The three primary thread form types Duff-Norton offers: Acme and Modified Square Threads, and Ball Screw Threads.

**Modified square thread** screws have straight-sided flanks. Larger size Duff-Norton acme screws have the modified square thread form. There is no measurable performance difference between the modified square and acme thread forms.

**Acme thread** screws have a nominal depth of thread of 0.50 x pitch and have a 29° included thread angle resulting in an angled tooth shape (some sizes have 40°).

There are three main classes of Acme thread forms: General Purpose (G), Centralizing (C), and Stub Acme.

- **Centralizing thread** class acme screws are manufactured with tighter flank tolerances and limited major diameter clearances. The combination of these features helps prevent the previously described operating scenario which can occur with general class threads Duff-Norton screw and nut assemblies ranging from 1/2” to 2 1/2” use centralizing thread forms.

- **Stub Acme** thread forms are used in some of the small diameter screws and are made with the same tolerance characteristics as our centralizing threads, but have a thread depth less than one half the normal acme pitch.

**Ball thread** screws have a rounded / gothic arch shape design to match the bearing balls within the ball nut. The ball nut will also have the same rounded / gothic arch shape. All ball screws are heat treated. Most ball screws are manganese phosphate coated, some ball screws are black oxide coated.

There are three main classes of Acme thread forms: General Purpose (G), Centralizing (C), and Stub Acme.
Screw Characteristics

Screw Starts
The number of independent threads on the screw shaft: one, two, or four.

- Single Start Screw - Lead & Pitch are the same
- Double Start Screw - Lead is 2 X Pitch
- Four Start Screw - Lead is 4 X Pitch

Lead
The distance the nut advances along the screw in one revolution (lead = pitch x number of starts).

Pitch
The distance along the screw axis from a point on one thread to a corresponding point on the adjacent thread.

Lead Error
All forms of screw production yield minor inconsistencies in the distance between screw threads. This difference is commonly referred to as lead error and is the difference between what the travel should be and what the travel is. For example: if an assembly were programmed to travel 24" and the screws’ lead error was .004 inch per foot, the actual distance traveled could be from 23.996" to 24.004". Most modern day controls and programs are sophisticated enough to account and correct for lead error.

Root Diameter
The diameter of the screw at the bottom of the thread groove.

Standard Screw Lengths and Materials
Most screws are available with right hand threads (our 4.5" and 5" acme screws are supplied with Left Hand threads as standard). Left hand thread screws may be available in other sizes depending on order requirements.

Standard screw lengths are 36", 72", and 144". Some custom ball screws are available in 240" lengths depending on screw diameter. Custom length acme screws over 144" can be manufactured based on material availability.

Stainless steel screws can be provided for many diameters and leads.

Production Processing
Duff-Norton employs three production techniques to manufacture screws.

- Rolled Acme screws – use a combination of feed rates and compression through a machine with cylindrical dies to roll a screw into its desired form.
- Machine cut Acme screws – use high-end flat bed machines and several different cutting techniques to produce the desired form.
- Rolled ball screws – are rolled, induction hardened, inspected for quench cracks, and then manganese phosphate or black oxide coated.

There are only minor screw surface finish differences resulting from rolling or machine cutting Acme screws, and there are production and functional advantages and disadvantages to screws made from either process.

Good and consistent lubrication is much more important to a successful application than whether or not a screw was cut or rolled. All screw and nut systems should be lubricated often enough or in such a fashion the lubricant film is always present.
Bronze Acme Nuts

Through our years of experience Duff-Norton has chosen and uses two different bronze blends based on the desired performance characteristics. The bronze used for our smaller size nut performs extremely well in applications where the probability of friction and wear are high (Yield 49,000 psi, Ultimate Strength 68,000 psi, Hardness 74 Rockwell B min, Thermal Conductivity 58 BTU (Sqft-ft-hr-f)).

Larger size acme nuts use a different bronze selected for strength, abrasion, and impact properties (Yield 29,500 psi, Ultimate Strength 74,500 psi, Compressive Strength 100,000 psi, Hardness 170 BHN).

Plastic Acme Nuts

Duff-Norton plastic acme nuts are made from a high viscosity homopolymer with Teflon fibers and serve most industrial applications very well (Tensile Strength 7,700 psi @ 73° F, Ultimate Strength 7,700 psi @ 73° F, PV Limit @ ft-lbs 11,000). Specialty plastics may be provided upon request.

Ball Nuts

Duff-Norton ball nuts are provided with external bearing ball return tubes with a deflector which helps provide a smooth and quiet ball re-circulation. Our ball nuts can be supplied with flanges and wiper kits. All ball nuts are carburized, and black oxide coated. Some ball nuts are also provided with a load lock spring which helps prevent the ball nut from failing if the ball threads or return tubes are worn out.

Flanges

All ball nut flanges are made from steel and black oxidized. Smaller size acme nut flanges are also made from steel and black oxidized. Larger size acme nuts have an integral bronze flange.

Flange Installation

During installation, after threading the flange and nut together; the nut may be drilled and tapped from the back end for a set screw. While spot drilling the nut and flange assembly avoid getting metal chips in the nuts’ ball threads. Then install a dog point set screw or pin to secure the assembly.

Ball Nut Installation

Ball nuts are normally supplied on arbors. After clipping the retaining binder, care must be taken to slide or position the arbor onto or next to the ball screw. Rotate the screw or ball nut so that the ball nut clears the screws end before removing the arbor from its position. Ball nut removal should be done the same way. Failure to perform these actions may result in the bearing balls falling out of the ball nut and possible loss of bearing balls. While being installed or handled it is strongly advised that temporary stops such as tape or rubber bands be positioned on either end of the ball nut and only removed after installation is complete.
Performance Characteristics

Static Capacity
The maximum dead weight load the screw and nut assembly can advisably hold.

Dynamic Capacity
The maximum load the screw and nut assembly can advisably move.

Efficiency
A ratio of work output and work input with the difference being lost energy. These ratios are calculated as lubricated efficiencies and will vary depending on the nut material.

Torque to Raise
The amount of rotational force required to move one pound of load.

Acme Life
As mentioned, Duff-Norton manufactures our acme product from high quality materials. Still, there are too many variables involved in a given application for us to accurately predict acme nut life. This is largely due to inconsistent lubrication, and also the friction of dissimilar metals rubbing against one another.

Ball Life
Because of the ball screw and nut design, these assemblies operate very efficiently and life ratings can be provided. Please see page 115.

Ball Nut orientation
Proper orientation is important in horizontal applications. Return tubes located on one side of the ball nut only should be mounted facing up. Return tubes located on opposing sides of the ball nut should be mounted horizontally. Ball nut return tubes should not be installed in a downward position.

Backdriving
Generally speaking, any acme screw with a lead greater than .250” may be subject to backdriving or creep. Backdriving is when the force of the static load causes the undriven screw to rotate. The use of a brake motor is recommended in these applications. Acme screws with diameters .750” or larger and leads .250” or less are inherently self-locking.

Backlash
Backlash results from the space tolerance between the threads of the screw & nut and always increases with use. This undesirable motion will occur when the load is changing direction, and the load shifts to the opposite thread flank.
Load Conditions

End Fixity
The method by which the screw’s ends are supported. There are 3 common methods of end fixity which are frequently used in 4 combinations. “Free” support means the screw end is not supported. “Simple” support means the screw end is supported at one point only. “Fixed” support means the screw end is rigidly restrained.

Fixed - Free
Double bearing support on one screw end, the other end is not supported.

Simple - Simple
Single bearing support on both screw ends.

Fixed - Simple
Double bearing support on one screw end, single bearing support on the other screw end.

Fixed - Fixed
Double bearing support on both screw ends.

Column Strength
All screws loaded in compression are subject to buckling or bending although screw end-fixity can greatly impact column strength. It is important to understand the point at which these conditions are likely to occur. Please consult the tables on pages 113 & 116 for more information.

Critical Speed
Is the maximum recommended rate at which the screw should be turned. Critical speeds are highly subject to screw diameter, length, and end-fixity. Please consult pages 112 & 114.

Load Definitions

Static Load
The maximum dead-weight load that can be applied to a non-moving system.

Dynamic Load
The maximum recommended load that can be moved by a system.

PV Load
The severity of an application is something which should be considered when selecting a screw and nut system as all nuts are subject to heat buildup. The amount of pressure on the nut and surface velocity greatly impact system temperature. PV Values and formulas for Duff-Norton acme nuts provided on page 111.

Tension Load
Occurs when a load pulls on the screw and its support.

Compression Load
Occurs when a load pushes on the screw and its support.

Radial Load
Occurring either from the side or over-turning of the nut while travelling along the screw may be detrimental to system performance. Our customer service team will be glad to discuss your application with you to determine the best installation for your application.
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The “Maximum PV value” for plastic nuts is 11,000
The “Maximum PV value” for bronze nuts is 50,000

The PV calculation method is:
1) Find P;  \[ P = \text{Actual Load (pounds)} \times P_f (P \text{ factor}) \]
2) Find V;  \[ V = 0.2618 \times \text{Nominal diameter of the screw (inches)} \times \text{Rotational speed of the screw (rev per minute)} \]
3) Compare the results to the maximum limit:  \[ P \times V \text{ must be less than “Maximum PV Value”} \]

Note: Rotational speed of the screw (revolutions per minute) = Linear speed of the screw (inches per minute) / Lead of the screw (inches per revolution)
For best performance results always design your system to operate at parameters below and to the left of a given screw’s curve. The “Fixed-Simple” bearing support structure is recommended for most applications.
Small Acme Screw Column Strength

For best performance results; the “Fixed-Simple” bearing support structure is recommended for most applications. For vertical applications; tensions load structures are recommended.

Large Acme Screw Column Strength

For best performance results; the “Fixed-Simple” bearing support structure is recommended for most applications. For vertical applications; tensions load structures are recommended.
For best performance results always design your system to operate at parameters below and to the left of a given screw’s curve. The “Fixed-Simple” bearing support structure is recommended for most applications.
Ball Screw Life Performance

Load for alloy steel (lbs.)

Life Expectancy

1 = 1,000,000 In. Travel, 2C = Double Circuit Ball Nut

1 = 1,000,000 In. Travel, 2C = Double Circuit Ball Nut
For best performance results; the “Fixed-Simple” bearing support structure is recommended for most applications. For vertical applications; tensions load structures are recommended.
Rotary Limit Switches

Limit Switch Installation

Instructions for installing our NZ Series Limit Switches to our Simple End Blocks.

1. The Simple End Block is designed to be a “floating block” and should be moved backwards on to the acme or ball screw.
2. Mount the bearing in place on the screw’s journal.
3. Insert the cross pin into the hole drilled parallel to the screw’s end, then thread the lock nut in place.
4. Mount the Limit Switch adapter to the NZ Series Limit Switch with the input shaft extending beyond the adapter’s far edge.
5. Mount the Limit Switch and Adapter to the repositioned Simple End Block’s face, the end of the limit switches input shaft is slotted to fit into the screw’s end and over the cross pin. The acme or ball screw’s end will now be flush with the End Blocks face.

Note: Journal Ends and End Block sizes 000 and 001 use a small coupling to connect the Limit Switches input shaft to the screw’s journal. Contact Customer Service for SKA Series Limit Switch installation instructions.

Rotary Limit Switch Electrical Wiring Diagram and Setting Instructions

1. ▲ CAUTION: Disconnect power before making any adjustment.
2. Check drift before adjusting limits.
4. Run the screw system to desired limit.
5. Rotate appropriate nut until switch clicks, then turn 1/2 turn more.
6. Replace "A" and "B."
7. Run the screw system to other limit.
8. Repeat steps 2, 4 and 5 to adjust this nut.

Slight adjustments may be necessary. See Performance Specification Chart on page 83 for notch adjustment value.