering curves for compression load comparisons of all models can be found on page 16–17.

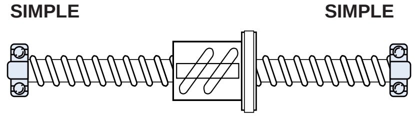
End mounting bearing supports

Four combinations of bearing supports are used throughout this catalog for selection purposes. They are:

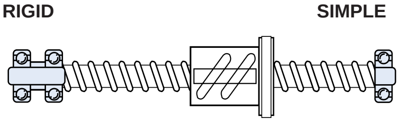
RIGID (least support) **FREE**



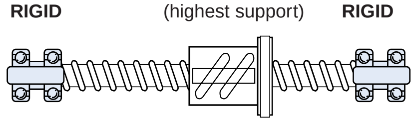
SIMPLE **SIMPLE**



RIGID **SIMPLE**



RIGID (highest support) **RIGID**



See pages 29–31 for more information on end journals and bearing supports.

Other considerations

In selecting a ball bearing screw, many factors such as load, length, bearing supports, life, speed, etc., are interrelated. Changing one factor often forces the designer to change another. The selection process consists largely of balancing these factors to arrive at the optimum design.

An example of the interrelationship of design factors is fine lead vs. coarse lead. A fine lead provides better positioning sensitivity and a lower drive torque, but it also results in higher rotary speed. A coarse lead results in lower rotary speed, but requires a higher drive torque which may require a larger motor and related drive components. The chart below presents the effect of change in parameter on common ball bearing screw characteristics.

Increase	Result
Screw Length	Critical Speed decreases Compression load decreases
Screw Diameter	Critical speed increases Inertia increases Compression load increases
Lead	Drive torque increases Angular velocity decreases
End mounting Rigidity	Critical speed increases Compression load increases
Load	Life decreases
Preload	Positioning accuracy increases System stiffness increases Drag torque increases

Selection Factors
Load/Life

In at least 90% of all the applications the only factor to be determined is the desired inches of travel for a stated load. Once this is known, selection of the proper size ball bearing screw can be made from various available models.

These load-life relationships are analogous to the B_{10} Rating common in the ball bearing industry. Basic load rating is at 1,000,000 inches. The relationship of load to life is an inverse cube ratio. For example, reducing the load by 1/2 increases life 8 times. Doubling the load decreases life to 1/8 the original expectation.

Load/Life Curves

Once you have established the design life objective at the operating load, you can use the engineering curves below which show the load/life relationship of all standard models. The load sets the initial consideration; a certain load must be moved a certain distance for the expected life of the machine. As a rule of thumb, start the selection process by choosing the smallest diameter screw that will handle the load/life requirement. Then verify that the screw selected will handle the compression load and critical speed. If the screw selected is borderline, go to the next largest diameter. Remember that the more rigid the end mounting bearing supports the more a given screw can tolerate in terms of speed and compression loads.

All loads are axial. Loads imparting side or torsional forces will reduce rated life.

Shaft speeds resulting in screw surface speeds above 8,000 IPM will also reduce rated life. The lines on the critical speed chart (page 14) represent the 8000 IPM maximum screw surface speed. The dashed lines exceed this value.

If the load varies, apply the following formula to determine average load:

$$P_{rms} = \sqrt[3]{\frac{\%(P_1)^3 + \%(P_2)^3 + \%(P_3)^3 + \ldots \%(P_n)^3}{100\%}}$$

Where:

P_{rms} = Equivalent load

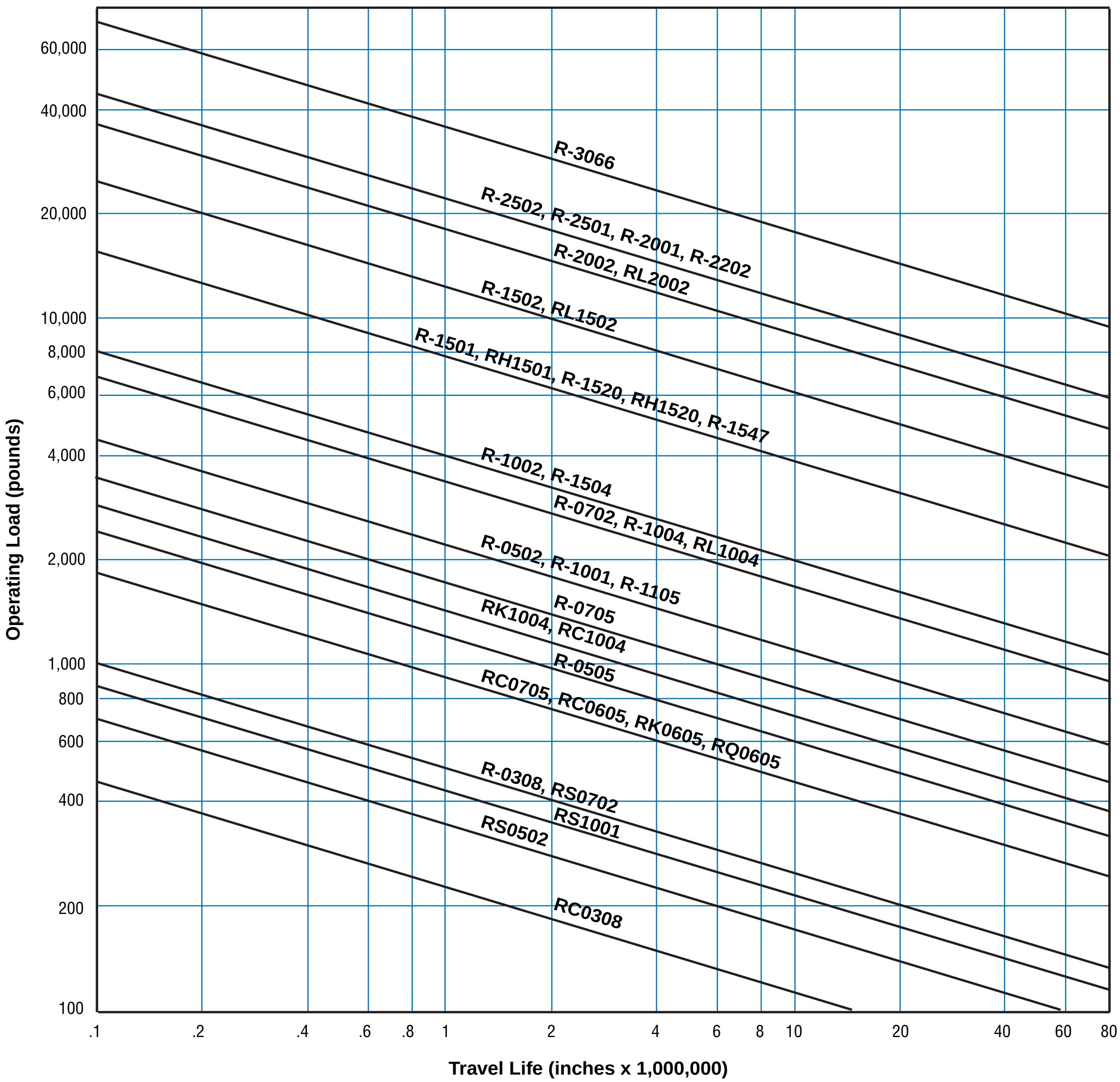
% = Percent of Stroke or Cycle at P_n

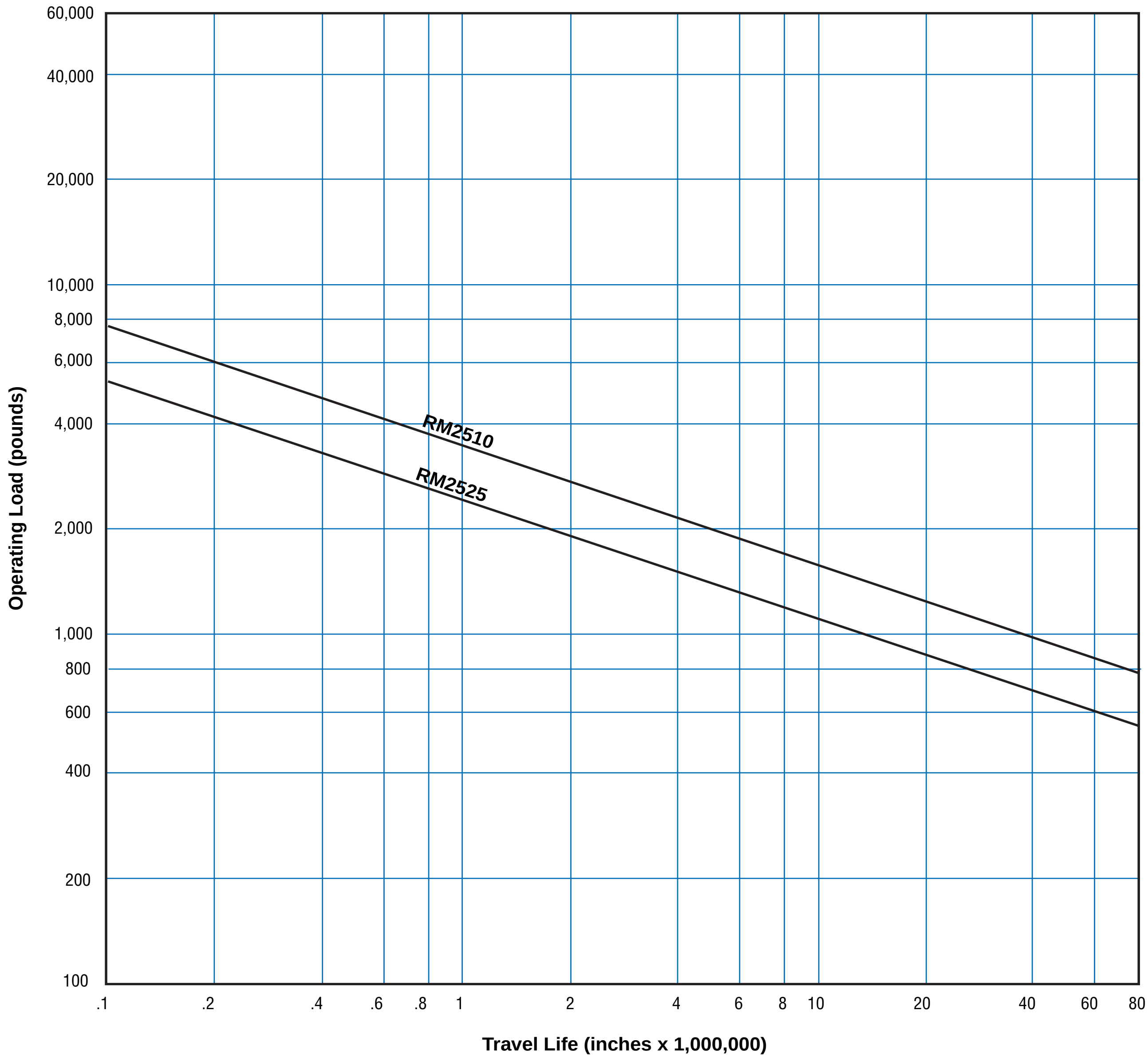
P_n = Increment of Load

How to use the graph

1. Determine the desired life objective at the operating load.
2. Select the proper size ball bearing screw on or to the right of the intersecting point.

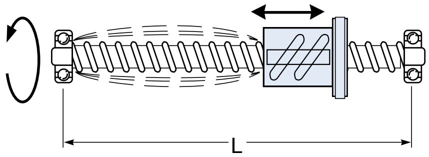
Series R




60,000
40,000
20,000
10,000
8,000
6,000
4,000
2,000
1,000
800
600
400
200
100
Operating Load (pounds)
RM2510
RM2525
.1
.2
.4
.6
.8
1
2
4
6
8
10
20
40
60
80
Travel Life (inches x 1,000,000)

Selection Factors
Critical Speed

After the load/life selection step has been completed, the model screw selected must be verified as being capable of handling the speed required.



The graph shows the critical speed as a function of the unsupported length and end fixity as determined from the following formula:

$$N = C_S \times 4.76 \times 10^6 \times \frac{D}{L^2}$$

$$N_S = N \times F_S$$

Where—

N = critical speed (RPM)

N_S = critical speed with safety factor

D = mean diameter = $\frac{\text{Major Dia.} + \text{Minor Dia.}}{2}$

L = length between bearing supports (in.)

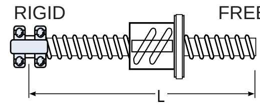
F_S = factor of safety (.80 maximum)

C_S = end fixity factor

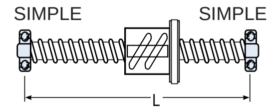
.36 one end rigid, one end free
1.00 both ends simple
1.47 one end rigid, one end simple
2.23 both ends rigid

Bearing supports

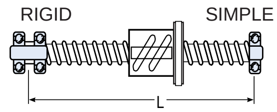
(C_S = .36)



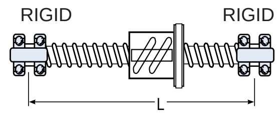
(C_S = 1.00)



(C_S = 1.47)



(C_S = 2.23)



How to use the graph

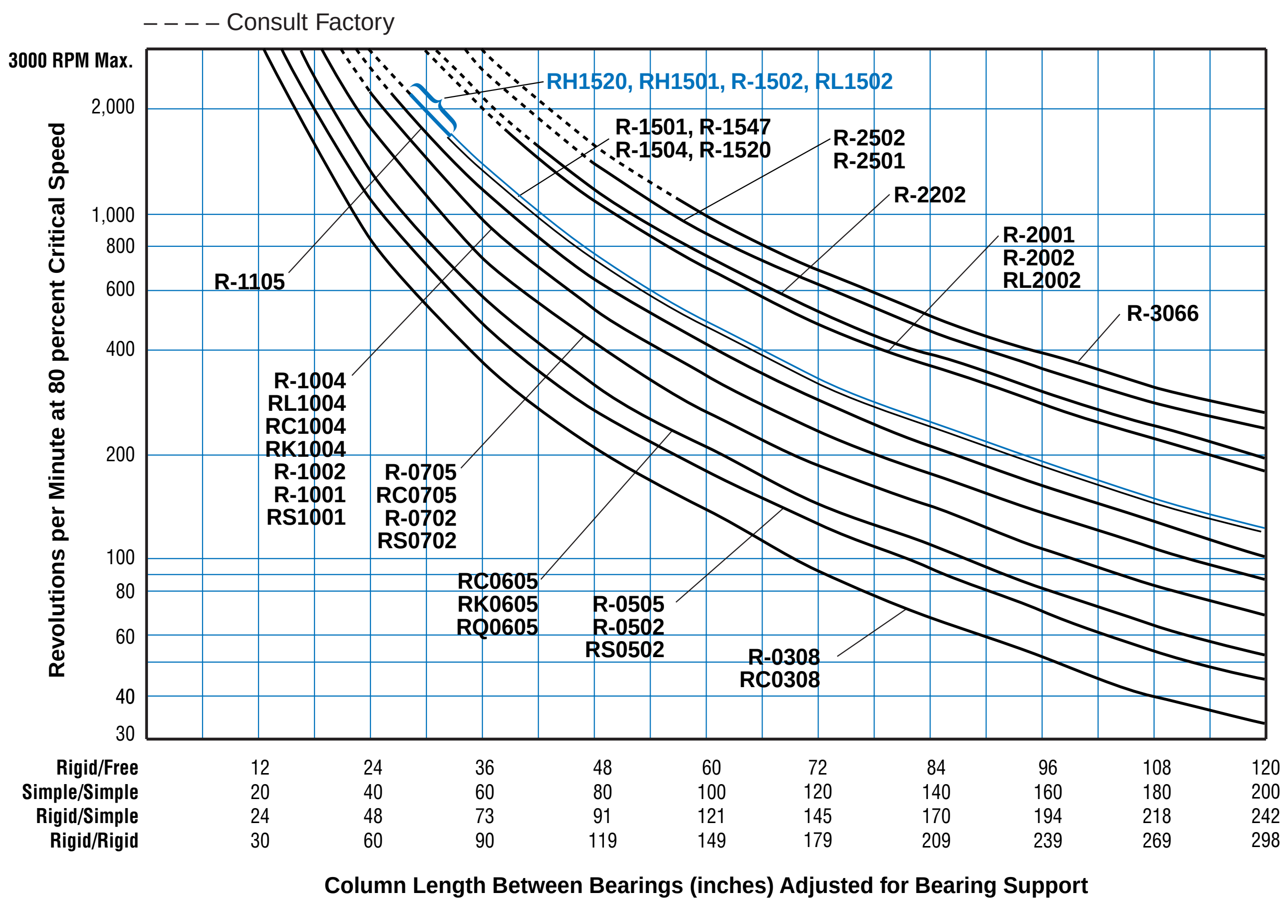
1. Determine end fixity (support bearing arrangement).
2. Determine the maximum length between bearings.
3. Read up vertically on the graph to the curves for the various size ball bearing screws.
4. Select the smallest size ball bearing screw that will operate within the safe speed shown at the intersection with the horizontal speed line.
5. Note that higher safe speeds and/or longer lengths can be accommodated by using more rigid bearing supports, or if necessary, a larger ball bearing screw.

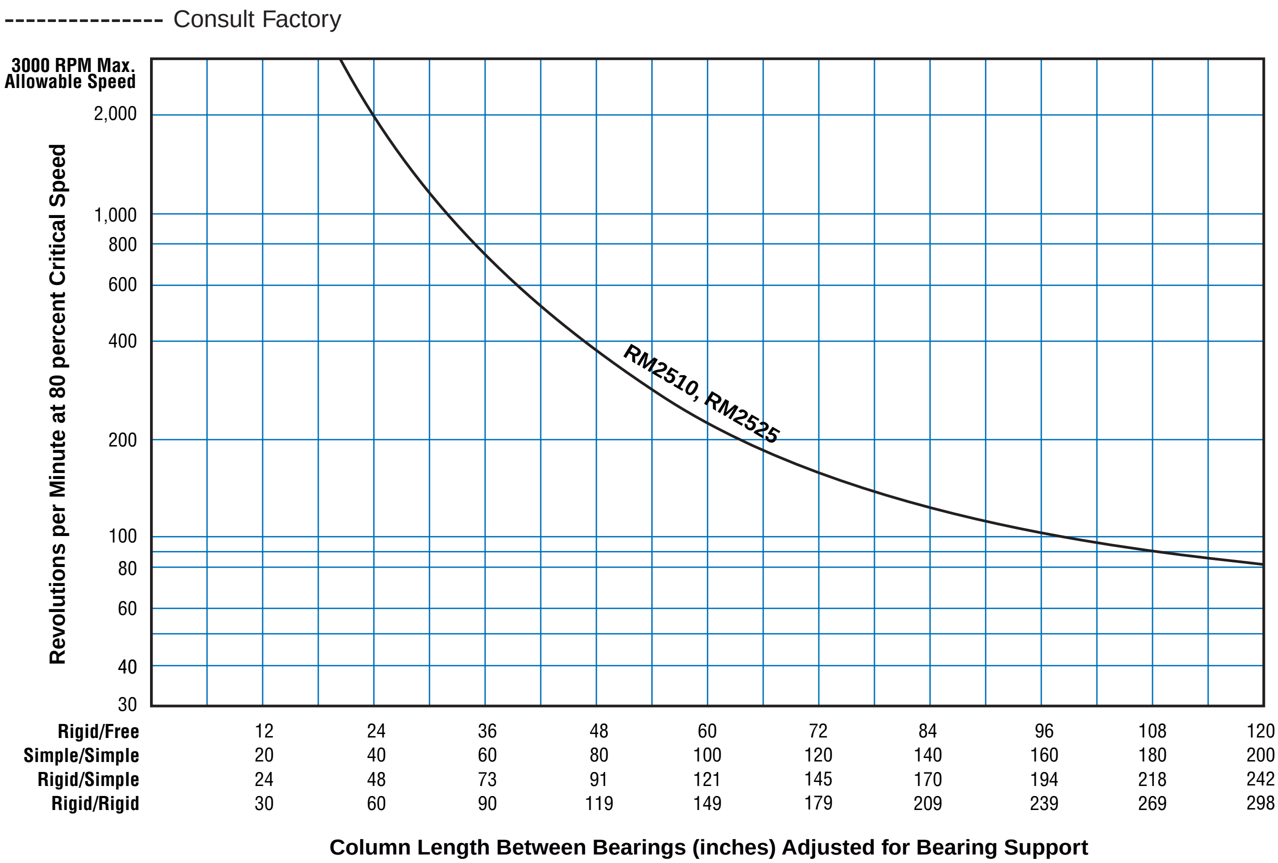
Angular Velocity

$$\text{RPM} = \frac{\text{Velocity (inches/min.)}}{\text{Lead (inches/rev.)}}$$

Acceleration/deceleration times below .10 seconds, please consult factory.

Series R

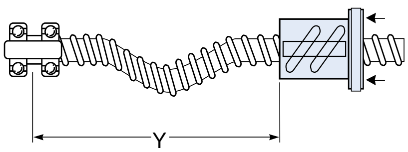




Acceleration/deceleration: For acceleration or deceleration rates faster than .10 seconds, please consult factory.

Selection Factors
Compression Loads

If the screw is subjected to a tension load, (a load that tends to stretch the screw) then check the maximum static load capacity. If the screw is subjected to a compression load (a load that tends to buckle the screw), then the compression load capacity must be verified.



The graph shows the compression load as a function of the unsupported length and end fixity as determined from the following formula:

$$P_{cr} = C_c \times 14.05 \times 10^6 \times \frac{D^4}{Y^2}$$

$$P_{safe} = P_{cr} \times F_s$$

Where–

P_{cr} = critical Euler load, lbs.

P_{safe} = maximum safe load, lbs.

D = minor diameter, inches

Y = unsupported length, inches

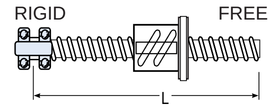
F_s = factor of safety (.80 maximum)

C_c = end fixity factor

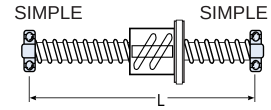
.25 one end rigid, one end free
1.00 both ends simple
2.00 one end rigid, one end simple
4.00 both ends rigid

Bearing supports

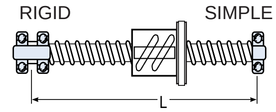
(C_c = .25)



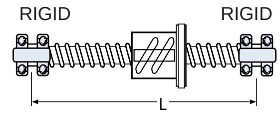
(C_c = 1.00)



(C_c = 2.00)



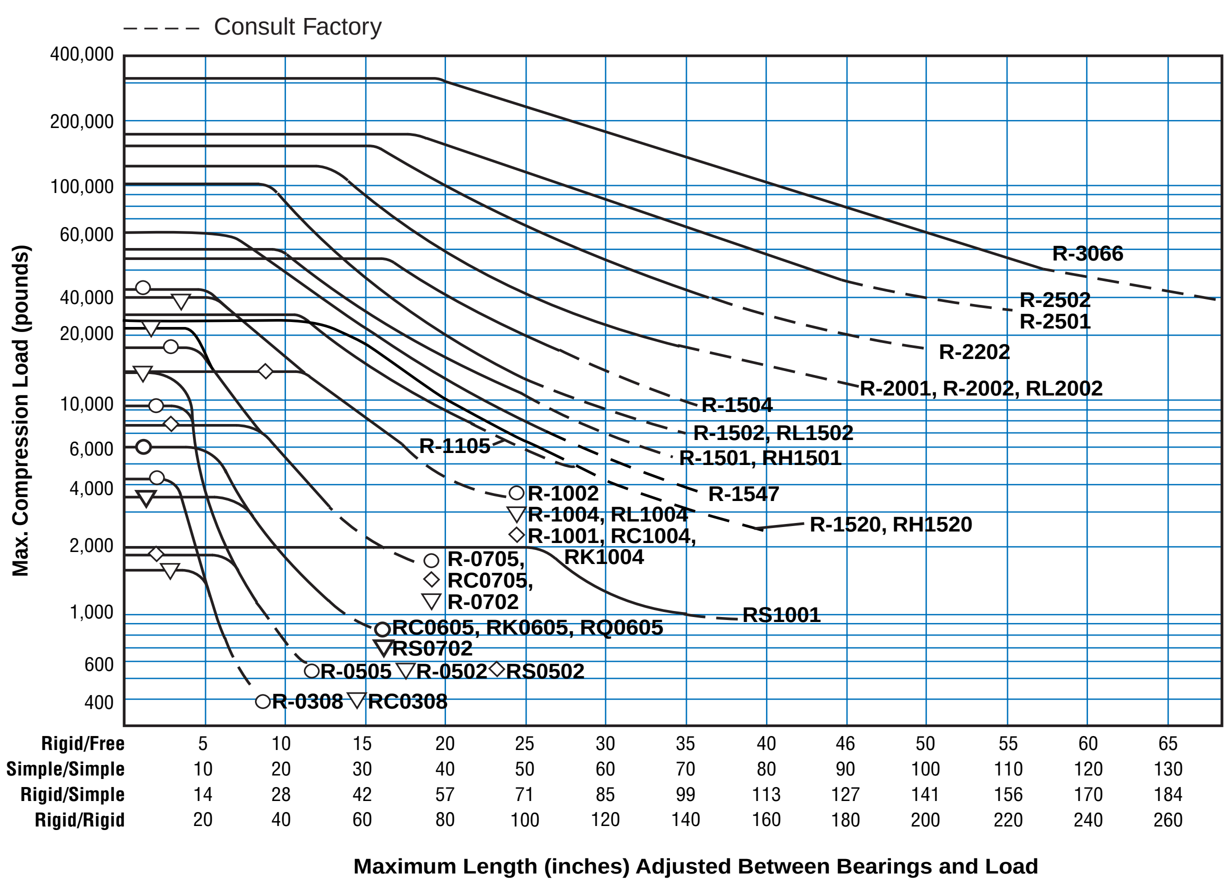
(C_c = 4.00)

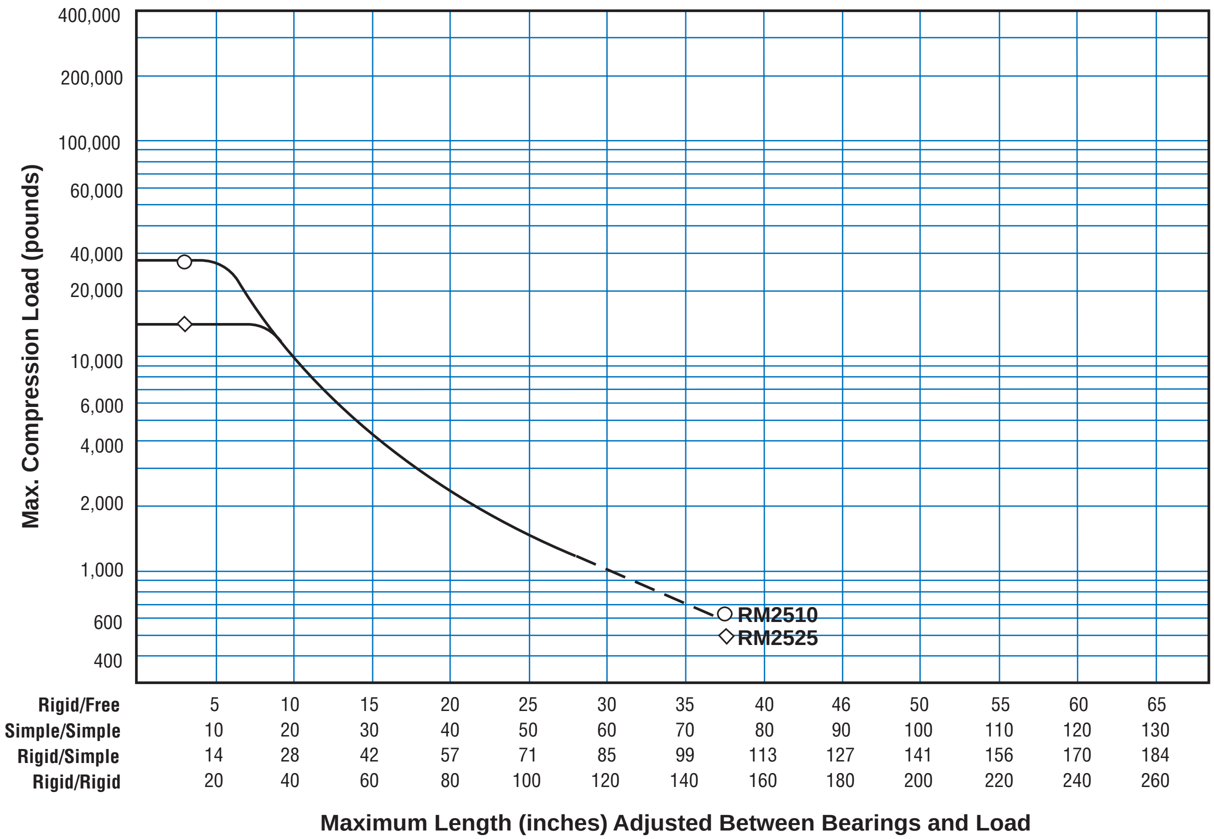


How to use the graph

1. Determine the maximum compression load in pounds.
2. Determine the unsupported length in inches.
3. Determine end fixity (support bearing arrangement).
4. Select the proper size ball bearing screw on or to the right of the intersecting point.

Series R

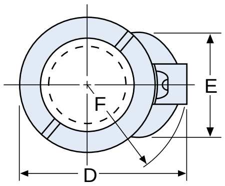




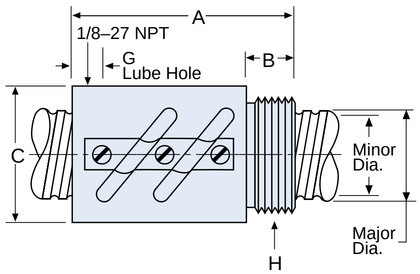
Max. Compression Load (pounds)
400,000
200,000
100,000
60,000
40,000
20,000
10,000
6,000
4,000
2,000
1,000
600
400
RM2510
RM2525
Rigid/Free
Simple/Simple
Rigid/Simple
Rigid/Rigid
5 10 15 20 25 30 35 40 46 50 55 60 65
10 20 30 40 50 60 70 80 90 100 110 120 130
14 28 42 57 71 85 99 113 127 141 156 170 184
20 40 60 80 100 120 140 160 180 200 220 240 260
Maximum Length (inches) Adjusted Between Bearings and Load

Dimensions
Series R

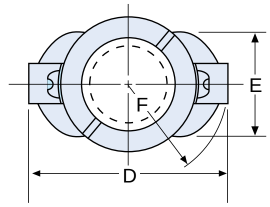
Ball Nuts

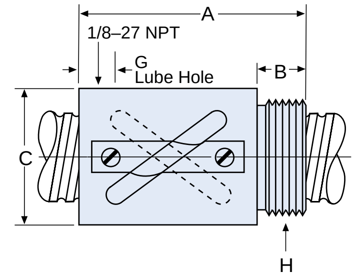


Type A, C & D

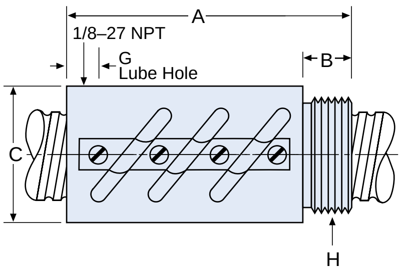


Type A

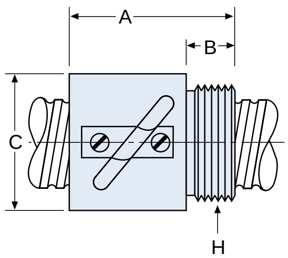




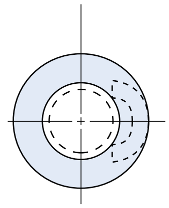
Type B

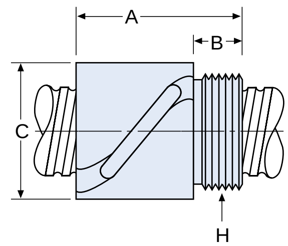


Type C



Type D





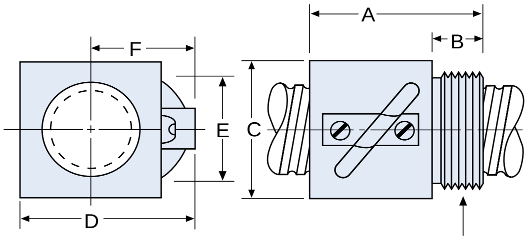
Type E

NOTE: Lube hole is 1/8 - 27 NPT tapped hole on R-1502, R-1520 and above

Model No.	Max. Major Screw Dia.	Minor Dia. Ref.	Ball Bearing Dia.	Screw Inertia/in. (oz.-in.^{2})	Lead	Max.* Standard Length	Weight (lb.)	RH LH	No. of Bearings	No. of Circuits	No. of Starts	Turns per Circuit	Nut Type	Weight (lb.)	A Max	B Max	C Max
R-0308	.380	.313	.078	.006	.125	72''	2	RH	108	2	1	2.5	A	.25	1.89	.317	.786
RC0308	.380	.313	.078	.006	.125	72''	2	RH	52	1	1	2.5	E	.25	1.01	.330	.830
R-0505	.510	.405	.125	.019	.200	72''	4	RH	96	2	1	2.5	A	.75	2.76	.390	1.067
R-0502	.510	.405	.125	.019	.500	72''	4	RH	146	2	2	3.5	B	.5	2.76	.390	1.070
RS0502	.513	.405	.125	.019	.500	72''	4	RH	146	2	2	3.5	B	.5	2.76	.390	1.070
RC0605	.610	.503	.125	.042	.200	72''	5.5	RH	70	1	1	3.5	D	.5	1.72	.505	1.130
RK0605	.610	.503	.125	.042	.200	72''	5.5	LH	70	1	1	3.5	D	.5	1.72	.505	1.130
RQ0605	.610	.503	.125	.042	.200	72''	5.5	RH	70	1	1	3.5	F	.5	1.72	.505	1.005
R-0705	.765	.655	.125	.112	.200	72''	8.5	RH	174	2	1	3.5	A	1	2.89	.505	1.317
RC0705	.765	.655	.125	.112	.200	72''	8.5	RH	84	1	1	3.5	D	1	1.89	.505	1.317
R-0702	.765	.629	.156	.104	.500	72''	8.5	RH	157	2	2	3.5	B	1	2.94	.505	1.317
RS0702	.765	.629	.156	.104	.500	72''	8.5	RH	157	2	2	3.5	B	1	2.94	.505	1.317
R-1004	.985	.836	.156	.302	.250	144''	28	RH	176	2	1	3.5	A	1.25	3.14	.630	1.692
RL1004	.985	.836	.156	.302	.250	144''	28	LH	176	2	1	3.5	A	1.25	3.14	.630	1.692
RC1004	.985	.836	.156	.302	.250	144''	28	RH	86	1	1	3.5	D	1	2.36	.630	1.692
RK1004	.985	.836	.156	.302	.250	144''	28	LH	86	1	1	3.5	D	1	2.36	.630	1.692
R-1002	1.015	.879	.156	.354	.500	144''	31	RH	194	2	2	3.5	B	1.25	3.13	.630	1.692
R-1001	.985	.836	.156	.302	1.000	144''	28	RH	107	2	4	1.5	B	1.25	3.10	.605	1.692
RS1001	.985	.836	.156	.302	1.000	144''	28	RH	107	2	4	1.5	B	1.25	3.10	.605	1.692
R-1105	1.130	1.020	.125	.587	.200	144''	38	RH	251	2	1	3.5	A	1	2.51	.485	1.692
R-1520	1.435	1.210	.281	1.345	2.000	144"	67	RH	96	2	4	1.5	B	4.5	5.26	1.005	2.621
RH1520	1.435	1.210	.281	1.345	2.000	144"	67	RH	96	2	4	1.5	B	4.5	5.26	1.005	2.621
R-1547	1.415	1.150	.344	1.126	.473	144"	67	RH	92	2	1	2.5	B	4	4.32	.875	2.621
R-1504	1.515	1.379	.156	1.928	.250	144''	67	RH	263	2	1	3.5	A	1.5	3.26	.760	2.098
R-1502	1.535	1.265	.312	1.690	.500	144''	67	RH	140	2	1	3.5	A	5.25	5.59	.755	2.630
RL1502	1.535	1.265	.312	1.690	.500	144''	67	LH	140	2	1	3.5	A	5.25	5.59	.755	2.630
R-1501	1.480	1.143	.344	1.301	1.000	144''	67	RH	68	2	2	1.5	B	3.25	3.65	1.010	2.630
RH1501	1.480	1.143	.344	1.301	1.000	144"	67	RH	68	2	2	1.5	B	3.25	3.65	1.010	2.630
R-2002	2.045	1.723	.375	5.541	.500	144''	117	RH	150	2	1	3.5	A	8	6.41	1.505	3.255
RL2002	2.045	1.723	.375	5.541	.500	144''	117	LH	150	2	1	3.5	A	8	6.41	1.505	3.255
R-2001	2.045	1.723	.375	5.541	1.000	144''	117	RH	157	2	2	3.5	B	8	6.41	1.505	3.255
R-2202	2.180	1.868	.375	7.381	.500	144''	140	RH	170	2	1	3.5	A	8.5	6.71	1.570	3.380
R-2502	2.545	2.222	.375	14.195	.500	144''	180	RH	184	2	1	3.5	A	13	6.78	1.755	4.005
R-2501	2.545	2.222	.375	14.195	1.000	144''	180	RH	194	2	2	3.5	B	13	6.78	1.755	4.005
R-3066	2.950	2.483	.500	23.951	.660	144''	220	RH	175	3	1	2.5	C	26	9.35	2.010	4.755

* Longer lengths available.

Ball Nuts



Type F

D Max	E Max	F Max	G Max	H "V" Threads
.915	.468	.55R	—	11/16-24 UNEF-2A
.830	—	—	—	11/16-24 UNEF-2A
1.339	.665	.85R	—	15/16-16 UN-2A
1.630	.667	.86R	—	15/16-16 UN-2A
1.630	.667	.83R	—	15/16-16 UN-2A
1.360	.787	.80R	—	15/16-16 UN-2A
1.357	.787	.80R	—	15/16-16 UN-2A
1.300	.797	.80R	—	15/16-16 UN-2A
1.521	.917	.94R	—	1.173-18-UNS-2A
1.550	.959	.90R	—	1.173-18-UNS-2A
1.984	.983	1.06R	—	1 1/4-16 UN-2A
1.984	.983	1.06R	—	1 1/4-16 UN-2A
1.887	1.204	1.06R	—	1 9/16-18 UNEF-2A
1.887	1.204	1.06R	—	1 9/16-18 UNEF-2A
1.913	1.185	1.09R	—	1 9/16-18 UNEF-2A
1.913	1.185	1.09R	—	1 9/16-18 UNEF-2A
1.882	1.191	1.12R	—	1 9/16-18 UNEF-2A
2.172	1.200	1.17R	—	1 9/16-18 UNEF-2A
2.172	1.199	1.10R	—	1 9/16-18 UNEF-2A
1.963	1.281	1.22R	—	1 5/8-20 UN-2A
3.400	1.576	1.68R	.500	2 1/4-20 UN-2A
3.400	1.576	1.68R	.500	2 1/4-20 UN-2A
2.909	1.916	1.61R	—	2.548-18 NS-3
2.427	1.733	1.53R	—	1.967-18 UNS-2A
3.161	1.565	1.89R	.460	2.360-18 UNS-2A
3.161	1.565	1.89R	.460	2.360-18 UNS-2A
3.696	1.737	1.96R	—	2 1/4-20 UN-2A
3.696	1.737	1.96R	—	2 1/4-20 UN-2A
3.861	2.010	2.27R	.500	3-12 UN-2A
3.861	2.010	2.27R	.500	3-12 UN-2A
4.460	2.330	2.29R	.500	3-12 UN-2A
3.995	2.545	2.48R	.500	3.137-12 UNS-2A
4.640	2.371	2.77R	.500	3 5/8-12 UN-2A
5.274	2.381	2.66R	.500	3 5/8-12 UN-2A
5.486	3.356	3.34R	.500	4.325-12 UNS-2A

Flanges

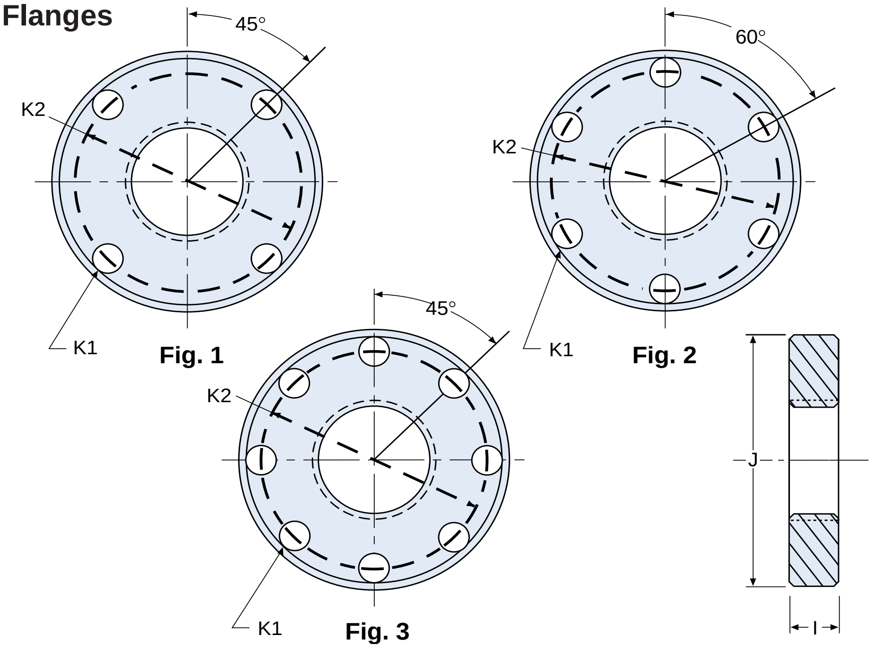
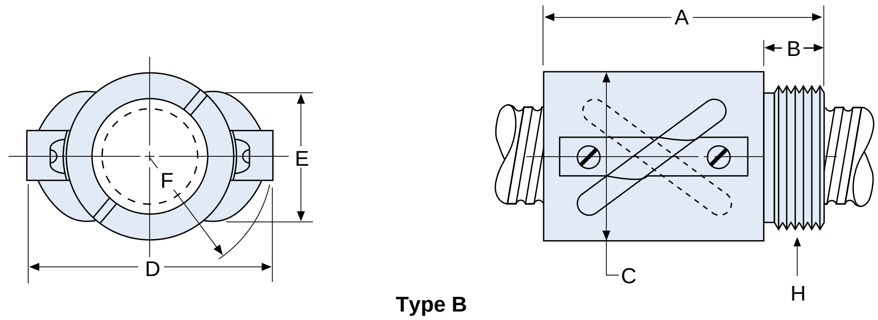


Fig. 1 **Fig. 2** **Fig. 3**

NOTE: True position of hole is .010 to "V" thread

Model No.	Flange Fig.	Weight (lb.)	I Max	J Max	K1 Hole Dia.	K2 Number of Flange Holes & Bolt Circle Dia.
R-0308	1	.25	.350	1.65	.177	(4) equally spaced on 1.24 dia. bolt circle
RC0308	1	.25	.350	1.65	.177	(4) equally spaced on 1.24 dia. bolt circle
R-0505	1	.5	.540	2.63	.281	(4) equally spaced on 2.09 dia. bolt circle
R-0502	1	.5	.540	2.63	.281	(4) equally spaced on 2.09 dia. bolt circle
RS0502	1	.5	.540	2.63	.281	(4) equally spaced on 2.09 dia. bolt circle
RC0605	1	.75	.540	2.63	.281	(4) equally spaced on 2.09 dia. bolt circle
RK0605	1	.75	.540	2.63	.281	(4) equally spaced on 2.09 dia. bolt circle
RQ0605	1	.75	.540	2.63	.281	(4) equally spaced on 2.09 dia. bolt circle
R-0705	1	.75	.540	2.63	.281	(4) equally spaced on 2.09 dia. bolt circle
RC0705	1	.75	.540	2.63	.281	(4) equally spaced on 2.09 dia. bolt circle
R-0702	1	.75	.540	2.63	.281	(4) equally spaced on 2.09 dia. bolt circle
RS0702	1	.75	.540	2.63	.281	(4) equally spaced on 2.09 dia. bolt circle
R-1004	1	1.25	.640	3.28	.281	(4) equally spaced on 2.75 dia. bolt circle
RL1004	1	1.25	.640	3.28	.281	(4) equally spaced on 2.75 dia. bolt circle
RC1004	1	1.25	.640	3.28	.281	(4) equally spaced on 2.75 dia. bolt circle
RK1004	1	1.25	.640	3.28	.281	(4) equally spaced on 2.75 dia. bolt circle
R-1002	1	1.25	.640	3.28	.281	(4) equally spaced on 2.75 dia. bolt circle
R-1001	1	1.25	.640	3.28	.281	(4) equally spaced on 2.75 dia. bolt circle
RS1001	1	1.25	.640	3.28	.281	(4) equally spaced on 2.75 dia. bolt circle
R-1105	1	1	.495	3.23	.281	(4) equally spaced on 2.702 dia. bolt circle
R-1520	1	4	1.030	4.97	.531	(4) equally spaced on 4.125 dia. bolt circle
RH1520	1	4	1.030	4.97	.531	(4) equally spaced on 4.125 dia. bolt circle
R-1547	1	4	.895	4.937	.531	(4) equally spaced on 4.062 dia. bolt circle
R-1504	1	2.75	.815	4.41	.397	(4) equally spaced on 3.50 dia. bolt circle
R-1502	1	2.5	.785	4.65	.531	(4) equally spaced on 3.875 dia. bolt circle
RL1502	1	2.5	.785	4.65	.531	(4) equally spaced on 3.875 dia. bolt circle
R-1501	1	4	1.030	4.97	.531	(4) equally spaced on 4.125 dia. bolt circle
RH1501	1	4	1.030	4.97	.531	(4) equally spaced on 4.125 dia. bolt circle
R-2002	3	5.75	1.536	5.41	.656	(8) equally spaced on 4.25 dia. bolt circle
RL2002	3	5.75	1.536	5.41	.656	(8) equally spaced on 4.25 dia. bolt circle
R-2001	3	5.75	1.536	5.41	.656	(8) equally spaced on 4.25 dia. bolt circle
R-2202	2	6	1.587	5.41	.656	(6) equally spaced on 4.375 dia. bolt circle
R-2502	3	7.75	1.785	6.03	.656	(8) equally spaced on 5.00 dia. bolt circle
R-2501	3	7.75	1.785	6.03	.656	(8) equally spaced on 5.00 dia. bolt circle
R-3066	3	14	2.025	7.41	.781	(8) equally spaced on 6.25 dia. bolt circle

Dimensions
Series RM



Type B

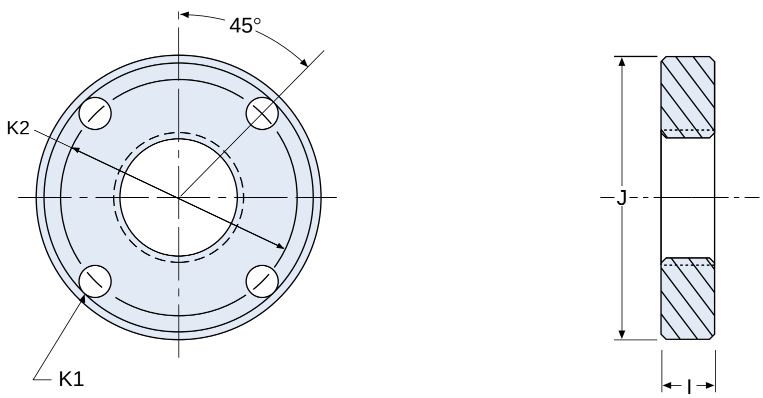
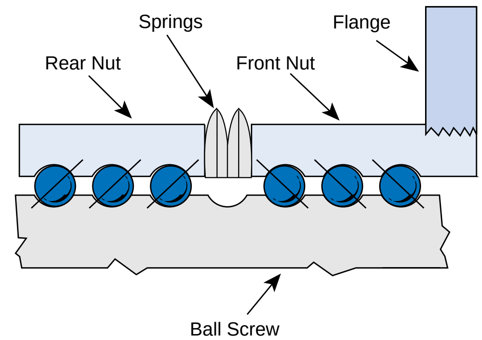


Fig. 1

Model No.	Major Screw Dia. mm	Minor Dia. Ref. mm	Lead mm	Max. Standard Length (mm)	RH LH	No. of Bearings	Size of Bearings	Nut Type	A Max.	B Max.	C Max.	D Max.	E Max.	F Max.
RM2510	24.740	21.971	10	3663	RH	193	.138	B	3.26	.610	1.692	2.133	1.013	1.083R
RM2525	24.409	21.260	25	3663	RH	95	.156	B	3.26	.610	1.692	2.197	1.044	1.175R

Model No.	Flange Fig.	H "V" Threads	I Max.	J Max.	K1 Hole Dia.(nom.)	K2 Number of Flange Holes & Bolt Circle Dia.(nom.)
RM2510	1	M40 x 1.5	.640	3.280	.281	(4) equally spaced on 2.750 dia. bolt circle
RM2525	1	M40 x 1.5	.640	3.280	.281	(4) equally spaced on 2.750 dia. bolt circle

All dimension in inches unless otherwise specified.



Cross section of preload assembly showing balls of front and rear nuts loaded in opposite directions against raceway to eliminate backlash.

When precise positional accuracy and repeatability are required, the use of Warner Linear Zero Backlash/Preload ball bearing screws may be appropriate or shall be considered. Typical applications include machine slide positioning on milling machines, CNC machines with position measurement systems, table guides for presses and X, Y, Z axis positioning devices.

Design Features

Zero Backlash/Preload ball bearing screws consist of a rolled thread screw and two standard single ball nuts joined by an adjustable preload package with springs. The resilient preload package forces the bearing balls in the front nut to ride on the opposite side of the ball raceway rather than those in the rear nut.

Preloaded ball nuts which are loaded in opposition to each other in this manner eliminate linear backlash. Under recommended conditions, Zero Backlash/Preload ball bearing screws provide high system stiffness and positive positioning in both directions.

Warner Linear preloaded ball bearing screws do not require any additional machining, and are easily adjusted to satisfy diverse load requirements. The high degree of system stiffness achieved with preloaded ball bearing screws is an important design consideration, and is frequently an advantage over hydraulic systems, which are relatively spongy.

Preload Examples

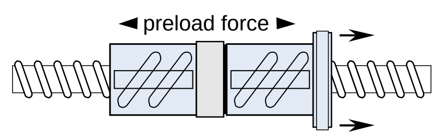
Use of preloaded ball bearing screws results in a slight reduction in overall efficiency and load capability. The three preload examples illustrate the effect of load direction and size on ball bearing screw stiffness and backlash.

The first example depicts a preload application in which the thrust load applied to the ball nut assembly will be added to the preload force setting. (Preload force is the amount of outward axial force between ball nuts.) For applications with a thrust load in this direction, the recommended preload setting is suggested. This will provide zero backlash and high stiffness with the least reduction in dynamic load. Dynamic load and preload force ratings are listed on page 23.

The second example illustrates a thrust load direction which will tend to relieve the preload force. Consequently, the preload force should always be greater than the thrust load applied on the ball nut assembly. This will ensure zero backlash and medium stiffness. The preload force can be set at any point between the recommended and maximum rating.

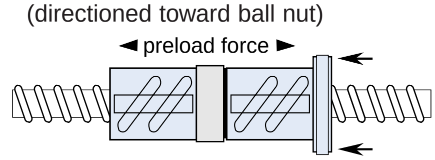
If the applied load is greater than the preload force, example three, the preload of the ball nut assembly will be negated. Ineffective backlash control and low stiffness will result. If example three is encountered a higher preload force setting or a larger ball bearing screw is recommended.

1. Any load
   (directioned away from ball load)



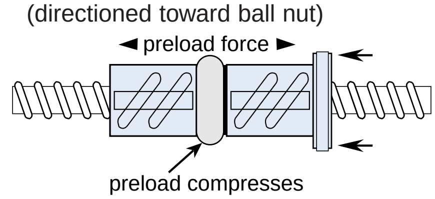
- Zero backlash
- High stiffness

2. Load less than preload force
   (directioned toward ball nut)



- Zero backlash
- Medium stiffness

3. Load greater than preload force
   (directioned toward ball nut)



- .010" maximum backlash
- Low stiffness

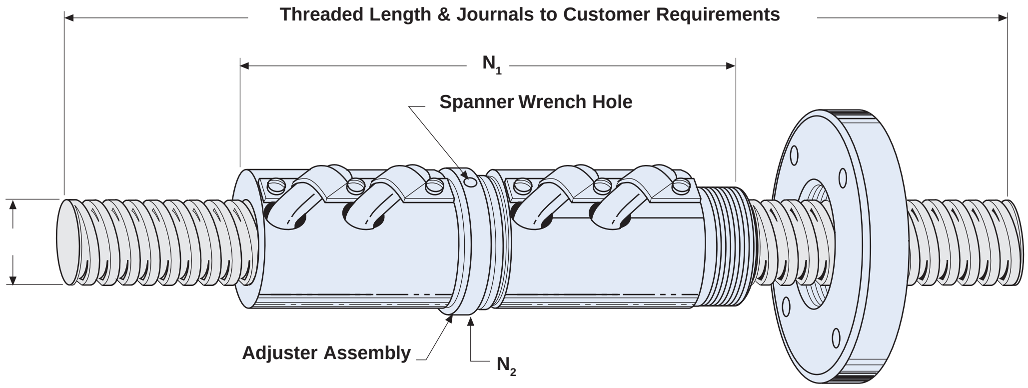
Zero Backlash/Preload Ball Bearing Screws

Preload Settings

Use of preloaded ball bearing screws results in a slight reduction of overall efficiency and load capability as explained in the three preload examples. Performance characteristics affected by preloading are drive torque, load/life and backdriving capability.

Dynamic and static load ratings are reduced by the amount of preload force applied. Thus, the resultant load capability of preloaded ball bearing screws is less than that of compatible single nut models. The recommended preload force reduces load capability by 10%. The maximum preload force setting produces a 30% reduction in load capability. Zero Backlash/Preload ball bearing screws are adjustable to any point within this range. An Installation and Technical Procedures manual, P-256, is available from Warner Linear which details the necessary installation steps and adjustment procedures.

The following chart lists the recommended and maximum load ratings for each model in addition to preload assembly dimensions. For further ball nut, screw stock and flange information, refer to the corresponding model dimensions on pages 18-19.



Model Number	Preloaded Ball Nut Part Number	Recommended Preload: Preload Force Lbs.	Recommended Preload: Dynamic Load* Lbs.	Recommended Preload: Static Load Lbs.	Maximum Preload: Preload Force Lbs.	Maximum Preload: Dynamic Load* Lbs.	Maximum Preload: Static Load Lbs.	Dimensions: Lead	Dimensions: D Max. Major Screw Dia.	Dimensions: N_1	Dimensions: N_2 Adj. Dia. Max	Dimensions: Spanner Wrench Hole Dia.(nom.)
RP0308	8103-448-004	50	450	4,200	150	350	4,100	.125	.375	4.13	1.170	.203
RP0505	8105-448-008	120	1,080	9,280	360	840	9,040	.200	.500	5.95	1.420	.203
RP0502	8105-448-009	220	1,980	13,130	660	1,540	12,690	.500	.500	6.00	1.420	.203
RD0605	8106-448-015	80	720	6,070	240	560	5,910	.200	.625	3.55	1.130	.203
RE0605	8106-448-019	80	720	6,070	240	560	5,910	.200	.625	3.55	1.130	.203
RP0705	8107-448-012	190	1,710	18,610	570	1,330	18,230	.200	.750	6.08	1.670	.266
RP0702	8107-448-011	345	3,150	23,855	1,035	2,415	23,165	.500	.750	6.18	1.670	.266
RP1004	8110-448-017	335	3,015	30,415	1,005	2,345	29,745	.250	1.000	6.64	2.070	.266
RT1004	8110-448-018	335	3,015	30,415	1,005	2,345	29,745	.250	1.000	6.64	2.070	.266
RP1002	8110-448-016	395	3,555	31,905	1,185	2,765	31,115	.500	1.000	6.64	2.070	.266
RP1001	8110-448-015	225	2,025	13,525	675	1,575	13,075	1.000	1.000	6.52	2.070	.266
RP1105	8111-448-004	240	2,160	27,310	720	1,680	26,830	.200	1.125	5.50	2.070	.266
RP1520	8115-448-059	760	6,840	28,240	2,280	5,320	26,720	2.000	1.435	11.25	3.114	.437
RJ1520	8115-448-060	760	6,840	28,240	2,280	5,320	26,720	2.000	1.435	11.25	3.114	.437
RP1504	8115-448-012	405	3,645	47,045	1,215	2,835	46,235	.250	1.500	7.00	2.420	.437
RP1502	8115-448-006	1,290	11,610	101,010	3,870	9,030	98,430	.500	1.500	12.10	3.114	.437
RT1502	8115-448-007	1,240	11,610	101,010	3,870	9,030	98,430	.500	1.500	12.10	3.114	.437
RP1501	8115-448-011	825	7,425	46,975	2,475	5,775	45,325	1.000	1.500	8.16	3.114	.437
RP2002	8120-448-006	1,915	17,235	154,635	5,245	13,405	150,805	.500	2.000	13.92	3.710	.500
RT2002	8120-448-007	1,915	17,235	154,635	5,245	13,405	150,805	.500	2.000	13.92	3.710	.500
RP2001	8120-448-023	2,195	19,755	152,605	6,585	15,365	148,215	1.000	2.000	13.90	3.710	.500
RP2202	8122-448-003	1,930	17,370	159,220	5,790	13,510	155,360	.500	2.250	14.22	4.010	.437
RP2502	8125-448-006	2,120	19,080	183,880	6,360	14,840	179,640	.500	2.500	14.79	4.510	.437
RP2501	8125-448-004	2,690	24,210	199,910	8,070	18,830	194,530	1.000	2.500	14.79	4.600	.437
RP3066	8130-448-004	3,800	34,200	320,150	11,400	26,600	312,550	.666	3.000	19.92	5.010	.500

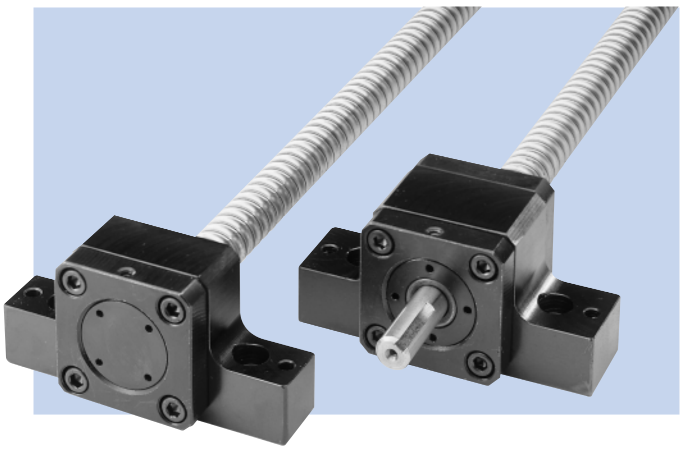
*Note: Preload (RP series) ratings shown are reduced from standard (R Series) ratings by amount of the preload.

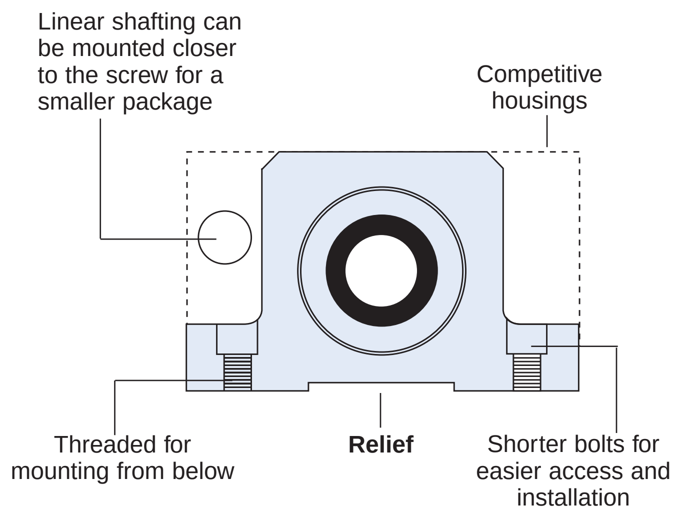
Ball Screw End Mounting Supports

Warner Linear now has a line of pre-engineered support bearings for use with our ball bearing screws. Bearing supports are available as a base mount (for mounting to a surface) or flange mount (for mounting through a surface).

Base Mount

Base mount supports are used to mount a ball screw parallel to a surface. These are relatively easy to install on a single flat surface. The mounting holes are counterbored and tapped for threading into or bolting through the support for added design versatility and ease of installation.





The base mounts are relieved on the bottom to allow compliance to uneven surfaces. The unique shape of the base mount units allows the use of shorter bolts for faster and easier installation. It also allows either for the linear bearings to be mounted closer to the ball screw or for more clearance for the carriage attached to the ball nut.

Flange Mount

Flange mount supports are used to mount a ball screw perpendicular to a surface. This mounting arrangement requires two parallel mounting surfaces for installing the ball screw with either the screw or shaft extension passing through the mounting surface.

Order Information

Selection of the support bearing is done during ball screw sizing and selection. At that time the diameter of the screw is determined along with the type of bearing – E, F, or H for each end. The only factor left to select is either base or flange mount for each end and if it is the driven or non-driven end. The part numbers for each support are listed in the table below. For assembled units, contact the factory. For ball screw sizing and selection refer to pages 10–17.

66 X O X - X X

Ball screw support

Flange or base mount
- Flange=2
- Base=4

Diameter of screw
- 0 = .6250
- 1 = .7500
- 2 = 1.000
- 3 = 1.125
- 4 = 1.500
- 5 = 2.000

Type of bearing
- E=simple
- F=duplex
- H=spaced duplex

Driven or non-driven
- Driven=blank
- Non-driven=1

Selection

Bearing Supports

The new bearing supports have counterbored and tapped mounting holes for threading into or bolting through the mounting surface for added versatility. Each unit is sealed and pre-lubricated to protect against contamination and ensure smooth operation.

The (3) types of bearing supports, E, F, H furnish the four most common ball screw mounting configurations: Rigid-Free, Simple-Simple, Simple-Rigid, and Rigid-Rigid.

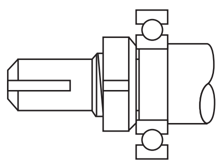
Mounting Arrangements

The bearings support arrangement is one of the most important design parameters of a ball screw system because it affects critical speed, load capacities and overall system stiffness.

Whenever possible the ball screw should be fixed at both ends using bi-directional thrust bearings and held in neither tension nor compression for maximum stiffness.

If the ball screw must be held under stress, tension is always more desirable than compression.

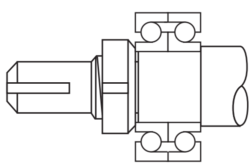
All versions of the ball screw support bearings are available in sizes for screws from 5/8" (16mm) to 2" (50mm) in diameter. Larger sizes are available upon request. Bearing supports can be ordered separately or already mounted to the ball screw when shipped.



Type E

Simple Single Bearings

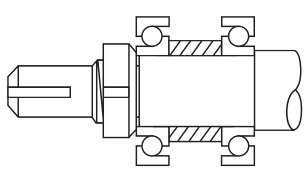
Type E bearing supports are designed for applications that require a simple, single bearing mount arrangement for radial support.



Type F

Simple Duplex Bearings

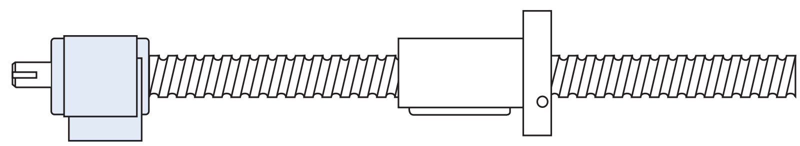
Type F supports feature a pair of back-to-back bi-directional angular contact bearings to control end play and provide simple, radial and axial support.

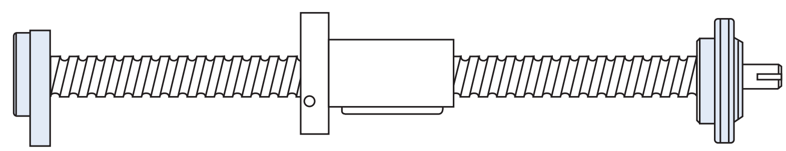


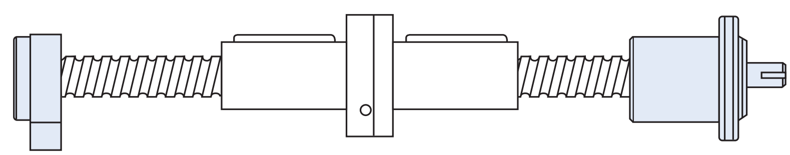
Type H

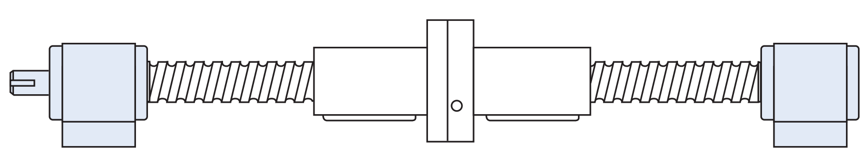
Spaced Multiple Bearings

Type H supports are designed for applications that require rigid support at one or both ends for the ball screw. A pair of spaced bi-directional angular contact bearings to provide maximum axial load capacity and prevent radial or axial movement are used.



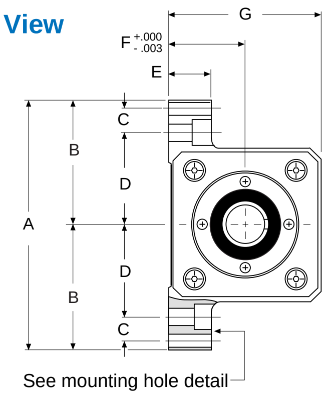




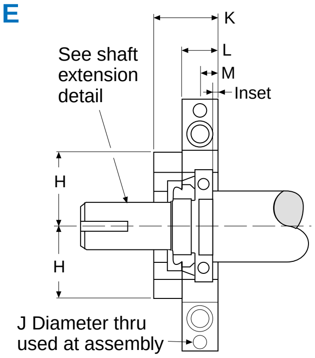


Base Mount

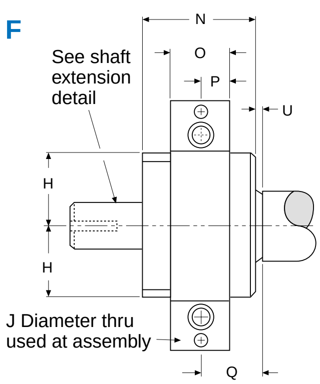
End View



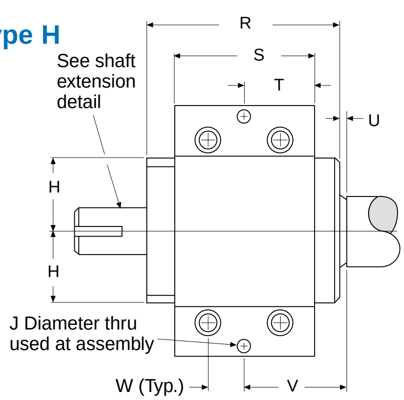
Type E



Type F



Type H



Dimensions inches (mm)

Driven End	Non-Driven End	Screw Diameter	A	B	C	D	E	F	G
66-400-X*	66-400-X1*	**0.625**	3.625	1.813	0.438	1.188	0.625	0.938 +.000/-.003	1.813
66-401-X*	66-401-X1*	**0.750**	4.125	2.063	0.500	1.313	0.750	1.125 +.000/-.003	2.125
66-402-X*	66-402-X1*	**1.000**	4.875	2.438	0.563	1.625	0.875	1.500 +.000/-.003	2.625
66-403-X*	66-403-X1*	**1.125**	5.250	2.625	0.563	1.750	0.875	1.500 +.000/-.003	2.625
66-404-X*	66-404-X1*	**1.500**	6.375	3.188	0.688	2.188	1.000	1.875 +.000/-.003	3.500
66-405-X*	66-405-X1*	**2.000**	7.500	3.750	0.500	2.875	1.500	2.500 +.000/-.003	4.750

*X=E, F, H depending on type of support selected

Driven End	Non-Driven End	Screw Diameter	H	J	K	L	M	N	O	Inset Dim.
66-400-X*	66-400-X1*	**0.625**	0.875	0.172	1.125	0.750	0.375	1.780	1.030	0.125
66-401-X*	66-401-X1*	**0.750**	1.000	0.234	1.500	1.000	0.500	2.312	1.312	0.125
66-402-X*	66-402-X1*	**1.000**	1.250	0.297	1.500	1.000	0.500	2.500	1.500	0.125
66-403-X*	66-403-X1*	**1.125**	1.250	0.297	1.813	1.188	0.594	2.875	1.625	0.188
66-404-X*	66-404-X1*	**1.500**	1.750	0.359	1.813	1.188	0.594	2.875	1.625	0.188
66-405-X*	66-405-X1*	**2.000**	2.375	0.359	2.188	1.438	0.719	3.375	1.875	0.250

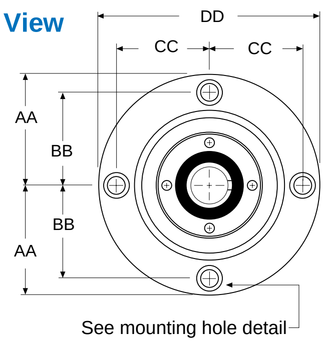
*X=E, F, H depending on type of support selected

Driven End	Non-Driven End	Screw Diameter	P	Q	R	S	T	U	V	W
66-400-X*	66-400-X1*	**0.625**	0.515	1.015	2.563	1.813	0.907	0.130	1.406	0.453
66-401-X*	66-401-X1*	**0.750**	0.656	1.281	3.375	2.375	1.188	0.130	1.813	0.594
66-402-X*	66-402-X1*	**1.000**	0.750	1.375	3.750	2.750	1.375	0.130	2.000	0.687
66-403-X*	66-403-X1*	**1.125**	0.813	1.563	4.000	2.750	1.375	0.130	2.125	0.687
66-404-X*	66-404-X1*	**1.500**	0.813	1.563	4.750	3.500	1.750	0.130	2.500	0.875
66-405-X*	66-405-X1*	**2.000**	0.938	1.813	5.750	4.250	2.125	0.130	3.000	1.063

*X=E, F, H depending on type of support selected

Flange Mount

End View

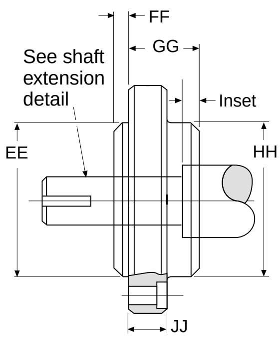


Dimensions inches (mm)

Driven End	Non-Driven End	Screw Diameter	AA	BB	CC	DD	EE	FF
66-200-X*	66-200-X1*	**0.625**	1.313	1.079	1.079	2.625	1.750/ 1.749	0.188
66-201-X*	66-201-X1*	**0.750**	1.625	1.375	1.375	3.250	2.250/ 2.249	0.250
66-202-X*	66-202-X1*	**1.000**	1.875	1.648	1.648	3.750	2.875/ 2.874	0.250
66-203-X*	66-203-X1*	**1.125**	1.875	1.648	1.648	3.750	2.875/ 2.874	0.313
66-204-X*	66-204-X1*	**1.500**	2.483	2.063	2.063	4.875	3.375/ 3.374	0.313
66-205-X*	66-205-X1*	**2.000**	3.375	2.813	2.813	6.750	4.500/ 4.499	0.375

*X=E, F, H depending on type of support selected

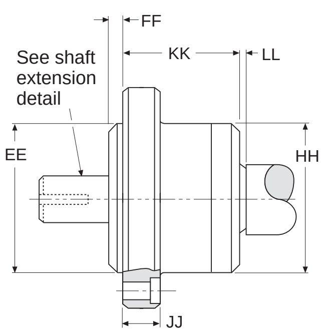
Type E



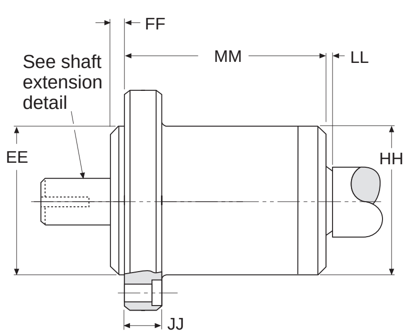
Driven End	Non-Driven End	Screw Diameter	GG	HH	JJ	KK	LL	MM	Inset Dim.
66-200-X*	66-200-X1*	**0.625**	0.937	1.750	0.750	1.592	0.130	2.375	0.125
66-201-X*	66-201-X1*	**0.750**	1.250	2.250	0.750	2.063	0.130	3.125	0.125
66-202-X*	66-202-X1*	**1.000**	1.250	2.875	1.000	2.250	0.130	3.500	0.125
66-203-X*	66-203-X1*	**1.125**	1.500	2.875	1.000	2.875	0.130	3.688	0.188
66-204-X*	66-204-X1*	**1.500**	1.500	3.375	1.000	2.563	0.130	4.438	0.188
66-205-X*	66-205-X1*	**2.000**	1.813	4.500	1.500	3.000	0.130	5.375	0.250

*X=E, F, H depending on type of support selected

Type F

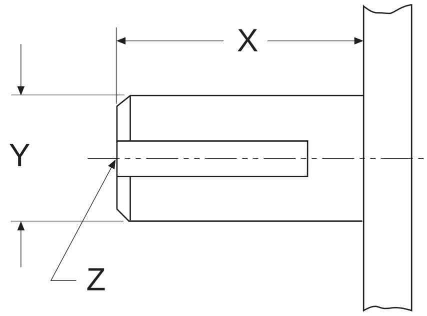


Type H



Shaft Extension (Typ.)

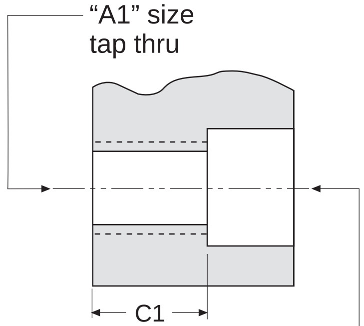
(For Base and Flange Mount)



Dimensions inches (mm)

Screw Diameter	X		Y	Z	
	H	E/F		H	E/F
0.625	1.100 (Ref)	1.100 (Ref)	.4060/ .4055	.125 sq x .625 lg key	.125 sq x .625 lg key
0.750	1.100 (Ref)	1.100 (Ref)	.5000/ .4995	.125 sq x .625 lg key	.125 sq x .625 lg key
1.000	1.250 (Ref)	1.250 (Ref)	.6250/ .6245	.187 sq x .625 lg key	.187 sq x .625 lg key
1.125	1.580 (Ref)	1.330 (Ref)	.7500/ .7495	.187 sq x 1.250 lg key	.187 sq x 1.000 lg key
1.500	1.830 (Ref)	1.330 (Ref)	1.0000/ .9995	.250 sq x 1.500 lg key	.250 sq x 1.000 lg key
2.000	2.500 (Ref)	2.000 (Ref)	1.3750/ 1.3745	.313 sq x 2.000 lg key	.313 sq x 1.500 lg key

Mounting Hole

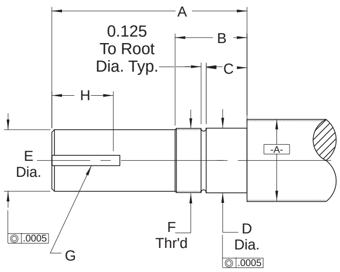


Screw Diameter	Base Mount			Flange Mount		
	A1	B1	C1	A1	B1	C1
0.625	5/16 -24	1/4 -20	0.375	5/16 -24	1/4 -20	0.500
0.750	7/16 -20	3/8 -16	0.440	5/16 -24	1/4 -20	0.500
1.000	1/2 -20	7/16 -14	0.500	5/16 -24	1/4 -20	0.750
1.125	1/2 -20	7/16 -14	0.500	5/16 -24	1/4 -20	0.750
1.500	5/8 -11	1/2 -13	0.750	7/16 -20	3/8-16	0.656
2.000	5/8 -11	1/2-13	1.000	3/4 -10	5/8 -11	1.125

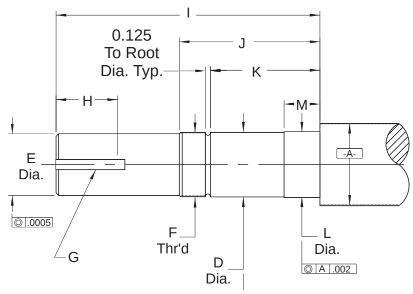
End Journals for Warner Electric Mounting Supports

Driven End

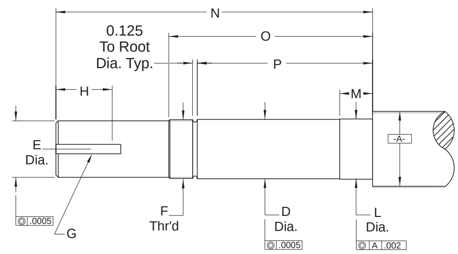
Type E



Type F

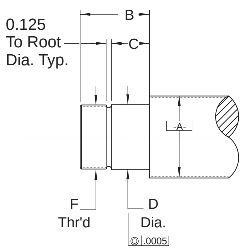


Type H

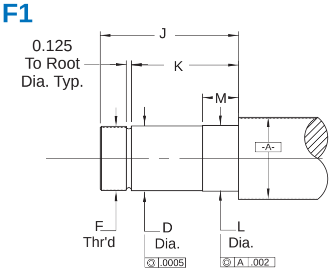


Non-Driven End

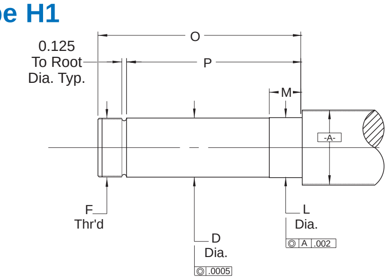
Type E1



Type F1



Type H1



Screw Diameter	Reference Number	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
0.625	R-0605 RL-0605 RM-1605A	2.10	.812	.3312	.4726 .4723	.406 .405	.469-32 THD/IN	.125	.625	3.00	1.70	1.2249	.4756 .4753	.500	3.79	2.49	2.0135
0.750	R-0705C1 R-0705 R-0702 RS-0702	2.48	.940	.4493	.5908 .5905	.500 .499	.586-32 THD/IN	.125	.625	3.54	2.08	1.5861	.6153 .6150	.625	4.60	3.22	2.7287
1.000	R-1004C1 RL-1004C1 R-1004A RL-1004A R-1002 R-1001 RM-2505A RM-2510A RM-2525A	2.63	1.040	.4887	.7877 .7873	.625 .624	.781-32 THD/IN	.187	.625	3.88	2.23	1.6649	.8122 .8119	.625	5.13	3.51	2.9641
1.125	R-1105	2.96	1.125	.5281	.9846 .9842	.750 .749	.969-32 THD/IN	.187	1.250	4.33	2.46	1.8687	1.0006 1.0003	.750	5.71	3.64	3.0495
1.500	R-1501 R-1504 R-1502 RL-1502 RM-4005A RM-4010A	2.96	1.150	.5674	1.1814 1.1810	1.000 0.999	1.17-18 THD/IN	.250	1.500	4.33	2.53	1.9473	1.2059 1.2056	.750	6.71	4.33	3.7583
2.000	R-2002 RL-2002 R-2001 RM-5010A	3.94	1.300	.6462	1.5752 1.5747	1.375 1.374	1.56-18 THD/IN	.312	2.000	5.50	2.88	2.2299	1.5997 1.5994	.875	8.38	5.31	4.6708

*X=E, F, H depending on type of support selected

End Journals
Series R & RM

Standard end journals represent typical end journal designs which are most compatible with Warner Linear ball bearing screws. Standard ends can be used to provide simple or rigid end support. Refer to the illustrations at right for acceptable end mounting arrangements. The appropriate bearings, keys, lock washers and lock nuts used in conjunction with standard ends are listed in the chart on page 31. End Journals for Warner Linear mounting supports are on page 29.

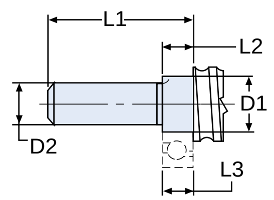
Special Ends

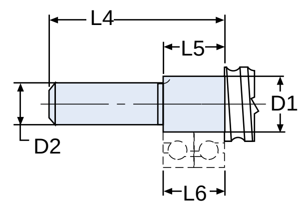
Applications requiring custom end journal modifications can be quickly and accurately machined by Warner Linear. A service manual and machining guide is available from Warner. Contact your Warner Linear distributor or representative with your special design requirements.

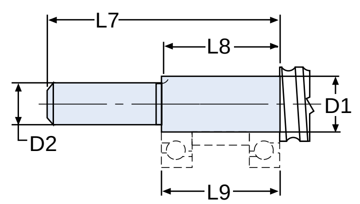
Customer Machined Ends

For customer machined ends, ball bearing screw stock can be ordered with ends annealed and ready for machining. Ball nuts, however, are not provided assembled on annealed stock, and consequently, require minimal extra assembly.

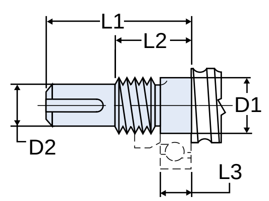
	SIMPLE … for single bearing	SIMPLE … for duplexed bearings	RIGID … for multiple bearing sets
	Type A	Type B	Type C

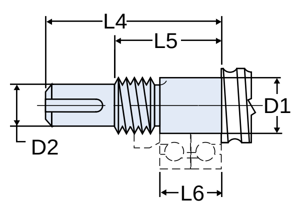


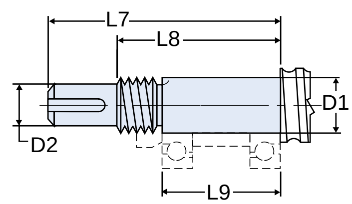




Model Number		D1	D2	L1	L2	L3	D1	D2	L4	L5	L6	D1	D2	L7	L8	L9
R-0308	RC0308	.2501 / .2498	.187 / .186	.625	.180	.1960	.2501 / .2498	.187 / .186	.750	.362	.3920	.2501 / .2498	.187 / .186	1.187	.791	.8210
R-0505 R-0502	RS0502	.3751 / .3748	.312 / .311	1.00	.200	.2188	.3751 / .3748	.312 / .311	1.370	.406	.4376	.3751 / .3748	.312 / .311	2.000	1.343	1.3750





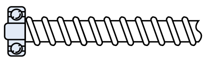


Model Number		D1	D2	L1	L2	L3	D1	D2	L4	L5	L6	D1	D2	L7	L8	L9
RC0605 RQ0605	RK0605	.4726 / .4723	.406 / .405	2.11	.810	.3937	.4726 / .4723	.406 / .405	2.500	1.200	.7874	.4726 / .4723	.406 / .405	3.290	1.990	1.5760
R-0705 R-0702	RC0705 RS0702	.5908 / .5905	.500 / .499	1.93	.940	.5118	.5908 / .5905	.500 / .499	2.500	1.450	1.0236	.5908 / .5905	.500 / .499	3.590	2.590	2.1654
R-1004 RL1004 RC1004 RK1004 R-1002	R-1001 RS1001 RM2510 RM2525	.7877 / .7873	.625 / .624	2.15	1.04	.5512	.7877 / .7873	.625 / .624	2.870	1.600	1.1024	.7877 / .7873	.625 / .624	4.000	2.880	2.4016
R-1105 R-1501 RH1501	R-1520 RH1520 R-1547	.9846 / .9842	.750 / .749	2.68	1.12	.5906	.9846 / .9842	.750 / .749	3.280	1.710	1.1811	.9846 / .9842	.750 / .749	4.450	2.890	2.3622
R-1502 RL1502 R-1504		1.1814 / 1.1810	1.000 / .999	2.93	1.15	.6299	1.1814 / 1.1810	1.000 / .999	3.560	1.780	1.2598	1.1814 / 1.1810	1.000 / .999	5.330	3.580	3.0709
R-2002 RL2002	R-2001	1.5752 / 1.5747	1.375 / 1.374	3.78	1.30	.7087	1.5752 / 1.5747	1.375 / 1.374	4.500	2.000	1.4174	1.5752 / 1.5747	1.375 / 1.374	6.930	4.430	3.8600
R-2202		1.7721 / 1.7716	1.375 / 1.374	3.73	1.54	.9843	1.7721 / 1.7716	1.375 / 1.374	4.710	2.520	1.9685	1.7721 / 1.7716	1.375 / 1.374	6.680	4.490	3.9370
R-2501 R-2502		2.1659 / 2.1653	1.875 / 1.874	4.50	1.47	.8268	2.1659 / 2.1653	1.875 / 1.874	5.370	2.300	1.6535	2.1659 / 2.1653	1.875 / 1.874	8.400	5.400	4.7638
R-3066		2.3627 / 2.3621	2.250 / 2.249	5.56	1.87	1.2205	2.3627 / 2.6321	2.250 / 2.249	6.780	3.090	2.4409	2.3627 / 2.3621	2.250 / 2.249	9.220	5.540	4.8819

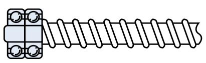
End Mounting Bearing Supports

The three basic bearing configurations that are commonly used to support the ends of a ball screw are:

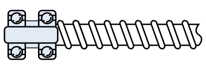
A. A single journal or ball type bearing (simple support).



B. A pair of back-to-back, angular contact bearings to control end play (simple support).



C. A pair of spaced bearings for added rigidity (rigid support).

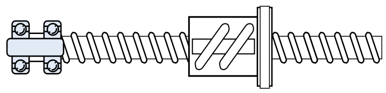


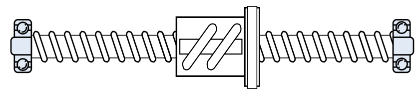
Pillow Block Mounting

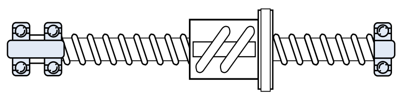
Pillow block mounting may be considered rigid or simple depending on design. If the distance between bearings is similar to the L9 dimension shown in Type C, the mounting is considered rigid.

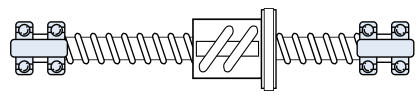
Mounting Arrangements

Four combinations of bearing supports are used throughout this catalog for selection purposes. They are:



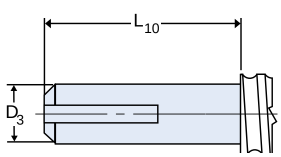






Pillow Block Journal

Type D



Model Number		D3	L10
RC0605 RQ0605	RK0605	.5000 .4995	2.25
R-0705 R-0702	RC0705 RS0702	.5000 .4995	2.25
R-1004 RL1004 RC1004 RK1004 R-1002	R-1001 RS1001 RM2510 RM2525	.7500 .7495	2.88
R-1105 R-1501 RH1501	R-1520 RH1520 R-1547	1.000 .9995	2.88
R-1502 RL1502 R-1504		1.1875 1.1870	4.13
R-2002 RL2002	R-2001	1.5000 1.4995	4.94
R-2202		1.7500 1.7495	4.94
R-2501 R-2502		2.0000 1.9990	6.38
R-3066		2.4375 2.4365	7.25

Suggested Bearings/Keys/Lock Washers/Lock Nuts (to be furnished by customer)

Model Number		Bearing O.D.	Standard Bearings by End Journal Type: A	B, C	D	Key: Type A, B, C	Key: Type D	Lock Washer Type	Lock Nut: Type	Lock Nut: Thread
R-0308	RC0308	0.625	R-4**	R-4	—	—	—	—	—	—
R-0505 R-0502	RS0502	0.875	R-6	R-6	—	—	—	—	—	—
RC0605 RQ0605	RK0605	1.2598	201 S*	201 A*	No. 8	1/8 x 5/8	1/8 x 1-1/2	W-01	N-01	No. 2 Class .469-32
R-0705 R-0702	RC0705 RS0702	1.6535	302 S	302 A	No. 8	1/8 x 5/8	1/8 x 1-1/2	W-02	N-02	No. 2 Class .586-32
R-1004 RL1004 RC1004 RK1004 R-1002	R-1001 RS1001 RM2510 RM2525	1.8504	204 S	204 A	No. 12	3/16 x 5/8	3/16 x 1-1/2	W-04	N-04	No. 4 Class .781-32
R-1105 R-1501 RH1501	R-1520 RH1520 R-1547	2.0472	205 S	205 A	No. 100	3/16 x 1	1/4 x 1-1/2	W-05	N-05	No. 5 Class .969-32
R-1502 RL1502 R-1504		2.4409	206 S	206 A	No. 103	1/4 x 1	1/4 x 1-3/4	W-06	N-06	No. 6 Class 1.173-18
R-2002 RL2002	R-2001	3.1496	208 S	208 A	No. 109	5/16 x 1-1/2	3/8 x 3	W-08	N-08	No. 8 Class 1.563-18
R-2202		3.937	309 S	309 A	No. 112	5/16 x 1-1/2	3/8 x 3	W-09	N-09	No. 9 Class 1.767-18
R-2501 R-2502		3.937	211 S	211 A	No. 200	1/2 x 1-1/2	1/2 x 3-1/2	W-11	N-11	No. 11 Class 2.159-18
R-3066		5.1181	312	312 A	No. 207	1/2 x 2	5/8 x 4-11/16	W-12	N-12	No. 12 Class 2.360-18

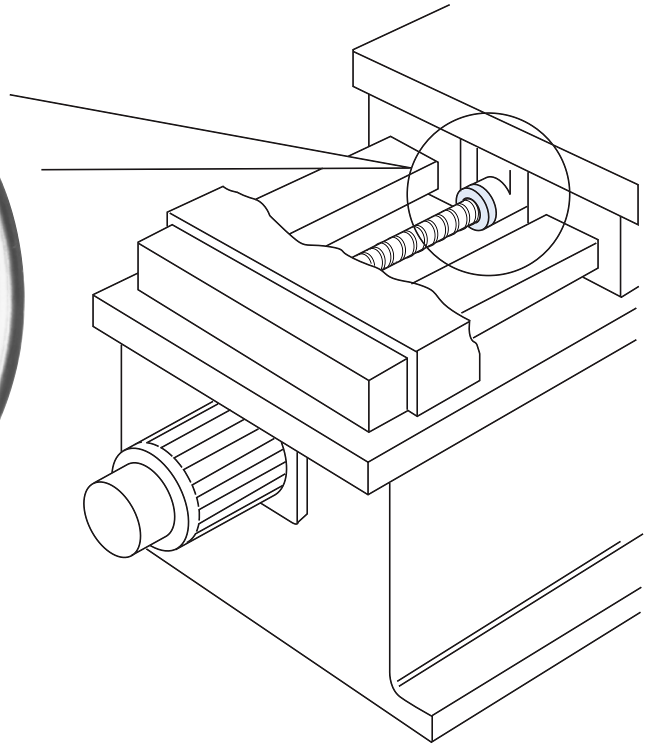
Note: *S Designation = Single Row Radial Contact - Simple Bearing Sets
*A Designation = Single Row Angular Contact (used in multiple and duplexed bearing sets)
**R Prefix Designation = Inch Series Bearings

Wiper Kits

Brush type wiper kits maximize Warner Linear ball bearing screw performance by helping to spread lubricant over the length of the screw and preventing internal ball nut contamination from foreign materials. Wiper kits are optional on models R-0308 through R-1504, and standard on models R-1502 through R-3066. Optional and standard wiper kits are also available for comparable zero backlash/preload ball nut assemblies.

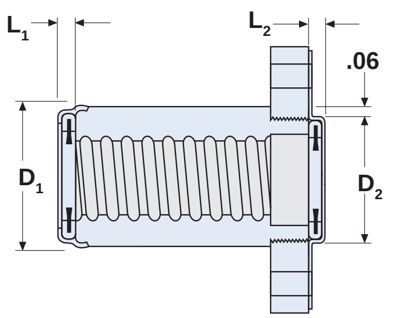
For heavily contaminated environments. Warner Linear recommends the use of metal shields, bellows type enclosures or extensions in conjunction with brush wipers for maximum protection.

NOTE: Add 1-2 lb.in. of torque with wiper (drive torque)



Type A

For these ball bearing screw sizes, end caps attached to the ball nut and flange hold the wipers in position. The Type A wiper kit includes a flange end cap. If the application does not use a flange, discard the flange end cap and epoxy the wiper to the end of the ball nut.

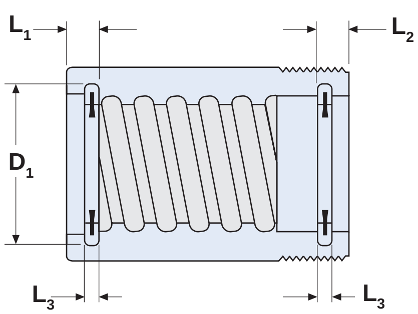


Type A

Model	D_1 Max.	D_2 Max.	L_1 Max.	L_2 Max.	Wiper Part Number
R-0308	.838	.880	.139	.148	8103-101-002
RC0308	.838	.880	.139	.148	8103-101-002
R-0505	1.122	1.138	.139	.148	8105-101-002
R-0502	1.122	1.138	.139	.148	8105-101-002
RS0502	1.122	1.138	.139	.148	8105-101-002
RC0605	1.177	1.060	.139	.148	8106-101-002
RK0605	1.177	1.060	.139	.148	8106-101-002
R-0705	1.382	1.230	.158	.148	8107-101-002
R-0702	1.382	1.230	.158	.148	8107-101-002
RC0705	1.382	1.230	.158	.148	8107-101-002
RS0702	1.382	1.230	.158	.148	8107-101-002
R-1001	1.763	1.610	.158	.148	8110-101-002
R-1004	1.763	1.610	.158	.148	8110-101-002
R-1002	1.763	1.610	.158	.148	8110-101-002
RC1004	1.763	1.610	.158	.148	8110-101-002
RK1004	1.763	1.610	.158	.148	8110-101-002
RL1004	1.763	1.610	.158	.148	8110-101-002
RS1001	1.763	1.610	.158	.148	8110-101-002
R-1105	1.763	1.610	.158	.148	8111-101-002
R-1504	2.163	2.050	.158	.148	8115-101-006
RM2510	1.763	1.610	.158	.148	8110-101-002
RM2525	1.763	1.610	.158	.148	8110-101-002

Type B

For these models, easy-to-install snap-in wiper kits prevent internal ball nut contamination which decreases performance and dynamic life ratings.



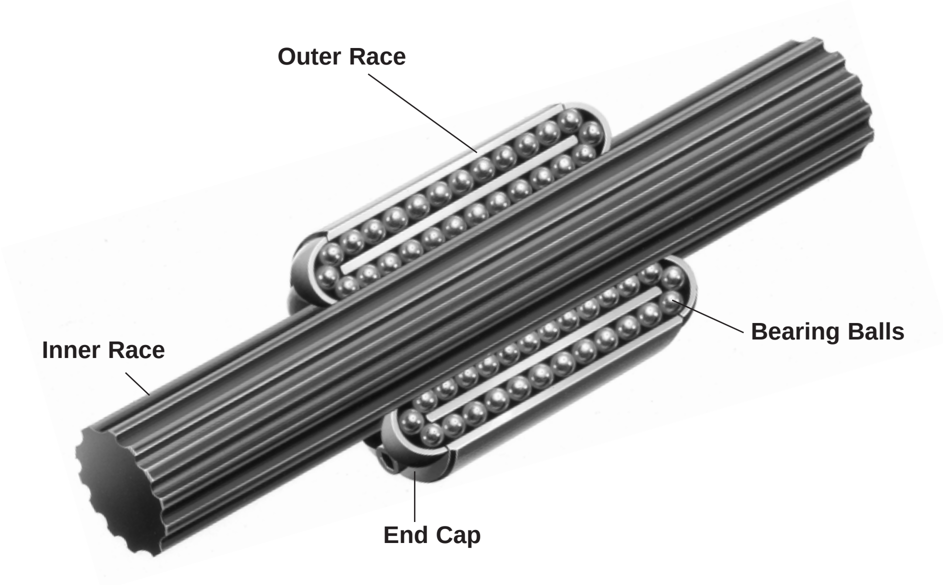
Type B

Model	D_1 Nom.	L_1 Nom.	L_2 Nom.	L_3 Nom.	Wiper Part Number
R-1501*	2.096	.200	.190	.130	8115-101-004
RH1501*	2.096	.200	.190	.130	8115-101-004
R-1520*	2.096	.200	.190	.130	8115-101-004
RH1520*	2.096	.200	.190	.130	8115-101-004
R-1547*	2.096	.200	.190	.130	8115-101-004
R-1502*	2.096	.200	.190	.130	8115-101-004
RL1502*	2.096	.200	.190	.130	8115-101-004
R-2002*	2.600	.250	.190	.130	8120-101-002
RL2002*	2.600	.250	.190	.130	8120-101-002
R-2001*	2.600	.250	.190	.130	8120-101-002
R-2202*	2.793	.220	.190	.130	8122-101-002
R-2502*	3.126	.250	.190	.130	8125-101-002
R-2501*	3.126	.250	.190	.130	8125-101-002
R-3066*	3.762	.250	.190	.130	8130-101-002

* Wiper kit standard with ball nut

Series A Ball Bearing Splines

Warner Linear Ball Splines supply nearly friction-free linear motion while simultaneously transmitting torsional loads. Recirculating bearing balls reduce friction providing predictable life and smooth operation. Similar to a ball screw, the bearing balls provide the only physical contact between the inner and outer race. However, in a ball bearing spline, the path of the bearing balls is straight, not helical, which allows for a highly efficient coupling device suitable for a variety of applications involving axial load transfer and/or torque transmittal.



Ball Spline Selection

To determine the correct ball spline for your application, you must first determine the load measured in pounds, the life required in inches of travel, speed measured in RPM and the length between support bearings measured in inches. To determine the life required, multiply the total stroke in inches by the total number of strokes required for the designed life of the equipment.

Life Expectancy

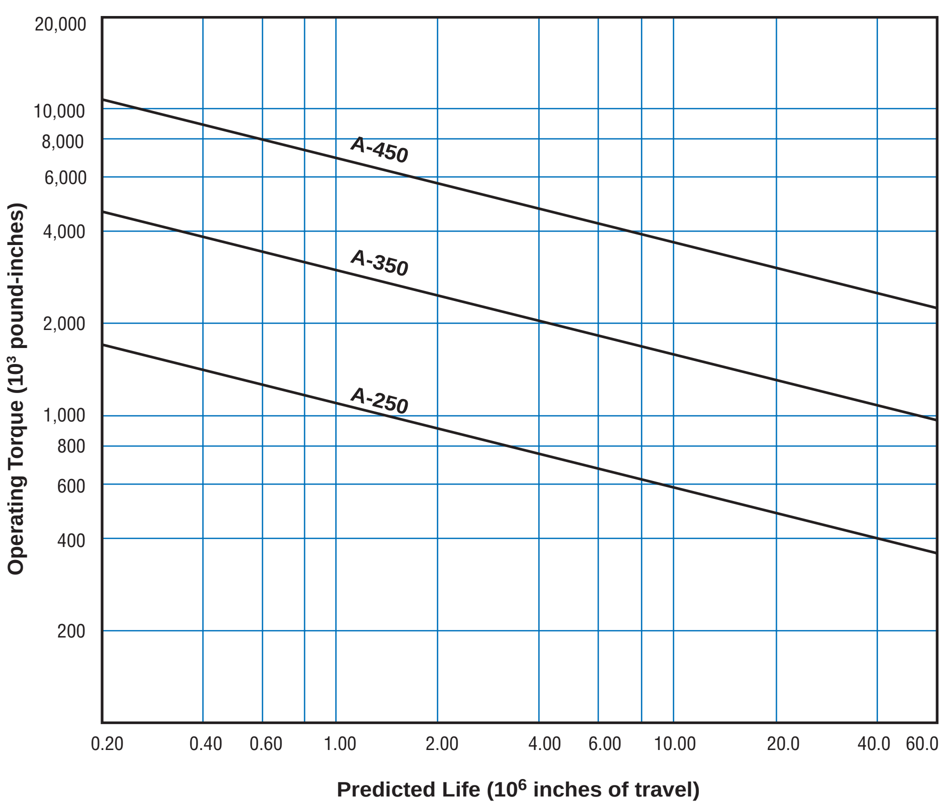
Once these variables have been determined, you must first determine which size spline assembly will give you the required life at the average torque. For applications where the torque is fairly constant over the entire stoke of the spline, use the highest torque to select the proper spline. On an application where the torque will vary significantly over the length of the stroke, an equivalent torque can be determined using this formula:

$$T_m = \sqrt[3]{\frac{\%_1(T_1)^3+\%_2(T_2)^3+\%_3(T_3)^3+\%_n(T_n)^3}{100}}$$

where T_m = equivalent torque

T_n = each increment of torque

$\%_n$ = percent of stroke at load T_n



Determine the required life in millions of inches of travel at the equivalent operating load. Then find the point on the chart at which the load and life requirement intersect. Then simply select the spline designated by the line directly to the right or above the intersect point.

Critical Speed

Finally, verify the critical speed of the spline assembly. This is the maximum RPM at which the assembly can rotate without setting up an harmonic vibration in the inner race. Critical speed will vary with the diameter of the inner race, unsupported length of the spline assembly, the type of bearing supports used and the RPM. The following formula is used to calculate critical speed:

$$N = C_S \times 4.76 \times 10^6 \times \frac{D}{L^2}$$

$$N_S = N \times F_S$$

where N = Critical speed (RPM)

N_S = Critical speed with safety factor

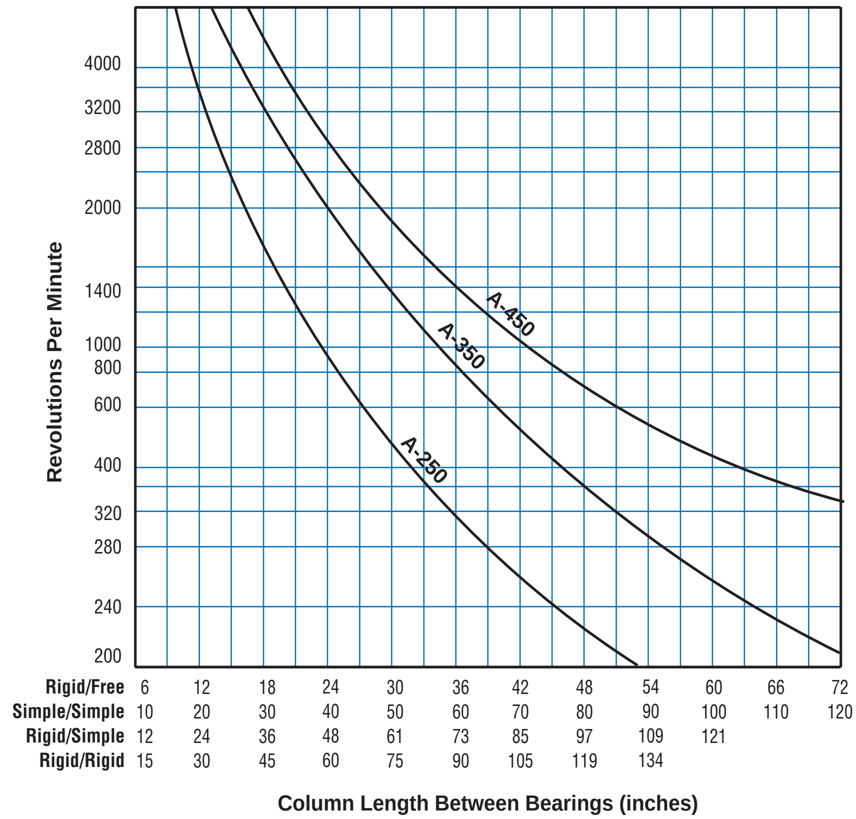
D = Minor (root) diameter of spline inner race (inches)

L = Length between bearing supports (inches)

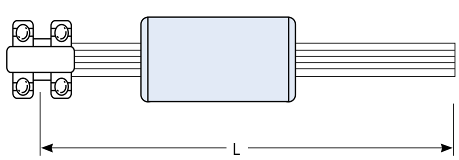
F_S = Factor of safety (80)

C_S = End fixity factor
.36 one end rigid, one end free
1.00 both ends simple
1.47 one end rigid, one end simple
2.23 both ends rigid

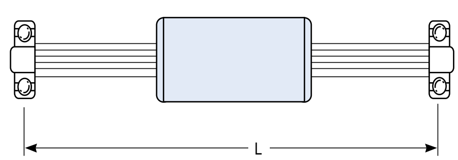
Critical speed is also affected by shaft straightness and the alignment of the spline assembly. It is recommended that the maximum speed be limited to 80% of the calculated critical speed.



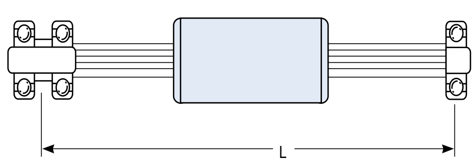
A C_S **= .36**
RIGID **FREE**



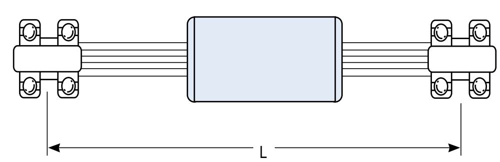
B C_S **= 1.00**
SIMPLE **SIMPLE**



C C_S **= 1.47**
RIGID **SIMPLE**

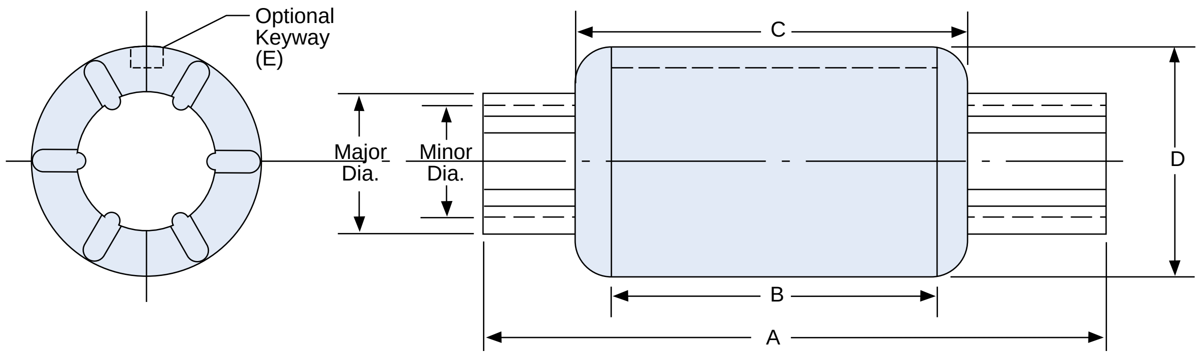


D C_S **= 2.23**
RIGID **RIGID**



Series A Ball Bearing Splines

Dimensions



Model	Torque Rating (lb.in.) Operating 1 million" travel	Torque Rating (lb.in.) Maximum Static	Inner Race Max. Major Dia.	Inner Race Minor Dia. (root) (ref.)	Inner Race Pitch Dia. (ref.)	Outer Race A Std. Length (Ft.)	Outer Race B Body Length (ref.)	Outer Race C Max. Overall Length	Outer Race D Max. Dia.
A-250	1170	3540	.610	.430	.624	4	1.50	2.13	1.531
A-350	2600	7800	.985	.805	1.002	12	2.06	2.69	1.906
A-450	8400	23170	1.480	1.230	1.494	12	3.08	3.71	2.693

Optional Outer Race Keyways (Dimension E)

A-250	.1855/.1875 Wide x .098/.114 Deep x Full Length of Outer Race Body Length (1.505)
A-350	.1855/.1875 Wide x .097/.113 Deep x Full Length of Outer Race Body Length (2.070)
A-450	.3730/.3750 Wide x .200/.216 Deep x Full Length of Outer Race Body Length (3.000)

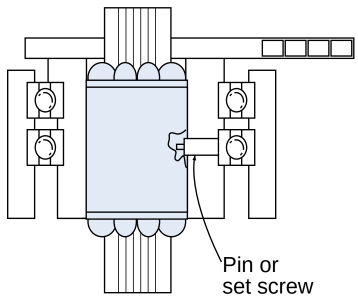
*Special keyways can be quoted

Mounting

The method of attaching or mounting ball bearing spline assemblies will vary depending on the application. The O.D. of the ball bearing spline outer race can be fitted to gears, sprockets, clutching devices, trunions or flanges by inserting it into machined adapters or hubs. Fastening of the adapter or hub to the spline's outer race can be accomplished with a pin or set screw or key and pin.

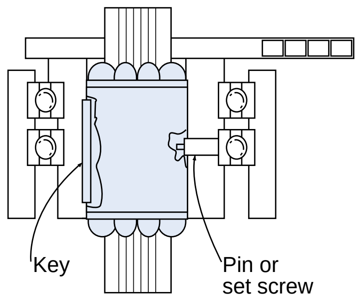
Pin or Set Screw

A pin or set screw is suitable for applications with low torque requirements.



Machining the Outer Race

Warner Linear recommends that all outer race machining be done at the factory prior to shipment.

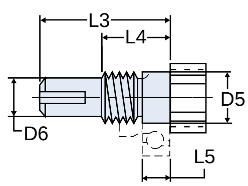
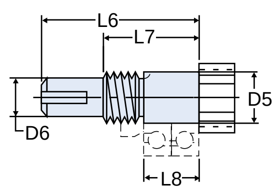
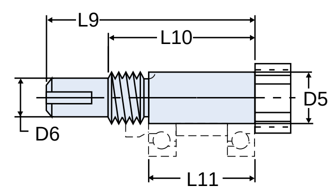


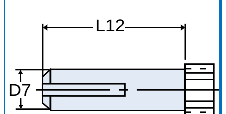
End Journals

Standard End Journals—Inner race end journals, which are most compatible with ball spline design and common applications requirements, are shown below. These end journals are designed to accommodate standard bearings and are sufficient for the majority of ball spline applications. End journals for Warner Linear mounting supports are on page 29.

Special end journals produced to customer requirements for unique applications are also available. Please consult factory with specific requirements.

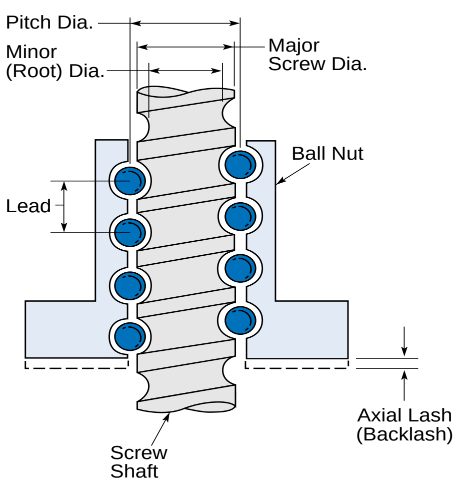
Customer machined ends—Inner race may be purchased with ends annealed and ready for machining.

	Type A 					Type B 					Type C 				
Model No.	**D5**	**D6**	**L3**	**L4**	**L5**	**D5**	**D6**	**L6**	**L7**	**L8**	**D5**	**D6**	**L9**	**L10**	**L11**
A-250	.4726 .4723	.406 .405	2.11	.81	.3937	.4726 .4723	.406 .405	2.50	1.20	.7874	.4726 .4723	.406 .405	3.29	1.99	1.576
A-350	.7877 .7873	.625 .624	2.15	1.04	.5512	.7877 .7873	.625 .624	2.87	1.60	1.1024	.7877 .7873	.625 .624	4.00	2.88	2.4016
A-450	1.1814 1.1810	1.000 .999	2.93	1.15	.6299	1.1814 1.1810	1.000 .999	3.56	1.78	1.2598	1.1814 1.1810	1.000 .999	5.33	3.58	3.0708

	Type D 	
Model No.	**D7**	**L12**
A-250	.5000 .4995	2.250
A-350	.7500 .7495	2.875
A-450	1.1875 1.1870	4.125

Suggested Bearings/Keys/Lock Washers/Lock Nuts (to be furnished by customer)									
						Standard Bearings by End Journal Type			
Type A-B-C Key sq. x long	**Type D Key sq. x long**	**Lock Washer Type**	**Lock Nut Type**	**Lock Nut Thread**	**Bearing O.D.**	**A**	**B**	**C**	**Pillow Block D**
1/8 x 5/8	1/8 x 1-1/2	W-01	N-01	No. 1 Class thread maj. dia. 0.469-32thds/in.	1.2598	201 S	201 A	201 A	No. 8
3/16 x 5/8	3/16 x 1-1/2	W-04	N-04	No. 4 Class thread md. 0.781-32 t/in.	1.8504	204 S	204 A	204 A	No. 12
1/4 x 1	1/4 x 1-3/4	W-06	N-06	No. 6 Class thread md. 1.173-18 t/in.	2.4409	206 S	206 A	206 A	No. 103

General definitions



Axial lash/backlash
The axial free motion between the ball nut and screw; a measure of system stiffness.

Bearing ball circuit
The closed path of recirculating balls within the ball nut assembly. A multiple circuit nut with two or more individual circuits has a greater load carrying capability than a single circuit ball nut assembly of the same diameter.

Cycle
The complete forward and reverse motion of the screw (or nut) when moving the load. One cycle is equivalent to two load carrying strokes (one forward and one backward).

Diameter—major
The outside diameter of the ball bearing screw shaft. In dealing with ball bearing screws, this is the basic measurement.

Diameter—minor (root)
Diameter of the screw measured at the bottom of the ball track.

Diameter—pitch
The nominal diameter of a theoretical cylinder passing through the centers of the balls when they are in contact with the ball bearing screw and ball nut tracks.

Effective ball turns
The number of ball groove revolutions within the ball nut body; a ball nut with seven effective ball turns will have a higher load carrying capability than one with five, all other characteristics being equal.

Lead
The axial distance a screw travels during one revolution.

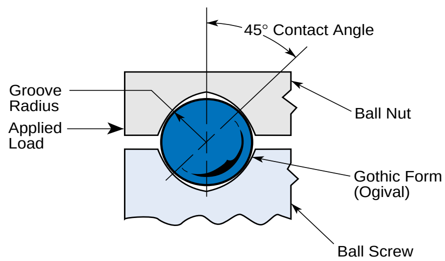
Lead tolerance
The maximum variation from nominal, measured in inches per foot, cumulative.

Load carrying balls
The balls in contact with the ball grooves of both the nut and the screw for load carrying purposes.

Right hand thread
The direction of the threads on the screw shaft causing the ball nut to travel away from the end viewed when rotated in a clockwise direction.

Screw starts
The integral number of independent threads on the screw shaft; typically one, two or four.

Ball Contact

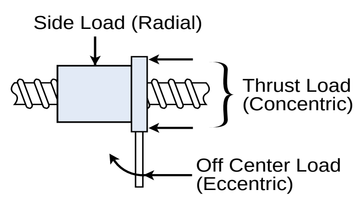


Gothic (or Ogival) Groove
A ball track cross-section shaped like a Gothic arch.

Conformity Ratio
Ratio of the ball track radius to the ball diameter.

Contact Angle
Nominal angle between a plane perpendicular to the screw and a line drawn between the theoretical points of tangency between a ball and the ball tracks and projected on a plane passing through the screw axis and the center of the ball. The angle at which the ball contacts the groove.

Loading



Dynamic load rating
Dynamic load rating is the maximum load which a ball bearing screw assembly can maintain for a prescribed length of travel.

Static load
Static load is the maximum non-operating load capacity above which brinelling of the ball track occurs.

Thrust load
Thrust load is loading parallel to and concentric with the centerline of the screw shaft which acts continuously in one direction. Thrust loading is the proper method of attaching the load to the ball bearing screw assembly.

Preload
The use of one group of bearing balls set in opposition to another to remove axial lash or backlash and increase ball bearing screw stiffness. All axial freedom is eliminated in preloading.

Tension load
Tension load is a load which would tend to stretch the ball screw shaft.

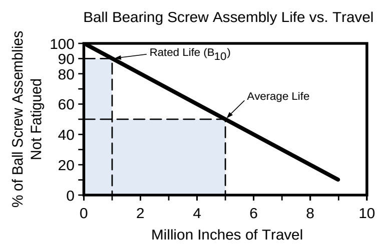
Compression load
Compression load is a load which would tend to compress or buckle the ball screw shaft.

Off center load (Eccentric)
A load tending to cock the ball nut on the screw, reducing the rated life. This must be considered in the selection of the ball bearing screw assembly.

Side load (Radial)
A load from the side that will reduce the rated life and must be considered in the selection of the ball bearing screw.

Load/Life

A rolling contact device such as a ball bearing screw is said to have reached the end of its usable life at the first sign of fatigue on the rolling surfaces. Fatigue results from the repeated flexing of metal as the balls pass over any given point under load.



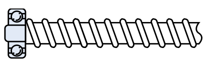
Load/life rating
The usable life of a ball bearing screw assembly measured in inches of travel under a specific load. The length of travel that 90 percent of a group of ball bearing screws will complete, or exceed, before the first evidence of fatigue develops. (B10)

Mounting-ends

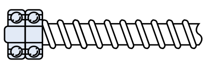
End bearing support (end fixity)

The three basic bearing configurations that are commonly used to support the ends of a ball screw are:

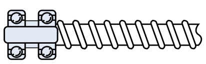
A. A single journal or ball type bearing (simple support).



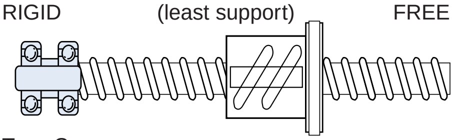
B. A pair of back-to-back, angular contact bearings to control end play (simple support).

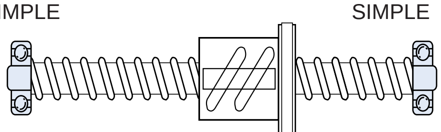


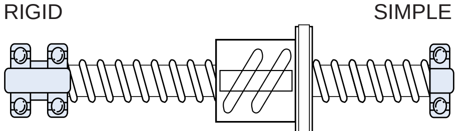
C. A pair of spaced bearings for added rigidity (rigid support).

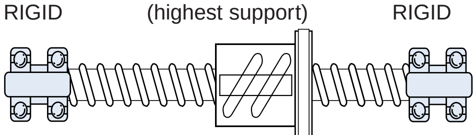


Four combinations of bearing supports are used throughout this catalog for selection purposes. They are:









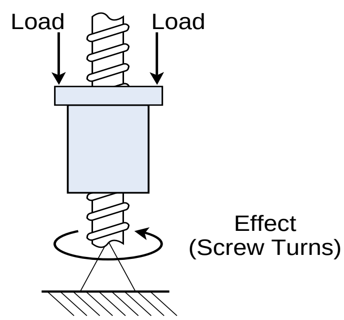
Annealed ends

A manufacturing process which removes brittleness while softening screw stock to allow for machining of end journals.

Backdriving

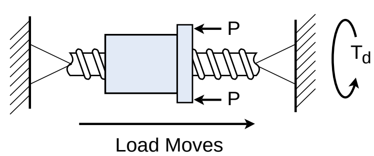
Conventional acme screws can not be backdriven. A load on the nut will not drive the screw because of the inherent low efficiency (20–30%).

Ball bearing screws can be backdriven. A load on the nut will drive the screw because of the inherent high efficiency (90%).



If backdriving is required in a particular application, the lead of the screw should be at least one third the screw diameter. Ideally the lead should be equal to the screw diameter.

Driving Torque



The amount of effort, measured in pound-inches, required to turn the ball screw and move the load.

$$T_d = \frac{P \times L}{2\pi e} = .177\ P \times L \text{ (pound-inches)}$$

T_d = Direct Torque (pound-inches)
P = Load
L = Screw Lead (inches/turn)
e = Ball Bearing Screw Efficiency (90%)

Backdriving Torque:

The backdriving torque (T_b) is the torque created by an applied load.

T_b = .143 (P) (L) = pound-inches

Preload Torque

$$T_{PL} = \frac{P_{PL} \times L \times .2}{2\pi} \text{ or } .032 \times P_{PL} \times L$$

T_{PL} = Torque (pound-inches)
P_{PL} = Preload setting (pounds)
L = Lead

Angular Velocity

$$\text{RPM} = \frac{\text{Velocity (inches/min.)}}{\text{Lead (inches/rev.)}}$$

Horsepower

$$\text{HP} = \frac{\text{RPM} \times \text{Torque (pound-inches)}}{63{,}000}$$

Rotational Torque

To accelerate the screw

$$T_r = \frac{WR^2 \text{ (RPM)}}{3700 \text{ (t)}} = \text{lb.in.}$$

T_r = Torque (lb.in.)
WR^2 = Inertia (lb.in.)
t = Time to accelerate (sec.)

Acceleration Torque

Under load

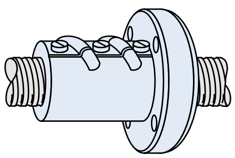
$$T_a = \frac{(p \div g)\ (A)\ (L)}{2\pi e} = \text{lb.in.}$$

A = Acceleration (in./sec.^{2})
g = 386 in./sec.^{2}
p = Load (lb.)
L = Screw lead (in./turn)

Thermal expansion of screw
= 6.25×10^{-6} in./°F

Most frequently asked questions about ball bearing screws

1 Question How do you restrict the flange from turning off the nut in reversing load applications?



Answer The flange may be held to the nut by three alternative methods:

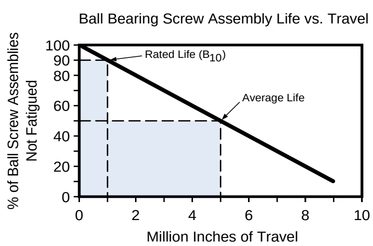
a) The most positive method of holding the flange to the nut is to order factory "drill and pin" prior to bearing loading. The flange and nut are drilled to accept a roll pin from the flange face.

b) The flange may be drilled and tapped from the O.D. into the nut threads. A carbide spade drill may be used to drill into the hardened nut threads. Avoid getting metal chips into the nut.

c) Commercially available adhesives such as Loctite may be used. Take care to avoid getting adhesive on the ball track. (Light loads only).

2 Question How do you calculate application life requirement in inches?

Answer Each ball bearing screw application will have an expected life requirement given the stroke length, duty cycle, years of expected life and load.



The dynamic load charts may be used to select the ball bearing screw size when the total inches of expected life has been calculated.

a) Life expectancy is the total inches of travel (under load) that an assembly will provide under a stated load. (Life is sensitive to load.)

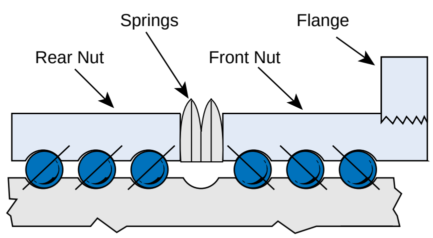
b) To determine the inches of life: multiply inches of stroke x two (only on vertical applications) x cycles per hour x hours of operation per day x number of working days per year x years of expected service. See page 10.

3 Question Is lubrication necessary?

Answer Proper and frequent lubrication must be provided for satisfactory service and life. A 90% reduction in ball bearing screw life should be allowed where dry operation is unavoidable. Lubricants reduce abrasive wear and dissipate heat caused by metal-to-metal contact between bearing surfaces. Generally spindle oil or 10 weight oil may be used for most applications. Applications with infrequent duty cycles may be lubricated for life with grease.

4 Question How are torque requirements for preload nuts calculated?

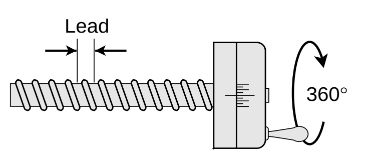
Answer Driving torque increases only slightly with preload since a preload



unit continues to be highly efficient. First, determine the driving torque for a single nut working at a given load. Second, determine the torque required for the preload load setting.

Add the driving torque and preload torque together to determine total torque requirement. See page 39 for formulas.

5 Question What is the standard lead accuracy that can be ordered?

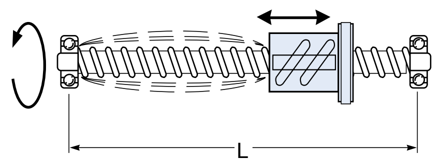


Answer Warner Linear R & RM series ball screws offer a standard lead accuracy of ±.005 inch anywhere on the screw. A more accurate certified load is available, contact the factory for details.

6 Question How are ball bearing screws synchronized?

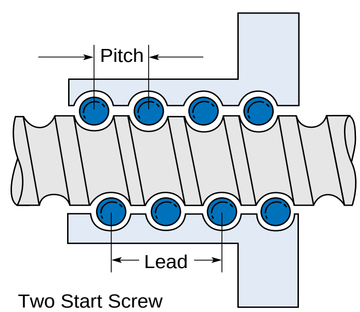
Answer Screw synchronizing is achieved by selecting screws with similar lead error and driven by a positive single source drive. "Matched sets required" should be specified when ordering screws that should be timed to run together without binding because of lead mis-match. (Special factory order).

7 Question What can be done to exceed calculated critical speed?



Answer The chart for critical speed is on page 14–15. Critical speed is a function of unsupported screw length, mean diameter of screw and bearing supports. Rigid/rigid screw mounting is the optimum support for high speeds. Consider a faster lead to reduce the RPM required. If higher speed is still necessary, go to a larger diameter screw.

8 Question What is the difference between pitch and lead?



Answer Pitch is the measurable distance between screw grooves. Lead is the linear travel the nut makes per screw revolution. The pitch and lead are equal with single start screws. The pitch is 1/2 the lead in two start screws, etc.

9 **Question** What is the standard straightness on machined screws with standard ends or screws machined to customer prints?

Answer The threaded portion is .005 T.I.R. per foot and not to exceed .010 T.I.R. total length of screw.

10 **Question** What is meant by tangential design nuts?

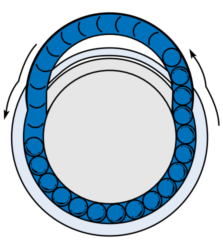


Fig. 1

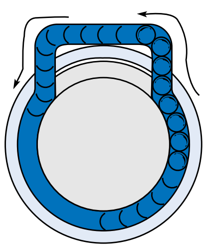


Fig. 2

Answer The tangential circuit (Fig. 1) consists of a pickup finger (or yoke deflector) geometry which allows the circuit balls to enter and leave the load carrying portion of the ball screw circuit in a straight line path—along the tangent to the pitch diameter.

The standard ball nut design (Fig. 2) places the return tube holes closer together resulting in a circuit which requires a change in direction of the ball travel as the return tubes are entered and exited.

11 **Question** What is the backlash of single nuts?

Answer The backlash range in a single nut is as follows:

Model	Max. Backlash
R-0308 to R-0705	.007"
R-0702 to R-1105 & 1504	.009"
R-1501 to R-1520	.013"
R-2001 to R-2502	.015"
R-3066	.018"

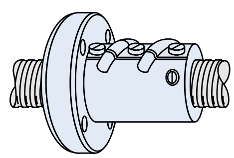
12 **Question** Can backlash be minimized?

Answer Yes, backlash can be minimized or eliminated completely by using a preloaded ball bearing screw. See pages 21–23.

13 **Question** What is a load locking spring and how does it work?

Answer The load locking spring is a coil that is turned into the inactive portion of the nut and conforms to the ball track. The spring does nothing in normal operation and does not touch the screw. In the event the ball bearings are lost from the nut, the load locking spring will not allow the load carrying nut to free-fall down the screw. See page 7.

14 **Question** Where is the lube hole in the large size nuts and what is the thread size?



Answer A 1/8-27 NPT pipe thread tapped hole is standard in large nuts from R-1502 through R-3066. The tapped hole is 1/2" from the end of the nut opposite the v-threads and 40 degrees from the tube center line.

15 **Question** How do you size a ball bearing screw?

Answer Refer to the selection guidelines on pages 10, 11 and 12. Select the screw that will satisfy the most critical requirement of the application, such as high RPM, heavy load, duty cycle, column loading or zero backlash. Design for the worst case.

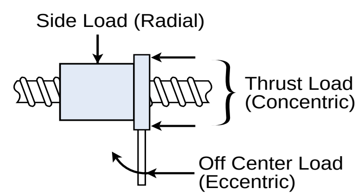
16 **Question** How is a hardened screw annealed?

Answer The ball bearing screws are case hardened to Rockwell C56 minimum. The screw ends are coil annealed after they are cut to length to reduce the case hardness to a machinable state. Screws may be annealed in the field by heating the ends to a cherry red with a torch, then putting the ends in sand to cool.

17 **Question** How should ball bearing screws be protected from dirt and contaminates?

Answer The brush wipers help prohibit contaminates from entering the nut as it translates along the screw. For heavily contaminated environments, metal shields, bellow type enclosures or extensions are recommended to be used with wipers.

18 **Question** What causes premature failure?



Answer Premature failure may be caused by any of the following:

a) **Misalignment** of ball nut to screw which results in side loading or eccentric loading will reduce life. This may cause the bearing balls to split or get flats on them. The bearings may even break out of the tubes.

b) **Metal Chips or Dirt** in the ball nut will not allow the bearings free circulation. The bearing balls may get flats on them because of skidding and spalling.

c) **Lack of Lubrication** Proper lubrication will help dissipate heat and reduce metal-to-metal wear of components.

d) **High speed operation** Shaft speeds resulting in screw surface speeds above 8,000 IPM will reduce rated life.

19 **Question** What is the normal operating temperature range for ball bearing screws?

Answer The normal operating temperature range is –65°F to 300°F (–55°C to 149°C) with suitable lubrication. Temperatures in excess of this may make the screw brittle, warped or annealed.

How to Order
Series R and Series RM Ball Screws

To order Warner Linear R and RM series ball bearing screws, simply insert the required information into the seven information boxes as described below.

1	2	3	4	5	6	7
Model No.	Threaded Length	With or without flange	Annealed ends or no annealing	LH end inches annealed, journal type or bearing type	RH end inches annealed, journal type or bearing type	Wiper kit or no wiper kit

1. Model Number

Simply insert the model number for the ball bearing screw assembly you have selected for your application.

2. Threaded Length

Once the model designation has been filled in, you must calculate the threaded length you require. Then place the threaded length in inches in Box #2. The threaded length = Stroke length + ball nut length + any additional threaded length you desire at each end of the stroke. **(Note: This threaded length plus the length of any standard end journals you select will equal your actual overall length. Threaded length includes annealed ends. Be sure to include the inset dimension when using type E and E1 bearing supports. [See pages 26–27])**

3. Nut and Flange

Use this box to indicate if you would like the optional flange or not.

F = nut with flange

O = nut without flange

X = no nut and no flange

4. Annealed Ends

Use this box to indicate whether or not you wish to have the ends annealed.

A = Annealed Ends

O = No Annealing

If you plan to do your own end machining, you'll need to specify annealed ends. If instead you order standard end journals from the catalog, you will not require annealing.

5. Left End

If you specified annealing in Box #4, then you'll also need to specify in Box #5 the length (in inches) that the left end should be annealed.

If instead you elected to have a standard catalog end journal machined by Warner Linear, use Box #5 to specify the type journal (A, B, C, D, E, F, H, E1, F1, H1) to be machined on the left end. If no standard end or annealing specify "0". If you want bearings installed, specify the type (B for Base or F for Flange) along with the journal type.

Example:

Base mount, Type E Journal=BE

Flange mount, Type H1 Journal=FH1

Standard Modified Ends for End Support Bearings

E = Simple support on driven end of screw- radial support only

F = Duplex support on driven end of screw - radial and axial support

H = Spaced duplex support (rigid) on driven end of screw - radial and axial support

E1 = Simple support on non-driven end of screw - radial support only

F1 = Duplex support on non-driven end of screw - radial and axial support

H1 = Spaced duplex support (rigid) on non-driven end of screw - radial and axial support

6. Right End

If you specified annealing in Box #4, then you'll also need to specify in Box #6 the length (in inches) that the right end should be annealed.

If instead you elected to have a standard catalog end journal machined by Warner Linear, use Box #6 to specify the type journal (A, B, C, D, E, F, H, E1, F1, H1) to be machined on the right end. If no standard end or annealing, specify "0".

(Note: It is also possible to order one end annealed and the other with a standard end journal. Simply place an "A" (Annealed) in Box #4 and the length in inches for the end you wish to have annealed. Then place the letter for the desired standard end journal in the box representing the end you wish to have Warner Linear machine for you.) If you want an end support bearing installed, specify the type (B for Base or F for Flange) along with the journal type.

Example:

Base mount, Type E1 Journal=BE1

Flange mount, Type F Journal=FF

7. Wiper Kits

To order an optional wiper kit, use box #7. Ball screw assemblies with a diameter larger than 1-1/2" (except R-1504) come with wiper kits standard.

W = with wiper kit

X = without wiper kit

Options

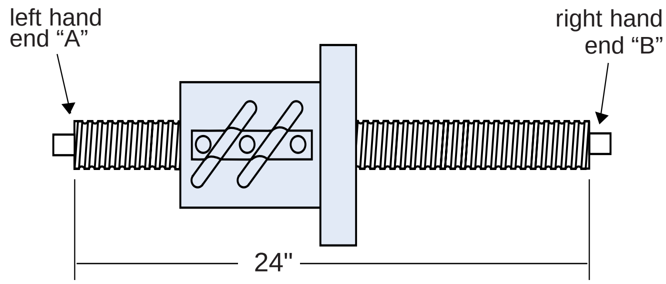
Warner Linear also offers a variety of special options in addition to the standard features you can order using the selection process above. To order any of these special options, please consult the factory.

These options include:

- Black oxide, bondarized or phosphate coatings are available for screw stock.
- Lead error charts can be provided for each ball screw.
- Matched leads can be selected for multiple ball screws.
- We can etch and stamp or tag and stamp ball nuts.
- We can face and center drill screw stock.
- The flange can be specially oriented on the ball nut.
- Lube holes can be provided on ball nuts.
- Special backlash can be provided.
- Special tolerances can be selected.
- Keyways can be provided on the outer race of splines.

Examples:

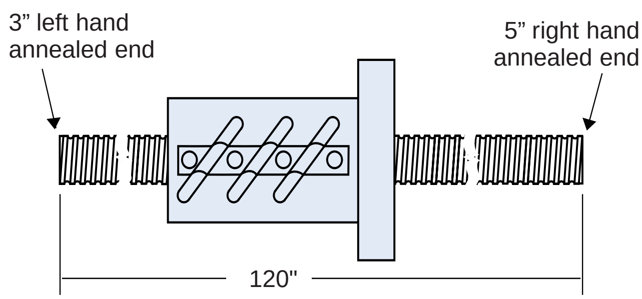
Model R-0308 with 24" threaded length, with flange, no annealing, A-type left-hand end, B-type right-hand end, with a wiper kit.



Order number R-0308—24-F-O-A-B-W

1	2	3	4	5	6	7
R-0308	24	F	O	A	B	W
Model No.	Threaded Length	With or without flange	Annealed ends or no annealing	LH end inches annealed, journal type or bearing type	RH end inches annealed, journal type or bearing type	Wiper kit or no wiper kit

Model R-3066 with 120" threaded length, with flange, annealed ends, 3" annealed left-hand end, 5" annealed right-hand end, without a wiper kit.

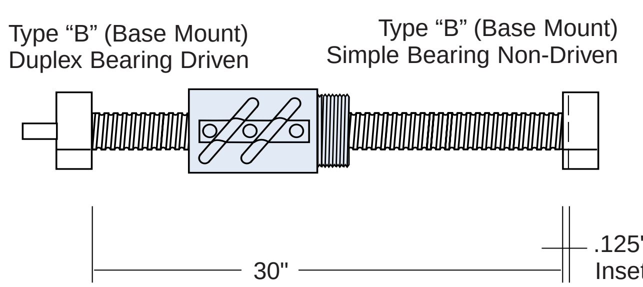


Order number R-3066—120-F-A-3-5-X

1	2	3	4	5	6	7
R-3066	120	F	A	3	5	X
Model No.	Threaded Length	With or without flange	Annealed ends or no annealing	LH end inches annealed, journal type or bearing type	RH end inches annealed, journal type or bearing type	Wiper kit or no wiper kit

The length of screw that is annealed still counts as threaded length.

Model R-0705 with 30" useful threaded length, nut with no flange, base type supports installed, driven duplex type (F) bearing support on the LH end, non-driven simple type (E1) bearing on right end, with a wiper kit.



Order number R-0705—30.125-O-O-BF-BE1-W

1	2	3	4	5	6	7
R-0705	30.125	O	O	BF	BE1	W
Model No.	Threaded Length	With or without flange	Annealed ends or no annealing	LH end inches annealed, journal type or bearing type	RH end inches annealed, journal type or bearing type	Wiper kit or no wiper kit

How to Order
Series A Ball Bearing Splines

Series A

To order Warner Linear A-series ball bearing splines, simply insert the required information into the six information boxes as described below.

1		2		3		4		5		6
	-		-		-		-		-	
Model No.		Inner Race Grooved Length		With or without outer race		Annealed ends or no annealing		LH end inches annealed or journal type		RH end inches annealed or journal type

1. Model Number

Simply insert the model number for the ball bearing screw assembly you have selected for your application.

2. Inner Race Grooved Length

Once the model designation has been filled in, you must calculate the groove length you require for the inner race. Then place the grooved length in inches in Box #2. The grooved length = Stroke length + outer race length + any additional grooved length you desire at each end of the stroke. **(Note: This grooved length plus the length of any standard end journals you select will equal your actual overall length).**

3. Outer Race

Use this box to indicate if you want to order an outer race or not.

W = with outer race

X = without outer race

4. Annealing

Use this box to indicate whether or not you wish to have the ends of the inner race annealed.

A = Annealed Ends

O = No Annealing

If you plan to do your own end machining, you'll need to specify annealed ends. If instead you order standard end journals from the catalog, you will not require annealing.

5. Left End

If you specified annealing in Box #4, then you'll also need to specify in Box #5 the length (in inches) that the left end should be annealed.

If instead you elected to have a standard catalog end journal machined by Warner Linear, use Box #5 to specify the type journal (A,B,C, or D) to be machined on the left end.

6. Right End

If you specified annealing in Box #4, then you'll also need to specify in Box #6 the length (in inches) that the right end should be annealed.

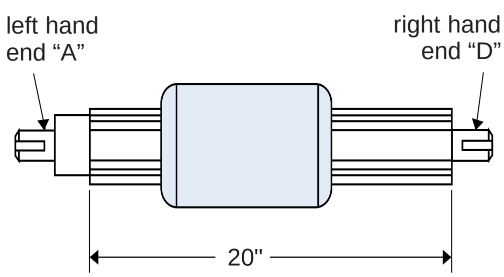
If instead you elected to have a standard catalog end journal machined by Warner Linear, use Box #6 to specify the type journal (A,B,C, or D) to be machined on the right end.

(Note: It is also possible to order one end annealed and the other with a standard end journal. Simply place an "A" (Annealed) in Box #4 and the length in inches for the end you wish to have annealed. Then place the letter in the box representing the end you wish to have a standard end journal machined).

Examples:

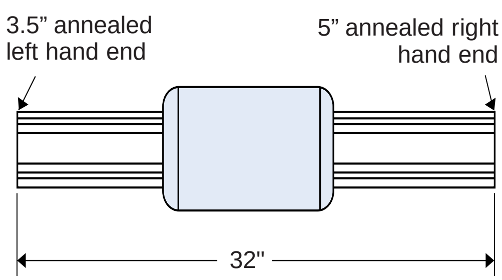
Order number A-250—20-W-O-A-D

1		2		3		4		5		6
A-250	-	**20**	-	**W**	-	**O**	-	**A**	-	**D**
Model No.		Inner Race Grooved Length		With or without outer race		Annealed ends or no annealing		LH end inches annealed or journal type		RH end inches annealed or journal type



Order number A-350—32-W-A-3.5-5.0

1		2		3		4		5		6
A-350	-	**32**	-	**W**	-	**A**	-	**3.5**	-	**5.0**
Model No.		Inner Race Grooved Length		With or without outer race		Annealed ends or no annealing		LH end inches annealed or journal type		RH end inches annealed or journal type



How to Order Component Parts

To order the component parts of a ball bearing screw or spline, use the part numbers shown below.

Series R

Model	Screw Stock	Ball Nut	Flange	Wiper Kit	Preloaded Ball Nut
R-0308	190-9217	8103-448-003	8103-448-002	8103-101-002	8103-448-004
RC0308	190-9217	8103-448-008	8103-448-002	8103-101-002	N/A
R-0505	190-9097	8105-448-013	8105-448-002	8105-101-002	8105-448-008
R-0502	190-9096	8105-448-011	8105-448-002	8105-101-002	8105-448-009
RS0502	190-9010	8105-448-016	8105-448-004	8105-101-002	N/A
RC0605	190-9098	8106-448-006	8105-448-002	8106-101-002	8106-448-015
RQ0605	190-9098	8106-448-010	8105-448-002	N/A	N/A
RK0605	190-9099	8106-448-007	8105-448-002	8106-101-002	8106-448-019
R-0705	190-9101	8107-448-016	8107-448-007	8107-101-002	8107-448-012
RC0705	190-9101	8107-448-017	8107-448-007	8107-101-002	N/A
R-0702	190-9100	8107-448-014	8107-448-002	8107-101-002	8107-448-011
RS0702	190-9006	8107-448-020	8107-448-004	8107-101-002	N/A
R-1004	190-9104	8110-448-026	8110-448-002	8110-101-002	8110-448-017
RC1004	190-9104	8110-448-029	8110-448-002	8110-101-002	N/A
RL1004	190-9105	8110-448-024	8110-448-002	8110-101-002	8110-448-018
RK1004	190-9105	8110-448-030	8110-448-002	8110-101-002	N/A
R-1002	190-9103	8110-448-022	8110-448-002	8110-101-002	8110-448-016
R-1001	190-9102	8110-448-020	8110-448-002	8110-101-002	8110-448-015
RS1001	190-9150	8110-448-034	8110-448-037	8110-101-002	N/A
R-1105	190-9106	8111-448-006	8111-448-002	8111-101-002	8111-448-004
R-1520	190-9345	8115-448-056	8115-448-002	8115-101-004	8115-448-059
RH1520	190-9345	8115-448-057	8115-448-002	8115-101-004	8115-448-060
R-1547	190-9328	8115-448-055	8115-448-064	8115-101-004	N/A
R-1504	190-9110	8115-448-020	8115-448-009	8115-101-006	8115-448-012
R-1502	190-9108	8115-448-016	8115-448-004	*8115-101-004	8115-448-006
RL1502	190-9109	8115-448-018	8115-448-004	*8115-101-004	8115-448-007
R-1501	190-9107	8115-448-014	8115-448-002	*8115-101-004	8115-448-011
RH1501	190-9107	8115-448-049	8115-448-002	*8115-101-004	8115-448-061
R-2002	190-9112	8120-448-011	8120-448-002	*8120-101-002	8120-448-006
RL2002	190-9113	8120-448-013	8120-448-002	*8120-101-002	8120-448-007
R-2001	190-9111	8120-448-021	8120-448-002	*8120-101-002	8120-448-019
R-2202	190-9114	8122-448-005	8122-448-002	*8122-101-002	8122-448-003
R-2502	190-9116	8125-448-010	8125-448-002	*8125-101-002	8125-448-006
R-2501	190-9115	8125-448-008	8125-448-002	*8125-101-002	8125-448-004
R-3066	190-9117	8130-448-007	8130-448-002	*8130-101-002	8130-448-004

*Replacement part number only — wiper kit is standard with ball nut

Series RM

Model	Screw Stock	Ball Nut	Flange	Wiper Kit	Preloaded Ball Nut
RM2510	190-9260	8110-448-045	8110-448-047	8110-101-002	N/A
RM2525	190-9259	8110-448-046	8110-448-047	8110-101-002	N/A