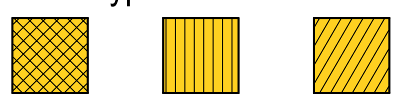
# SPIROL® INSERT DESIGN

**The objective is to design an Insert with sufficient torque resistance to accommodate the tightening torque necessary to achieve sufficient axial tension load on the threaded joint to keep it together and prevent loosening, while also achieving pull-out values necessary for the load conditions that the Insert will be exposed to while in service.**

**In general, resistance to torque is a function of diameter and resistance to pull-out is a function of length. These functions, however, are interactive and the challenge for the designer is to achieve the optimum combination of both.**

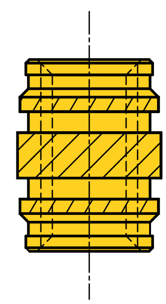
### Post-Mold Installed with Heat or Ultrasonic Installation

Types of Knurls




**Knurls** are used to increase resistance to torque. Straight knurls, as opposed to diamond knurls, are the preferred design. Coarser knurls increase resistance to torque but they also induce greater stress on the plastic. In addition, the circumference of the Insert determines the knurl pitch so there are practical limitations on knurl design. Helical knurls, in comparison to straight knurls, lower torque resistance but increase axial pull-out resistance. In practice, knurl angles between 30 and 45 degrees have a positive impact on pull-out resistance with a minimal loss of torque value. Several knurl bands with different helix angles can be combined on the same Insert to achieve an optimum combination of torque and pull-out resistance.

Some Inserts are designed with a slightly larger diameter knurl band between two slightly smaller diameter knurl bands on either side, separated from the larger knurl band by grooves. With a properly designed Insert installed in a hole manufactured as recommended, the plastic will flow over the larger knurl band into the groove and knurls behind the larger knurl band in the opposite direction of installation, significantly increasing pull-out resistance. All the plastic above the larger knurl band in effect becomes a shear plane. A head facilitates plastic flow into the upper grooves of the Insert.



Finally for best performance, it is essential that the Insert is properly aligned with the hole during installation. This can be facilitated with tapering the Insert or by providing a pilot. Pilots need to be of sufficient length and have a plain, unknurled diameter the same size or slightly smaller than the hole.

### Determining Proper Installation

Retention within the hole is provided by the plastic conforming to the external features of the Insert. A sufficient volume of plastic must be displaced to entirely fill these external features so that the Insert achieves maximum performance when the plastic solidifies. An accurate way of determining sufficient plastic flow into the knurls, barbs and undercuts of the Insert is to take a cross section of the installed Insert and ensure that the features are mirrored in the plastic as shown in *Figures 1* and *2*. It is extremely important to ensure proper plastic flow into the features of the Insert as this dictates the torque and pull-out performance. In *Figure 2*, the plastic did not sufficiently flow into the retention features, which will result in low Insert performance.

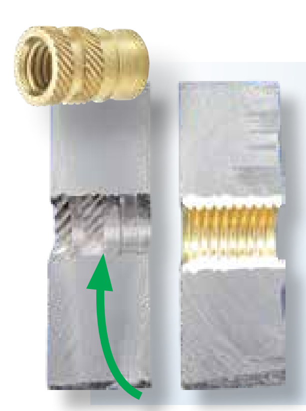
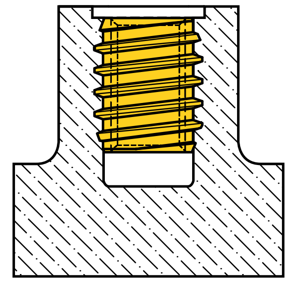


Figure 1. Proper Plastic Flow

Figure 2. Improper Plastic Flow

## Self-Tapping Inserts

Provide the best pull-out resistance for a post-mold installed Insert. The threads are designed with a thin profile to minimize inducing stress into the plastic and a relative coarse pitch to provide the maximum plastic shear surface to resist pull-out.

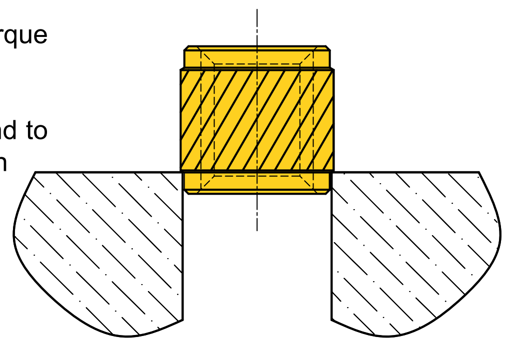


Installation torque is not a problem in that tightening increases the friction between the plastic and threads, and the larger diameter of the external Insert thread increases the frictional surface. Back-out torque performance relies totally on the greater surface area of the external Insert thread and the tension between the threads and plastic.

Again, to facilitate installation square to the hole, a good pilot is essential.

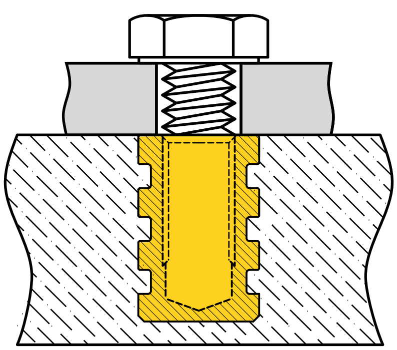
## Press-In Inserts

These Inserts are designed to reduce installation cost at a sacrifice of torque and pull-out performance.



Helical knurls are used to provide both torque and pull-out resistance and to ensure good plastic flow as the Insert rotates into the hole. Installation torque to achieve sufficient tension between the threads is not a problem in that the helical knurls are designed so that the direction of the installation torque will have the tendency to drive the Insert into the hole — which of course is not possible — as the threaded joint is tightened.

A pilot only slightly smaller than the hole and of sufficient length is designed to assure straight insertion into the hole.



Blind-end Inserts provide an additional alternative to prevent plastic from flowing into the inside of the Insert.

## Molded-In Inserts

This process, although generally more costly in getting the Insert into place than the post-mold installation process, provides the best performance.

Both length and diameter have an impact on pull-out resistance and torque. The challenge is to find the most cost-effective solution that provides/meets the installation torque requirements to achieve a good threaded joint, and the pull-out values that meet the application load requirements.

Axial grooves are the designer's choice to maximize the torque resistance for a given diameter. The volume of these grooves must be such that sufficient plastic is encapsulated in the voids to meet the installation torque requirements for the given bolt.

The amount of plastic trapped in the undercuts of the Insert must be sufficient to achieve the pull-out resistance to which the Insert is subjected while in service.

In order to facilitate insertion into the mold squarely on the core pin, the tolerance of the minor thread diameter is reduced for a good fit between the Insert and these mold core pins. Countersinks are designed to simplify the placing of the Insert on the pin.

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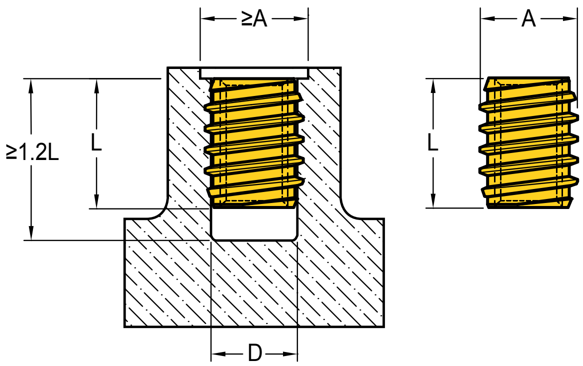
# SPIROL® DESIGN GUIDELINES

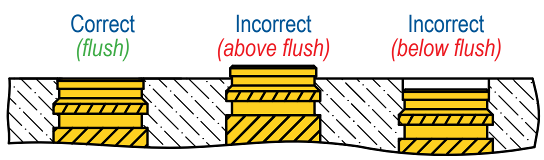



● **Holes** for post-mold installed Inserts should always be deeper than the length of the Insert. For Self-Tapping Inserts, a minimum depth of 1.2 times the Insert length is recommended. For other Inserts, the recommended minimum depth is the Insert length plus two (2) Insert thread pitches. The assembly screw should never bottom out in the hole, as jack-out would result.

● **Counterbores** are not recommended for any Insert types *except* Self-Tapping and Headed Inserts. Counterbores are recommended for Self-Tapping Inserts to reduce the risk of flaking. The outside diameter of the counterbore should be equal to or larger than the outside diameter of the Self-Tapping Insert. The mean counterbore depth should be equal to one thread pitch of the Insert's outer thread.

Counterbores are also recommended for Headed Inserts so that the top of the Insert will be flush with the surface of the plastic after installation. The diameter of the counterbore should be 0.5mm (.02") to 1.3mm (.05") larger than the head diameter of the Insert. The minimum depth of the counterbore should be specified as the thickness of the head. Insert heads are sometimes left above flush to reduce jack-out or improve match-up with the mating component.

The top of the installed Insert should be flush with the surface of the plastic part with maximum protrusion from the host of 0.13mm (.005").




Top of the Insert should be installed as close to flush as possible with the surface of the plastic.

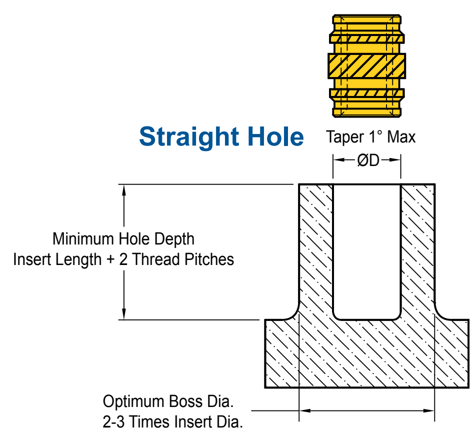
● **Correct hole size** is critical. Larger holes decrease performance, while smaller holes induce undesirable stresses and potential cracks in the plastic. Undersized holes may also result in flash at the hole edge and make the Insert more difficult to install. The recommended holes need to be reviewed if fillers are used. If the filler content is equal to or greater than 15%, it is suggested to increase the hole 0.08mm (.003"), and if the content is equal to or greater than 35%, the suggested hole increase is 0.15mm (.006"). For intermediate contents interpolation is suggested. Due to the great variety of fillers and plastics and combinations thereof, consultation with **SPIROL** Engineering is strongly recommended.

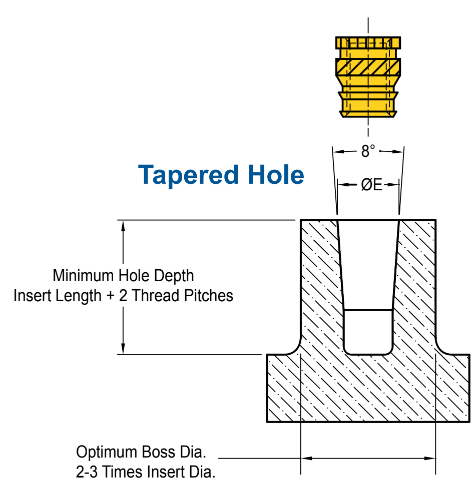
● **Molded holes** are preferred over drilled holes. The strong, denser surface of the molded hole increases performance. Core pins should be large enough to allow for shrinkage. For straight holes, the taper should not exceed a 1˚ included angle. Tapered holes should have an 8˚ included angle.

● **Tapered holes** reduce installation time and ensure proper alignment of the Insert to the hole. Only tapered Inserts should be used in tapered holes. Easier release from the core pin is an additional benefit.

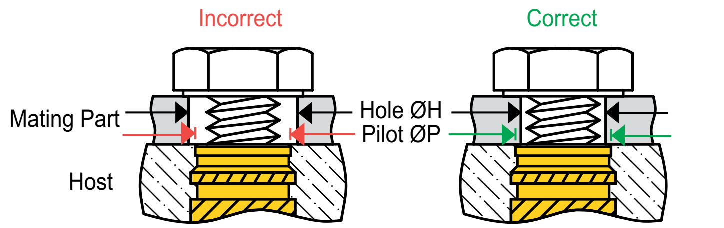
● Insert performance is affected by the plastic boss diameter and/or wall thickness. Generally the **optimum wall thickness** or **boss diameter** is two (2) to three (3) times the Insert diameter with the relative multiple decreasing as the Insert diameter increases. The wall thickness has to be enough to avoid bulging during installation, and for boss diameters to be strong enough for the recommended assembly screw installation torque. Poor knit lines will cause failures and reduced Insert performance. Ribs can be added to the boss for added strength.

● Post-mold installed Inserts that are **cold-pressed** into the hole require larger boss diameters and/or wall thickness to withstand the greater stresses induced during installation. Installing the Inserts while the plastic is still warm from the molding process generally eliminates this need.



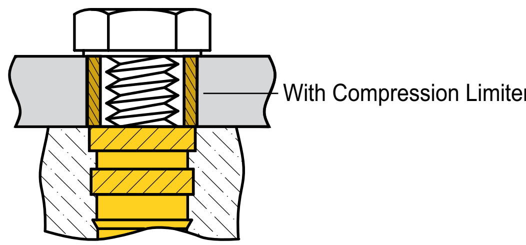



● The **diameter of the clearance hole in the mating component** is very important. The Insert and not the plastic must carry the load. The hole in the mating component must be larger than the outside diameter of the assembly screw but smaller than the pilot or face diameter of the Insert. This prevents **jack-out**. If a larger hole in the mating component is required for alignment purposes, a headed Insert should be considered. Inserts should be installed flush (or no more than 0.13mm (.005”) above the hole).

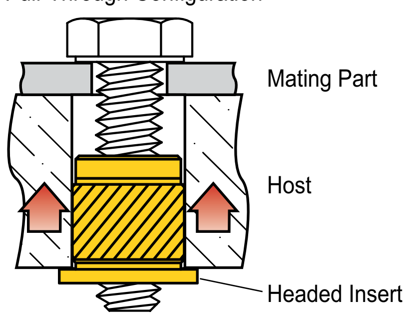



Hole In Mating Part Must Be Smaller Than Insert Pilot Diameter In Host To Prevent The Insert From Pulling Through The Assembly – Known As “Jack-Out”.

● If the mating component is plastic, the use of a **Compression Limiter** should be considered to maintain the preload of the threaded joint. In order for the Compression Limiter to work properly, it should abut the Insert so that the Insert, and not the plastic, carries the load. *For additional information see page 21.*

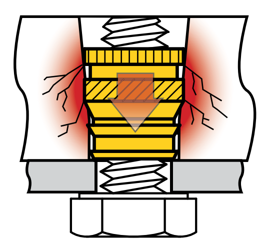



Pull-Through Configuration




● **Insert heads** provide a larger bearing surface and a conductive surface if this is a requirement. The head also facilitates plastic flow into the upper knurls and grooves for Heat/Ultrasonic Inserts. In high load applications, locating the head opposite the load in a **pull-through configuration** warrants design consideration.

**Tapered Inserts** should **NOT** be used in pull-through applications or in thin walled bosses as this will cause cracking of the plastic.



**The SPIROL Application Engineering Center can provide impartial advice relative to specifically defined requirements based on extensive experience in the field of Insert design and application. Testing facilities are available, and testing and a report of the results is a free service provided to our customers.**

**STANDARD MATERIALS**

| Type | Grade |
|---|---|
| **A** - Aluminum<br>High Strength Aluminum Alloy | ASTM B211 2024<br>ISO AlCu4Mg1 |
| **E** - Brass<br>Free-Cutting Brass | ASTM B16<br>UNS C36000<br>EN 12164 CW603N CuZn36Pb3 |
| RoHS compliant | |

**ORDER DESCRIPTION**

**INS (Series #) / Thread Size / Length Material Finish**
**Example:** INS 29 / 8-32 / .321L EK

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