



# The Engineer's Guide to Identifying Lead Screw Thread Forms

# Thread Forms

There are hundreds of different thread forms that have been designed over several decades. There are only a few specific thread forms that are commonly used for power transmission screws that convert rotary motion to linear motion. The most common thread forms used for lead screws are:

- Acme – both centralizing and general purpose
- Stub Acme
- ISO – Metric Trapezoidal
- Worm



# Thread Forms

**Thread Types** - There are three main classes of Acme thread forms:

1. General Purpose (G)
2. Centralizing (C)
3. Stub Acme

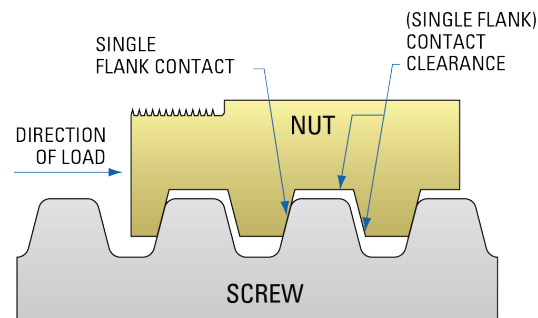
The General Purpose and Centralizing thread forms have a nominal depth of thread of  $0.50 \times \text{pitch}$  and have a  $29^\circ$  included thread angle. Some Helix sizes have  $40^\circ$  included angle. Trapezoidal thread forms have a  $30^\circ$  included thread angle.

# Thread Forms

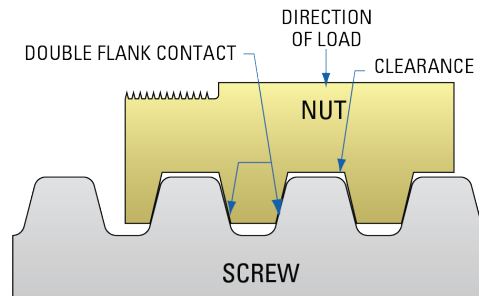
When compared to general-purpose thread forms, centralizing threads are manufactured with tighter tolerances and reduced clearance on the major diameter.

Stub Acme threads follow the same basic design, but have a thread depth less than one half the pitch.

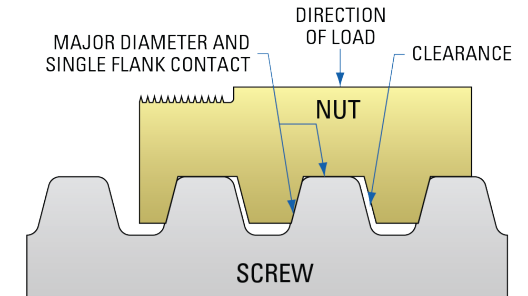
## NORMALLY LOADED NUT



## SIDE LOADED CONVENTIONAL 'G' CLASS NUT



## SIDE LOADED CENTRALIZED 'C' CLASS NUT



# Thread Forms

If an acme nut is side loaded with a radial load, a “G” class will “wedge” when the nut thread flanks come in contact with the screw thread flanks. To prevent wedging, less clearance and tighter tolerances are allowed between the major diameter of the nut and the major diameter of the screw.

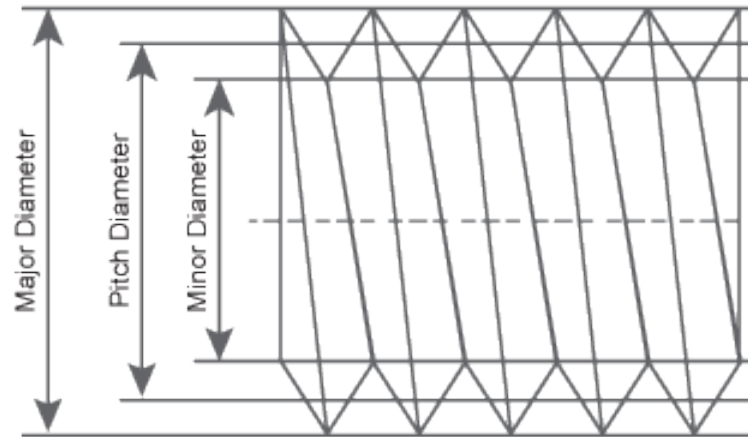


# Thread Form Terms

**Land (Major) Diameter** – The outside diameter of the screw.

**Pitch Diameter** – On an acme screw, this diameter is approximately halfway between the land diameter and the root diameter. It is the diameter at which the thread thickness is equal to the space between threads.

**Root (Minor ) Diameter** – The diameter of the screw measured at the bottom of the thread.

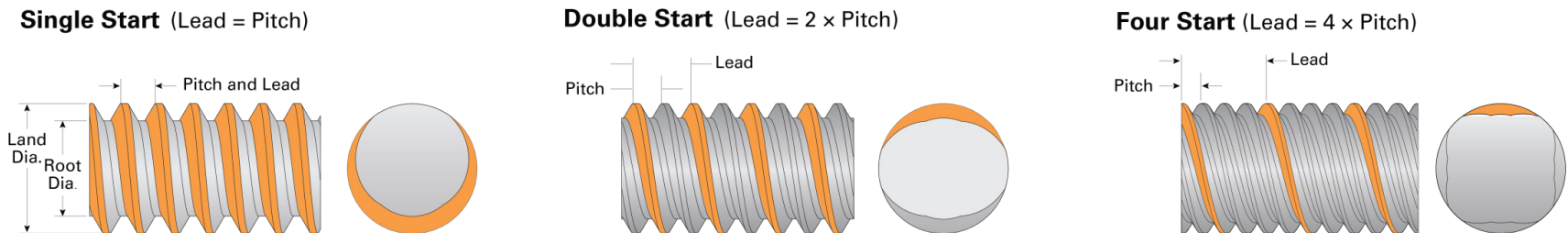


# Thread Form Terms

**Pitch** – The axial distance between threads. Pitch is equal to the lead in a single start screw.

**Lead** – The axial distance the nut advances in one revolution of the screw. The lead is equal to the pitch times the number of starts.

**Screw Starts** – The number of independent threads on the screw shaft; example one, two or four in the figure below.



# Thread Form Terms

**Lead Accuracy** – Lead accuracy is the difference between the actual distance traveled versus the theoretical distance traveled based on lead. For example: A screw with a 0.5 inch lead and 0.004 inch per foot lead accuracy rotated 24 times theoretically moves the nut 12 inches.

- 24 Revolutions × .500 inches per revolution = 12.000 inches of travel
- With a Lead accuracy of .0003"/inch, actual travel could be from 11.996 to 12.004 inches

**Matched Lead** – When multiple screws are used to move a load with precise synchronicity, screws of similar lead accuracy can be factory selected and supplied as sets. Consult factory for matched lead set tolerances.



# Thread Form Terms

**Straightness** – Although PowerAc™ Acme Screws are manufactured from straight, cylindrical material, internal stresses may cause the material to bend or yield. When ordering random lengths or cut material without end machining, straightening is recommended. Handling or machining of screws can also cause the material to bend or yield. Before, during and after machining, additional straightening is required. When ordering screws with machined ends from Helix, the following straightness tolerances can be expected:

- PowerAc™ Rolled and Milled Acme Screws are straight within 0.010 inch/foot and will not exceed 0.030 inch in any 6-foot section, when shipped from the factory.
- PowerAc™ Ground Acme Screws are straight within 0.001 inch/foot when shipped from the factory.

If tighter straightness tolerances are required, contact Helix customer service.

# Thread Form Terms

**Life** – PowerAc™ Acme Screws are manufactured from high quality materials with excellent dynamic properties. Because of the variable effects of friction, lubrication and cleanliness, a specific life cannot be predicted. Proper lubrication, regular maintenance, and operation within specified limits will extend the life of PowerAc™ Acme Screws.

**Efficiency** – Efficiency of PowerAc™ Acme Screw assemblies range from 15% to 85%. These efficiencies are dependent upon nut material, lubrication, lead and thread form. The efficiencies for each assembly are listed on the following pages.

# Thread Form Terms

**Backdriving** – Normally, acme screws are used to convert rotary motion into linear motion. Backdriving is the result of the load pushing axially on the screw or nut to create rotary motion.

Generally, a nut with efficiency greater than 50% will have a tendency to backdrive. If a selflocking assembly is required, select a nut with efficiency below 35%.

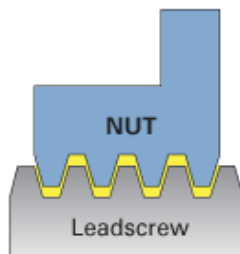
**CAUTION** - Vibration can cause any acme screw assembly to creep or backdrive. When using lead screws, applications should be analyzed to determine the necessity of a brake, especially when the possibility of injury may occur.

# Thread Form Terms

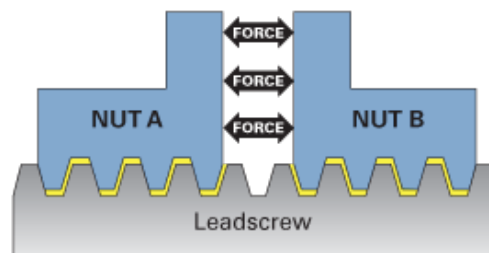
**Backlash** – Backlash (lash) is the relative axial clearance between a screw and nut without rotation of the screw or nut. Backlash information for PowerAc™ Acme Screws and Nuts is listed within the data section of this catalog. Lash will always increase with use. Helix has developed several unique ways to reduce or remove the lash between the screw and nut.

For screw diameters over 5/8 inch, PowerAc™ No-Lash™ Flanges are available. The PowerAc™ No-Lash™ Flange is identical to a standard flange except for slotted mounting holes. The backlash can be removed by using a nut with a PowerAc™ No-Lash™ Flange in combination with a standard nut and flange. By rotating the slotted PowerAc™ No-Lash™ Flange and nut relative to the other, the thread in the second nut advances until the lash is reduced.

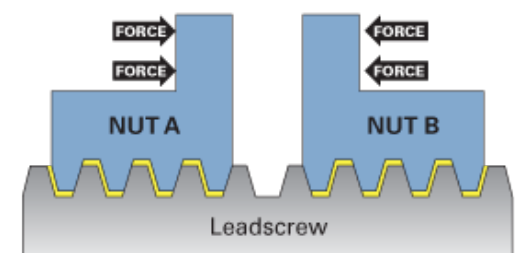
Standard Nut



Anti-Backlash Nut in Tension



Anti-Backlash Nut in Compression



# Thread Form Terms

**Backlash** Cont. – As the nuts wear and backlash increases, loosen the mounting bolts and readjust the PowerAc™ No-Lash™ Flange and nut until the lash is minimized.

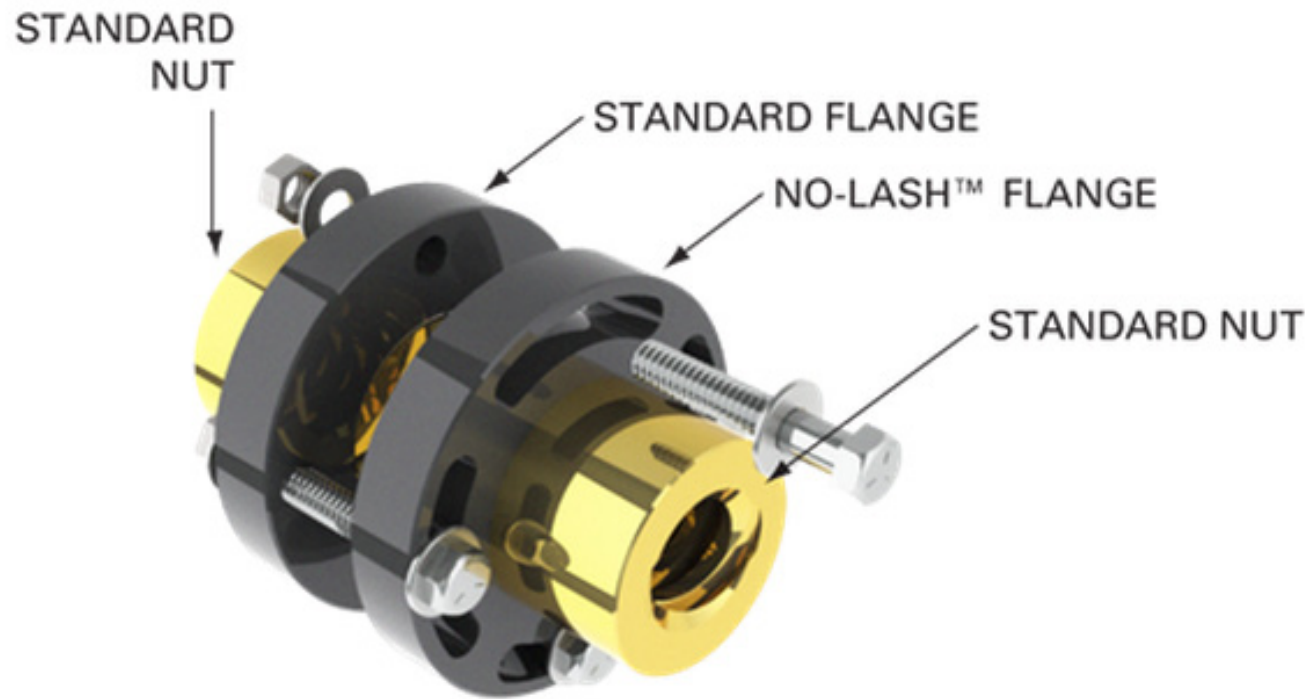
For a complete PowerAc™ No-Lash™ Flange assembly order 2 standard nuts, 1 standard flange and 1 No-Lash™ Flange. For example a 3/4"-2 assembly requires the following:

- 2 – 20072 Standard Nuts
- 1 – 70262 Standard Flange
- 1 – 73262 No-Lash™ Flange

**CAUTION** - When the uncompensated lash is equal to or greater than times the pitch, the assembly should be replaced.

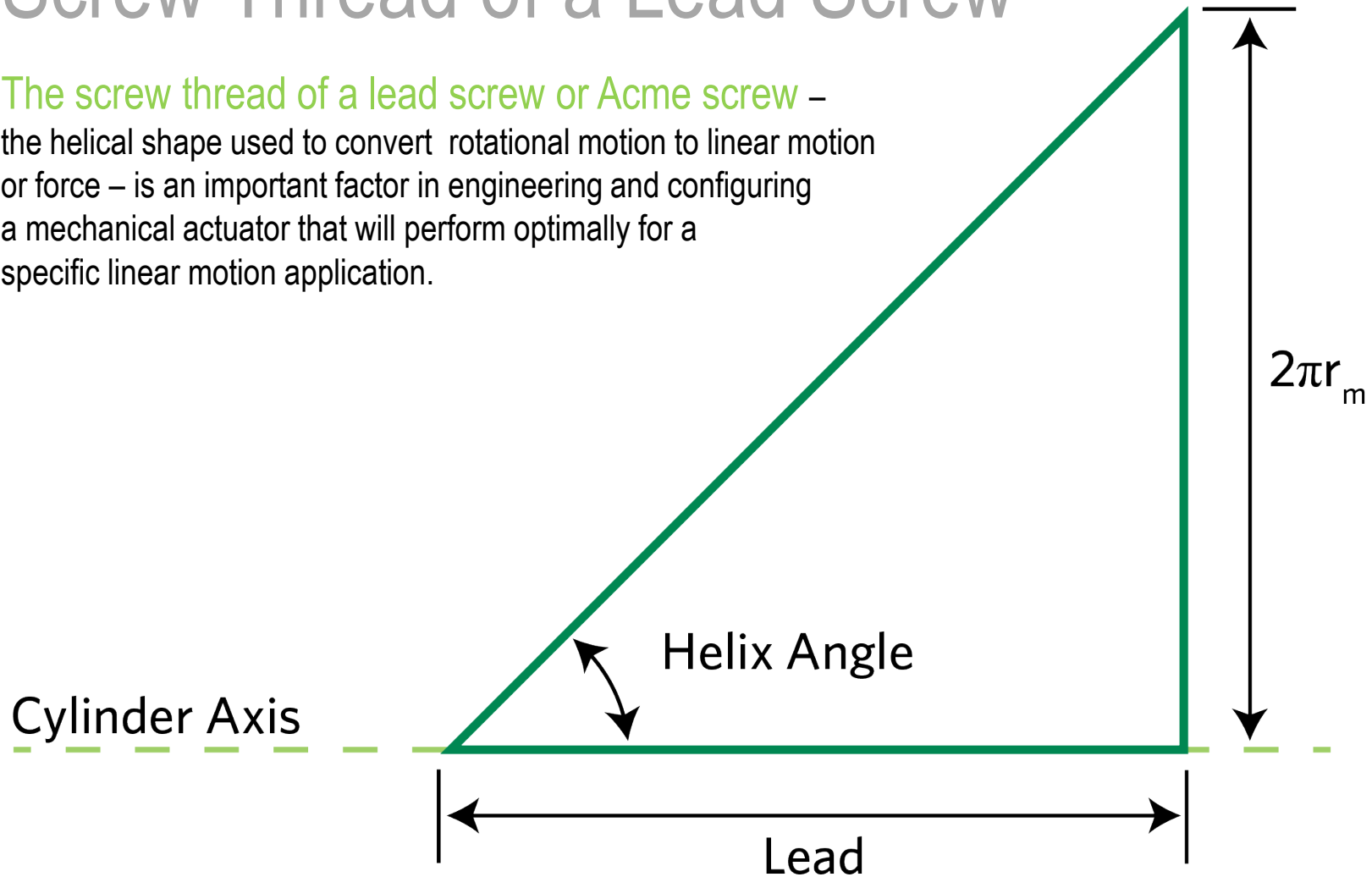
# Thread Form Terms

## Backlash Cont.



# Screw Thread of a Lead Screw

The screw thread of a lead screw or Acme screw – the helical shape used to convert rotational motion to linear motion or force – is an important factor in engineering and configuring a mechanical actuator that will perform optimally for a specific linear motion application.



# Screw Thread of a Lead Screw

The type of screw thread - the unique combination of form, class, size and specifications – indicated for your particular application is dependent on:

- **Lead**
- **Linear distance the nut travels in one revolution**
- **Direction**
- **Size**
- **Nature of loads**

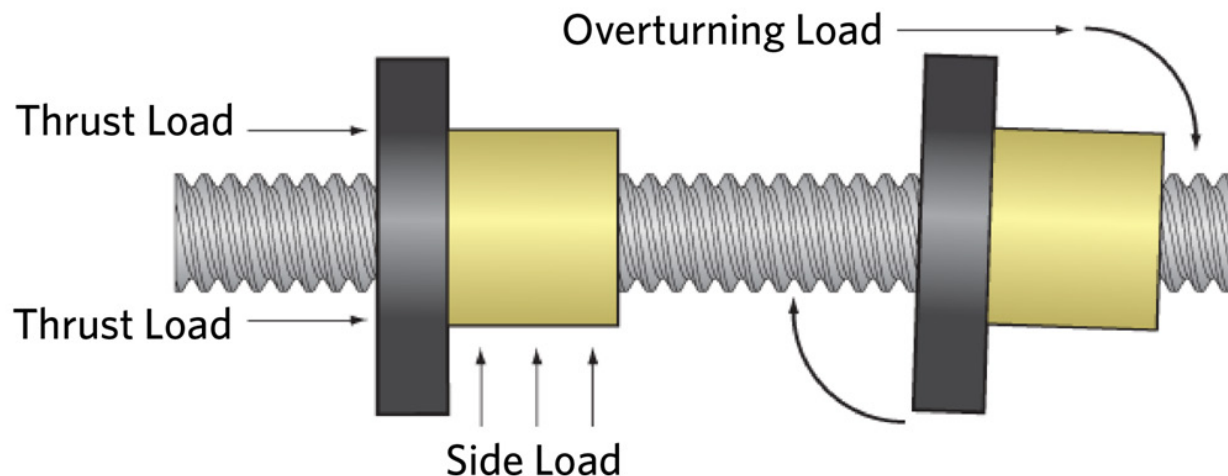




# Screw Thread of a Lead Screw

In most cases, the lead of a screw thread is selected to produce sufficient friction to maintain linear motion – so that the screw doesn't slip under load.

- An understanding of how screw threads can be configured, including screw materials and how unique configurations will function under different loading conditions, is critical to matching the right screw thread for your application.



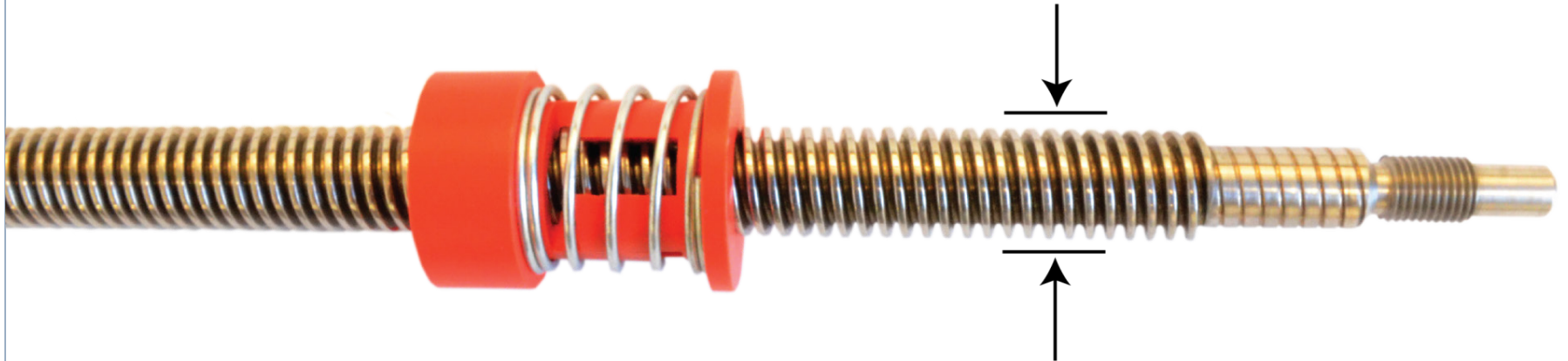
# Key Measurements of Screw Thread Sizes

When considering various screw thread forms for your applications, it's important to keep in mind the key measurements of screw thread sizes, which include:

- **Major diameter of external thread** – The diameter of an imaginary cylinder that touches the crest of the external thread.
- **Minor diameter of external thread** – The diameter of an imaginary cylinder that touches the root of the external thread.
- **Major diameter of internal thread** – The diameter of an imaginary cylinder that touches the root of the internal thread.
- **Minor diameter of internal thread** – The diameter of an imaginary cylinder that touches the crest of the internal thread.

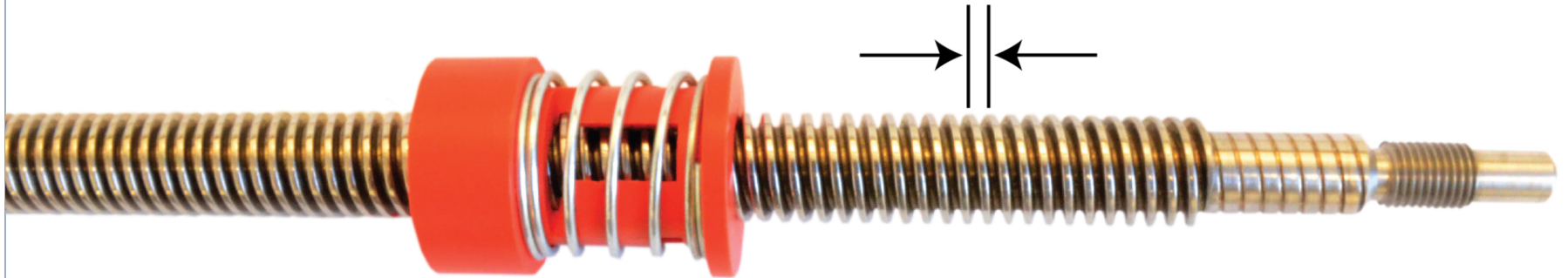
# Screw Thread Diameter

The major diameter for the threaded portion of the screw.



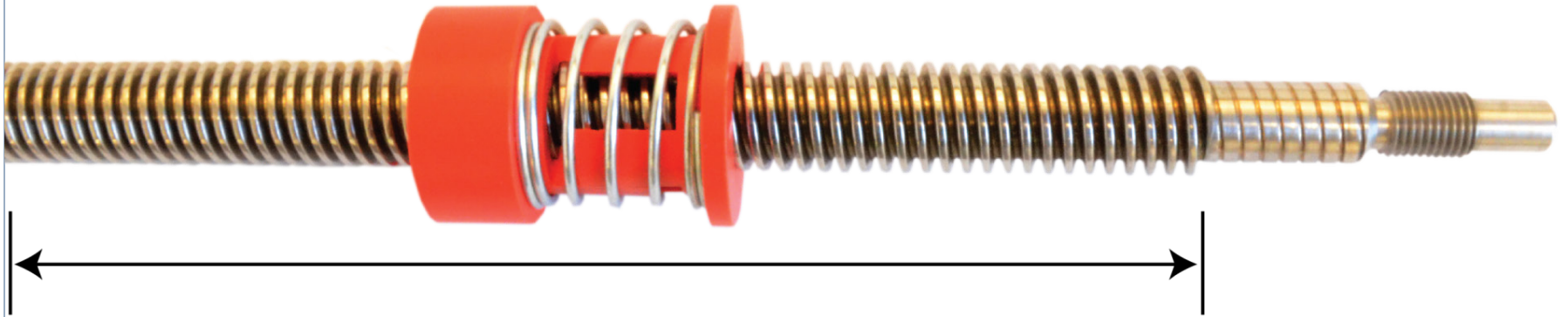
# Screw Thread Distance

The distance between adjacent threads, or thread pitch.



# Screw Thread Length

The length of most screws is measured from the bottom of the head.



# Screw Thread Materials

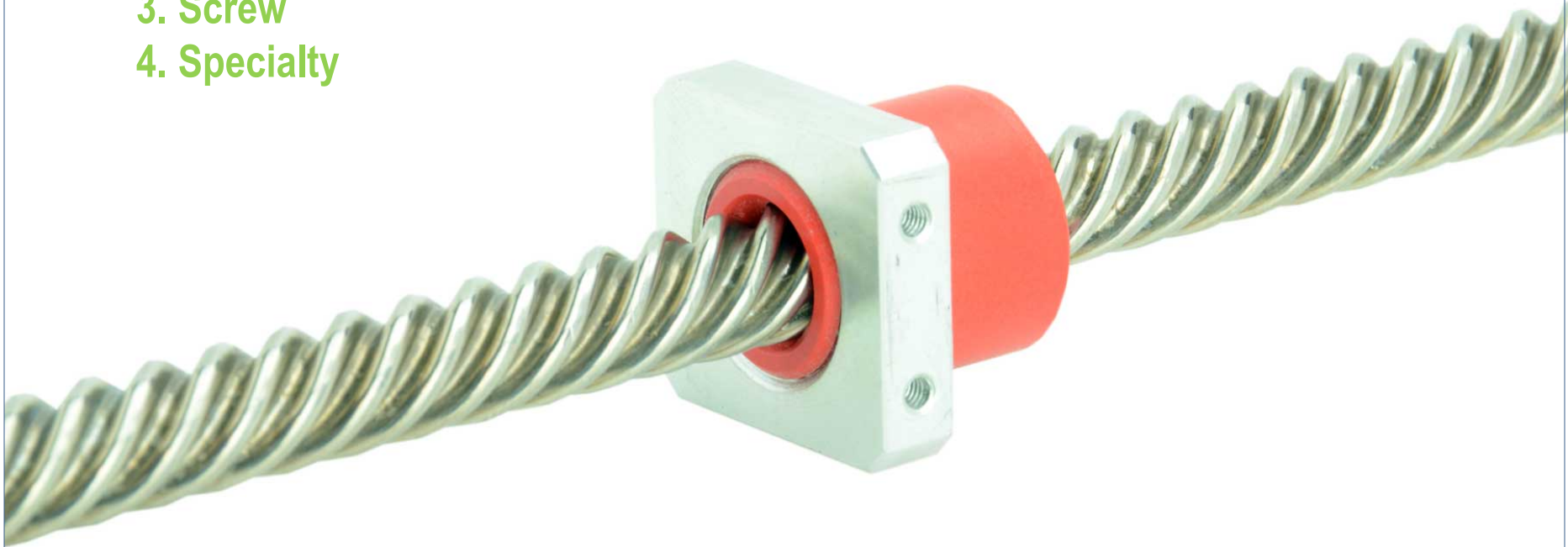
Another factor to consider when evaluating the appropriate screw thread for your lead screw or Acme screw application is the material of the screw itself. Screws are typically manufactured from the following materials:

- **Carbon Steels**
- **Alloy Steels**
- **Alloy Heat-Treated Steels**
- **Stainless Steel**
- **Aluminum**
- **Titanium**
- **Various Exotic Metals and Alloys**



# The Four Major Thread Form Families

1. Acme
2. Trapezoidal
3. Screw
4. Specialty

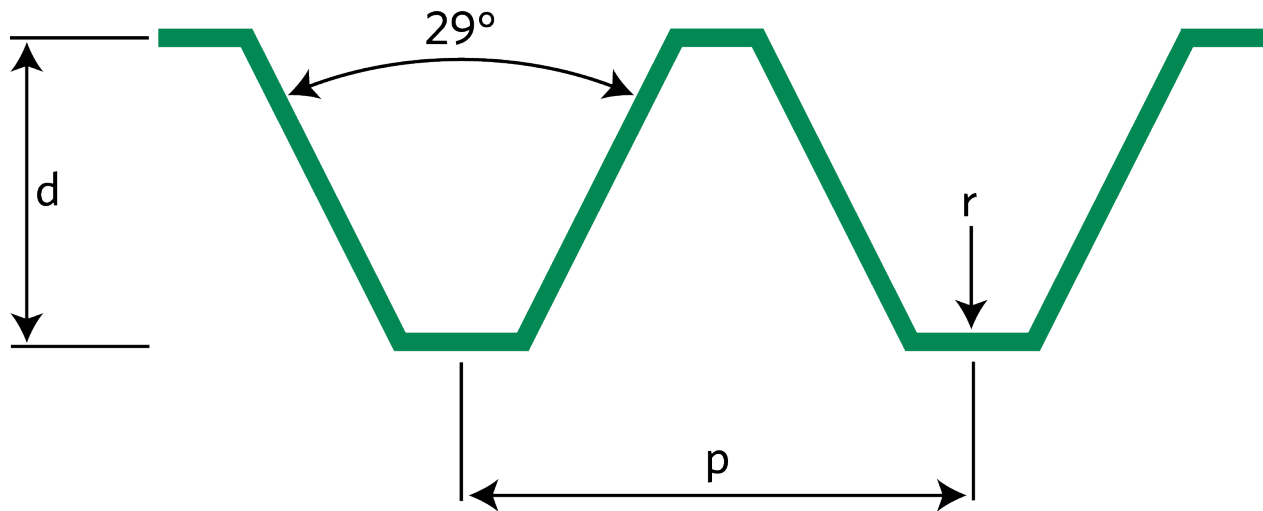


# 1. Acme Thread Form

- The Acme thread form is the original trapezoidal screw thread that was developed back in the late 1800s.
- 29° thread angle
- Half of the pitch, the distance between a point on one thread and a corresponding point on the next thread that is parallel to the axis.
- The apex and valley of the thread are flat
- There are 3 main classes of Acme thread forms:
  - a) Centralizing
  - b) General-Purpose
  - c) Stub Acme

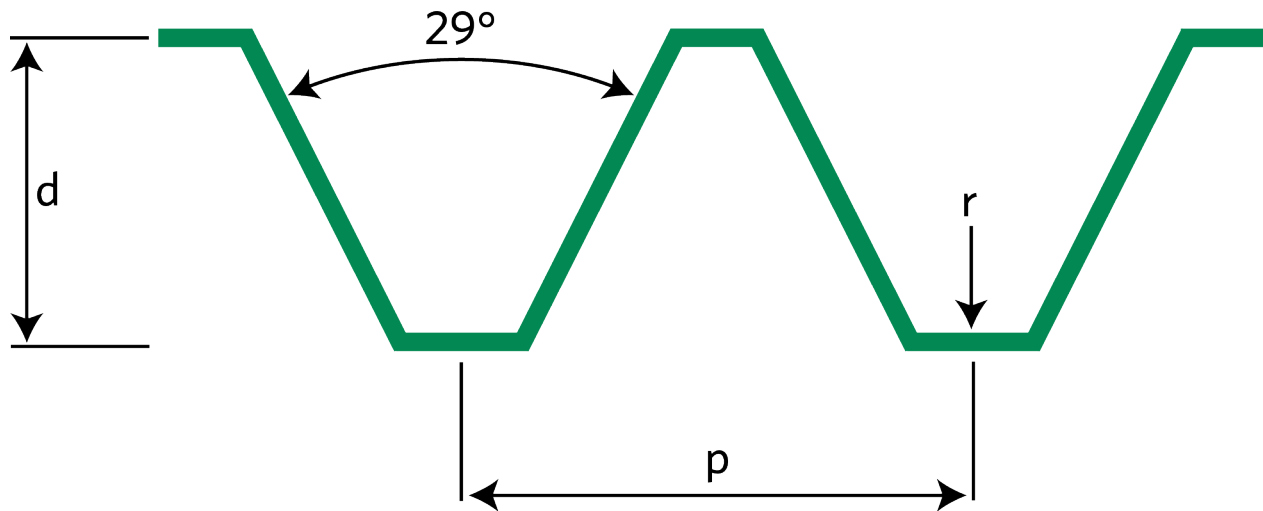


# 1. Acme Thread Form



Centralizing Acme

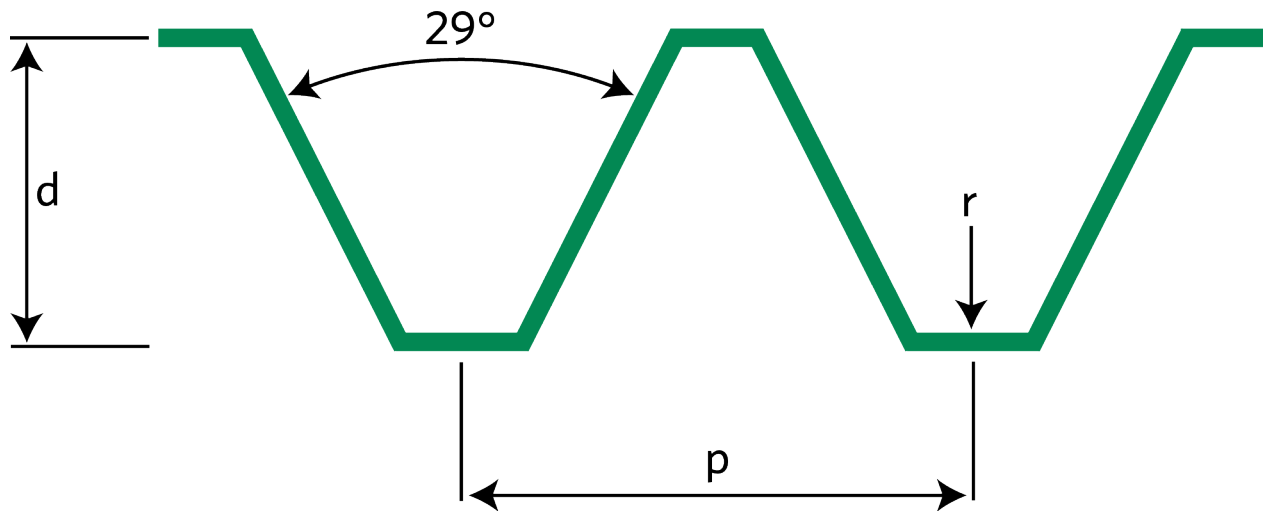
# 1. Acme Thread Form



General-Purpose Acme

# 1. Acme Thread Form

- Stub Acme threads follow the same basic design, but have a thread depth less than one half the pitch.



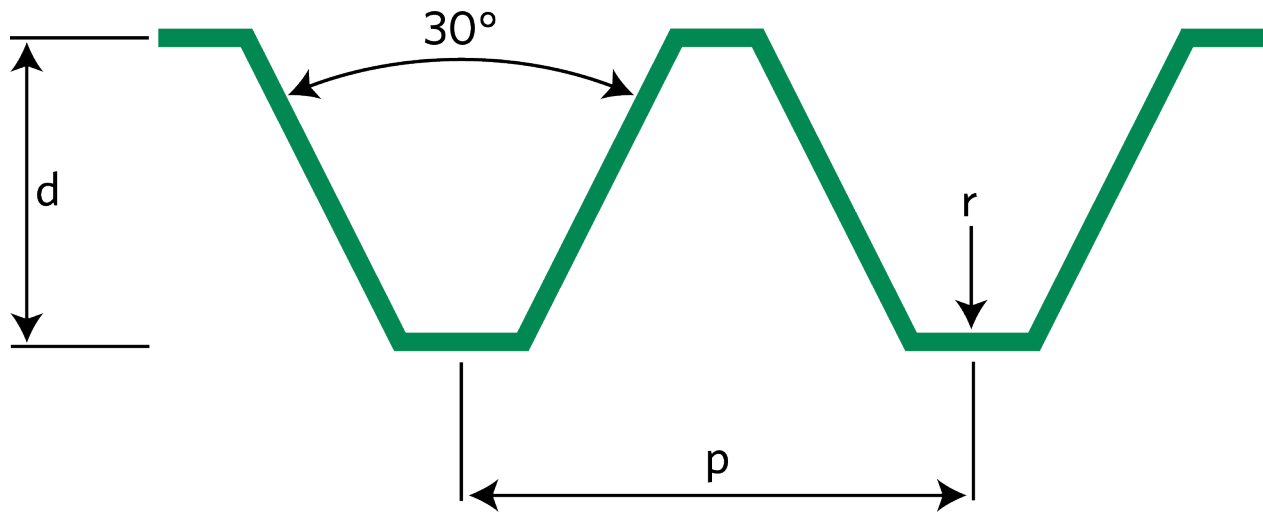
Stub Acme

## 2. Trapezoidal Thread Form

- Now commonly available in metric sizes
- 30° thread angle
- Offers greater strength for larger loads
- HELIX offers precision lead screw assemblies with a trapezoidal thread form that have a 40° thread angle.
- Standard variations of trapezoidal screws include:
  - Multiple-start threads
  - Left-hand turning threads
  - Self-centering threads



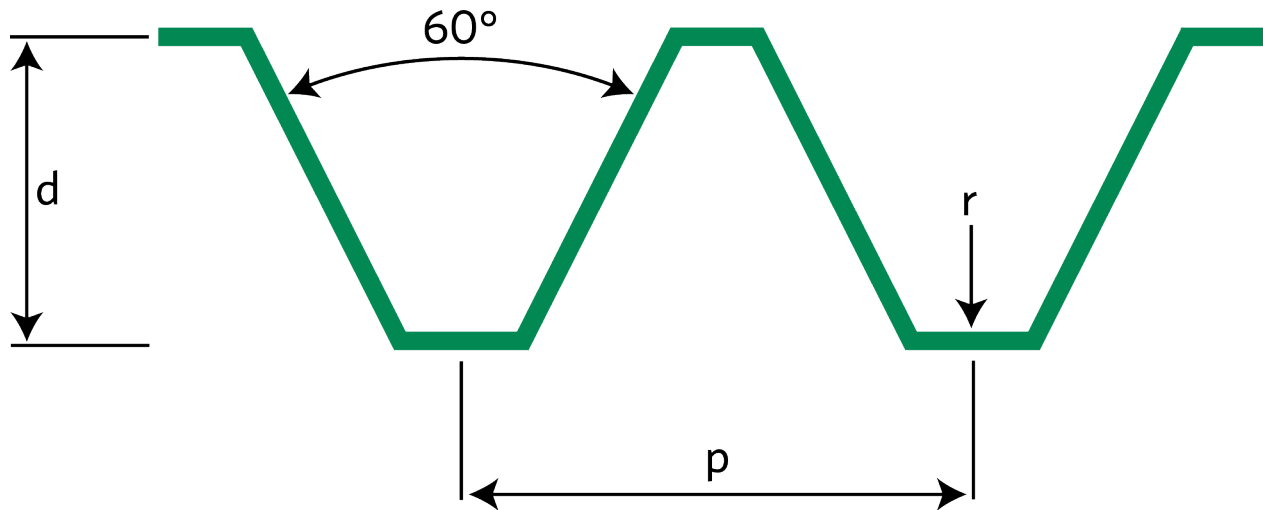
## 2. Trapezoidal Thread Form



Trapezoidal

# 3. Screw Thread Form

- Primarily used for large diameter lead screws with a 60° thread angle.



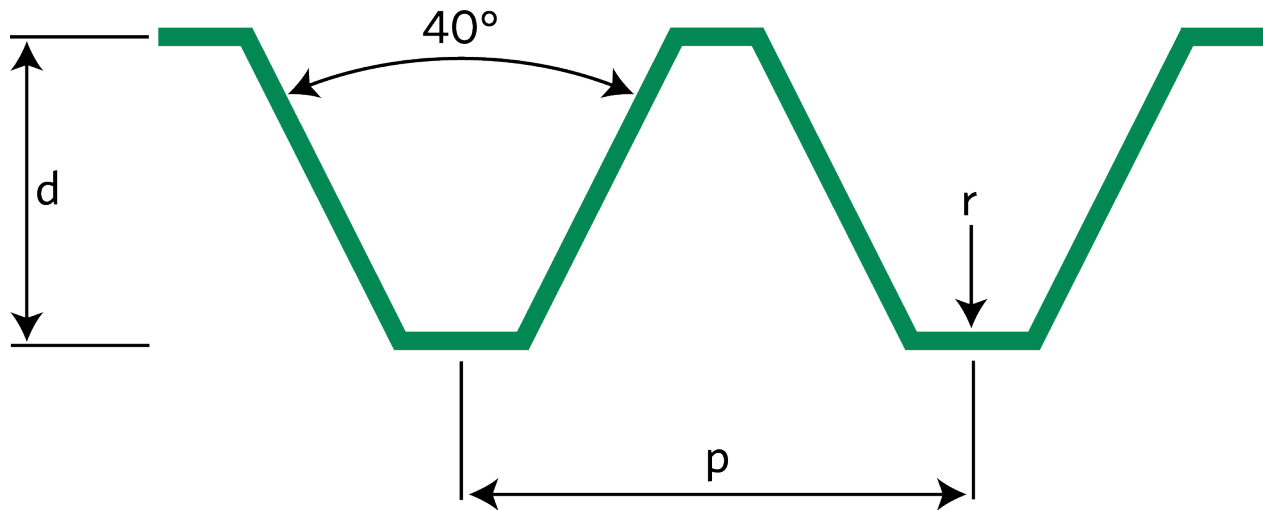
Screw

# 4. Specialty Thread Form

- Encompasses custom-engineered screw threads that are configured for unique applications and non-standard forms such as:
  - a. American Worm
  - b. Module Worm
  - c. Modified Buttress



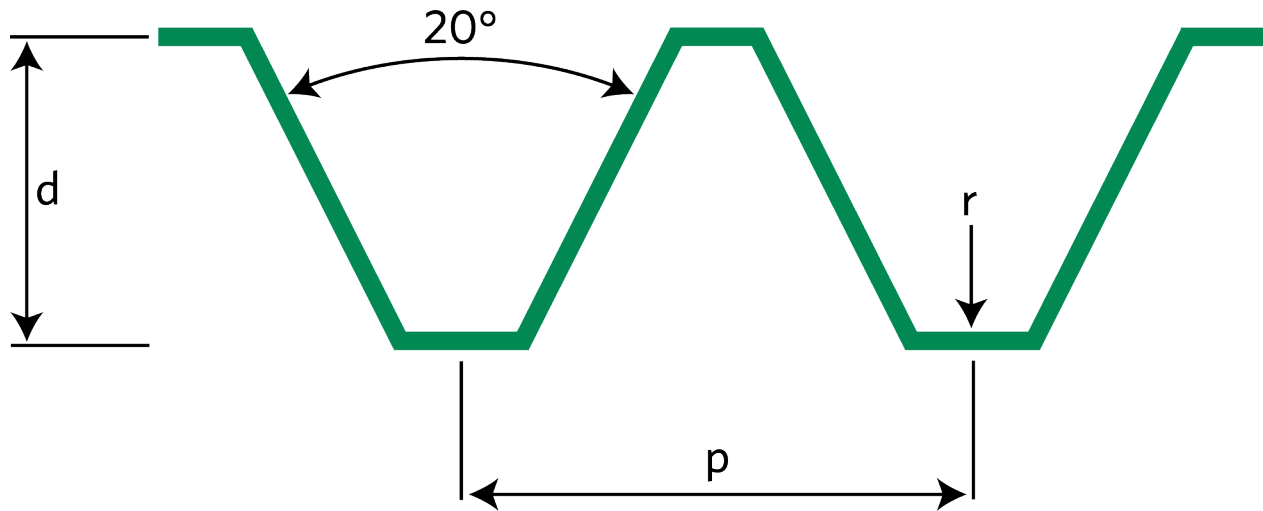
# 4. Specialty Thread Form



American Worm

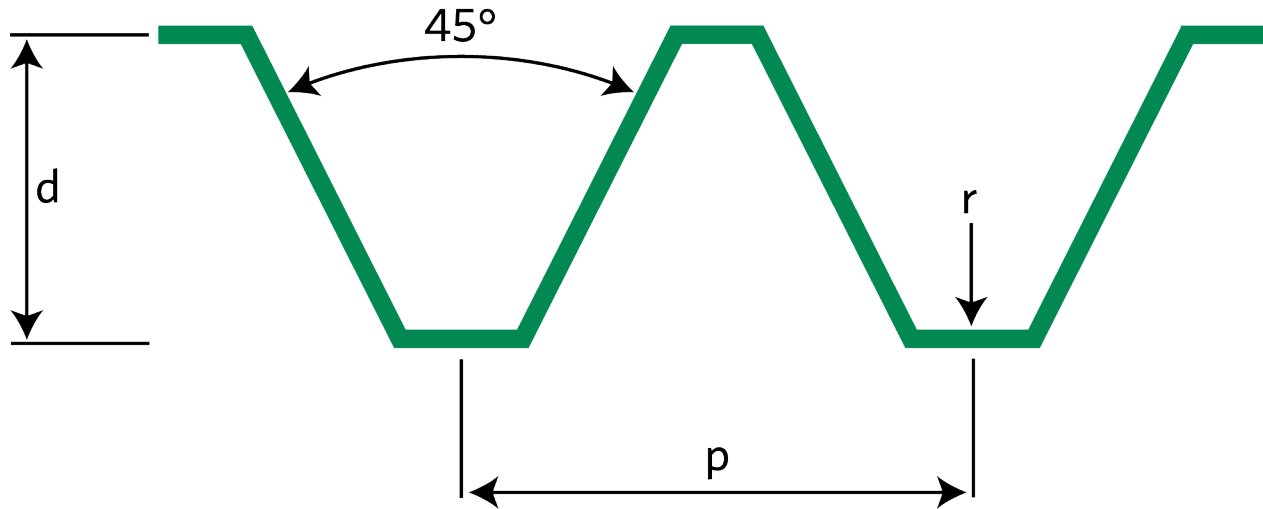


# 4. Specialty Thread Form



Module Worm

# 4. Specialty Thread Form



Modified Buttress

# Consult HELIX to Determine the Right Screw Thread for You

For design engineers who have screw thread questions or need a screw thread form that isn't standard, contact Helix. Whatever configuration you need, we can walk you through the process of specifying a screw thread that best fits your particular application.

To learn more about screw threads and HELIX options and capabilities, download our catalog.



We hope you found this presentation helpful.

For more information, please contact us at:

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