Selection, Design and Installation Guide for Press Fit Fastener Components, Part 1 Swage Fit

Press fit fasteners are an inexpensive method of mounting/spacing electronic circuit boards, electronic components and mechanical assemblies using a single component that is both fastened to the substrate and in turn, has the capability to be fastened to. There are a variety of Press Fit mounting options available to affix fastener components (standoffs, spacers, panel inserts, inserts, nuts, etc.) into substrates such as PC Boards, Thermoplastics, Castings, Panels and Metallic (aluminum, brass, mild steel) Enclosures for electronic packaging and mechanical assembly applications. For installation, normal equipment, such as an arbor press, punch press, and drill press are most commonly used. After installation the parts are permanently fixed onto the board/substrate and further assembly becomes simplified.

There are 2 main categories of press fit fasteners outlined in this document, namely, **Swage Fit** and **Cold Flow Fit**. The base substrate material properties will be the main factor determining whether a Mechanical Designer/Engineer would choose between a Swage Fit or Cold Flow Fit component. For instance, if the material is brittle (circuit board material, ceramics, glass, etc.) in nature and not conducive to cold working, Swage Fit mounting options would be preferred over a Cold Flow Fit mounting option. Swage Fit fasteners are designed to maintain minimal interference with the base substrate material during the pressing operation. The cold working forces are applied to the material of the Swage Fit fastener, not to the base substrate. Thus brittle base materials are not susceptible to cracking while press fitting. In contrast, the Cold Working Press fit fasteners are used in applications where the base material is "flowable" under cold working and the fastener is hard (as compared to base substrate). An example would be a stainless steel fastener press fit into an aluminum or brass base/substrate material. The forces of cold working are applied to the base material allowing this material to flow and lock the fastener into the base substrate after pressing. In this document we will focus on Swage Fit category of components. In our subsequent document we will discuss Cold Form Fit category of components.

Typical press fit fastener options identified here are to assist mechanical designers/engineers for ease of selection and proper implementation. For proper design and installation of these components, tips and calculations are also offered by Customizable Fasteners at info@cimageid.com.

SWAGE FIT DESIGN OPTIONS FOR FASTENERS:

The most common Swage Fit design options for connecting fastener components into substrates include:

- Straight Swage Fit
- Flared Swage Fit
- Flush Flared Swage Fit
- Knurled Swage Fit
- Face Knurled Swage Fit
- Positive Locking Swage Fit
- Hi Torque Swage Fit
- Snap-In Fit
- Snap-In Self Aligning- Retaining Fit

Straight Swage Fit (figure 1):

Straight Swage Fit is accomplished when the shank of a component is inserted into the bore hole of the substrate (PC Board, Enclosure material or other) and, using Punch and Anvil Tooling, the lead edge of the shank protruding from the backside of the substrate is dimensionally altered and rolled back. This roll back deformation process causes the component to be permanently affixed to the substrate.

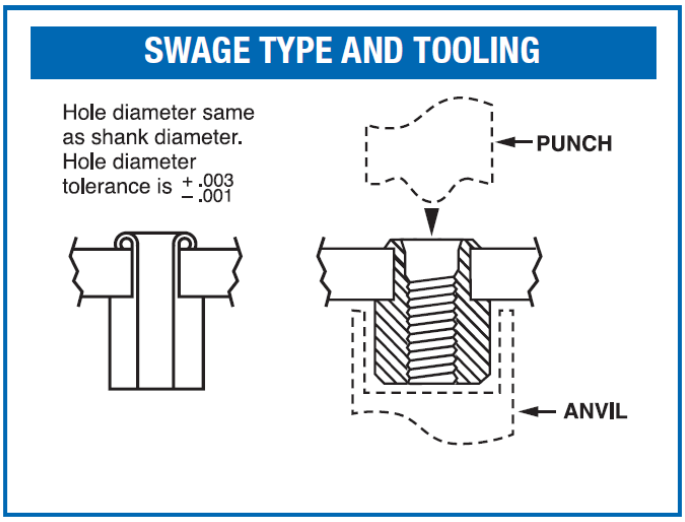

Figure I: Straight Swage Fit

The installation process is accomplished by using means of force to deform the shank as it passes to the back side of the base substrate. For pressing, normal equipment, such as an arbor press, punch press, drill press are most commonly used. For the appropriate Punch and Anvil Tools by component shank diameter, Customizable Fasteners can recommend the Swage Tooling for a component. Typical components utilizing the Straight Swage Fit are standoffs and Panel inserts shown below.

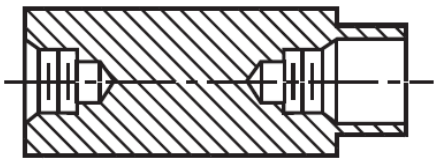

Figure 2. Swage Fit Standoff

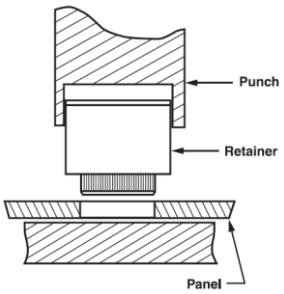

Figure 3. Straight Swage Fit Panel Insert

For ordinary Swage type installation, a properly sized bore hole either drilled or punched is necessary for proper fit during installation and for permanency. As well, the proper shank length for the thickness of the substrate being used is necessary. Bore hole diameter is recommended to be same diameter as the shank diameter with tolerance +.003/-.001. Recommended shank length is .040" longer than the substrate thickness. This shank length excess allows for proper roll over to backside of substrate post deformation process.

It should be noted the swage fit component will have protruding shank material on the backside of substrate. If this protrusion is not desirable, the Flush Flare Fit may be a more acceptable option. Also, if there is design criteria for affixing a component into substrate and avoiding the component from spinning during use, then refer to Knurled Fit, Positive Locking Fit or Hi Torque Fit options below.

Flare Swage Fit:

Flare Fit is used for installation of a component to gain additional frictional holding force between the component and base substrate by increasing the surface area of contact beyond the Straight Swage Fit above. Flare Swage Fit requires the substrate to have a properly sized bore hole and counter sink on the backside of the substrate for effective installation and permanency. Using Punch and Anvil Tooling, the lead edge of the shank protruding into the counter sunk region of the substrate is dimensionally altered by conically expanding the diameter to contact fit onto the counter sunk surface. The diameter of the conically deformed region is larger than the bore diameter and thus holds the component into the substrate permanently.

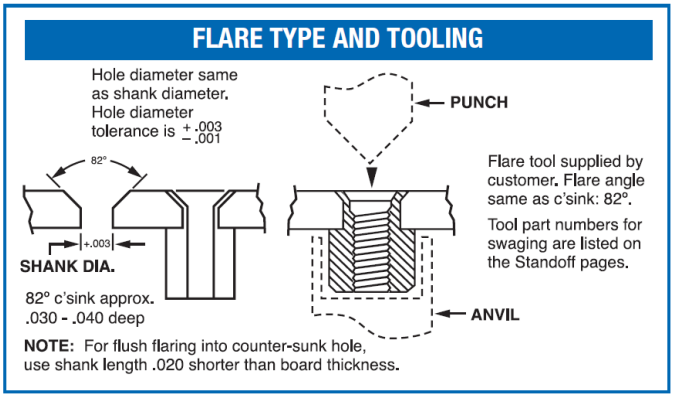

Figure 4. Flush Flare Spacer Example and Punch Anvil tooling for Installation

The installation process is accomplished by using means of force to deform the shank. For pressing equipment, an arbor press, punch press, drill press are most commonly used. For the appropriate Punch and Anvil Tools by component shank diameter, connect with Customizable Fasteners. For ordinary Flare Fit type installation, a properly sized bore hole either drilled or punched is necessary for proper fit. The recommended depth and angle of the counter sink are also necessary for proper fit. As well, the proper shank length for the thickness of the substrate being used is necessary. Bore hole diameter is recommended to be same diameter as the shank diameter with tolerance +.003/-.001. Recommended depth of counter sink is ½ the thickness of the substrate and the angle is 82 degrees. Recommended shank length is calculated using simple geometric and algebraic expressions as shown below:

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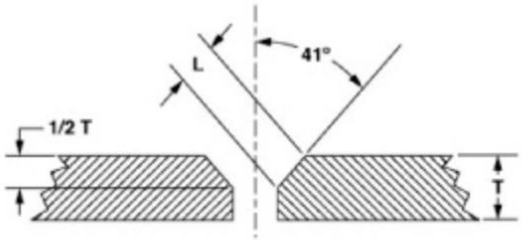
For proper installations countersink to approx. 1/2 panel thickness - the recommended depth. Panel thickness in the drawing below is represented by T. We start with known data, and then apply the formula below to determine the appropriate shank length for the base substrate thickness



The base shank length would be 1/2T + L, where L = $\frac{1/2T}{\text{cosine } 41°}$

Note, if there are design criteria for affixing a component into substrate and avoiding the component from spinning during use, refer to Knurled, Positive Locking and Hi Torque options below.

Flush Flare Swage Fit:

Flush Flare fit is accomplished the same as above Flare Fit except for the specified shank length. It is usually specified for the purpose of keeping the backside of the substrate free of protruding shank and completely flush. To accommodate this fit, the recommend shank length should be specified to be .010" less than calculated above. The general calculation for Flush Flare Fit shank length is shown below long with an example of a component in figure 4.

The base shank length for flush flare would be 1/2T + L, where L = .5T/cosine 41 minus .010"

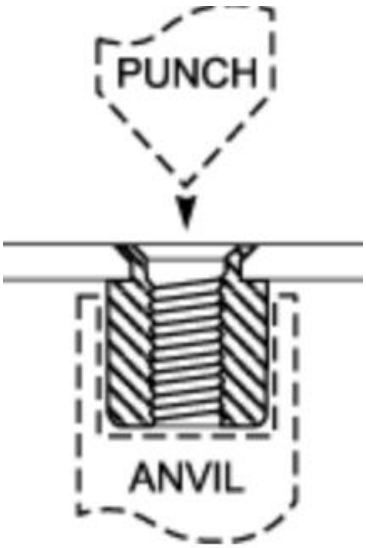


Figure 5. Flush Flare Standoff Swage Fit with Installation Tooling

Full Knurled Swage Fit:

Full Knurled press fit is both swage fit as shown above with the additional advantage of knurls to keep the component from spinning after swage fitting. For ordinary Full Knurled Press Fit type installation, the knurls are on the entire length of the shank and the shank extends beyond the boards thickness for swaging. The process of pressing the component digs into the bore hole and embeds the "knurls" into the substrate and is an additional deterrent to the component spinning. For pressing, equipment, an arbor press, punch press, drill press are most commonly used.

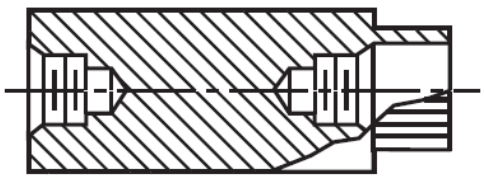


Figure 5. Knurled Swage Fit Standoff

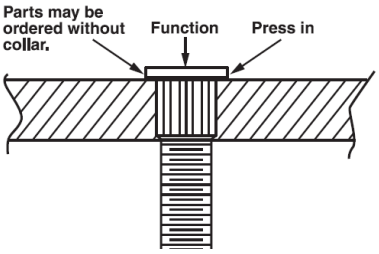


Figure 6. Knurled Swage Fit Standoff installed

A properly sized bore hole either drilled or punched is necessary for proper fit. Recommended bore hole diameter is approximately .012 less than the knurled shank diameter for best fit. Recommended shank length is .040" longer than the substrate thickness. This shank length excess allows for proper roll over to backside of substrate. The full knurled shank length is suitable for certain materials capable of withstanding the forces of press fitting a fully knurled shaft into a bore hole without cracking the substrate material, (such as Aluminum, Brass and Carbon Steel).

Positive Locking Swage Fit:

This option is very similar to the Full Knurled Fit above however, only the lower portion of the shank length is knurled, while the remaining portion of the shank length is a non-contact smooth surface. By reducing the amount of contact with the knurled surface, the potential for cracking the substrate while press fitting is greatly reduced. Installation procedures and specifications for bore hole and shank length of this option are the same as Knurled Fit Option above.

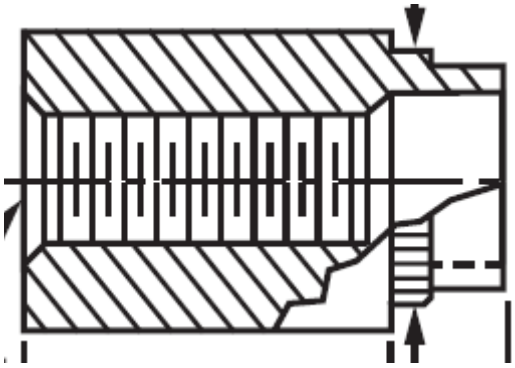


Figure 6. Positive Locking Swage Fit Standoff

Face Knurled Swage Fit

If a substrate is more brittle and susceptible to cracking Face Knurled may be an alternative to Full Knurled or Positive Locking while still giving the component a grip to base substrate avoiding a spin. When press fitting a Full Knurled or Positive Locking component the base material is being cold formed slightly and could cause cracking of brittle materials. By contrast a Face Knurled component is abrading the base substrate on the surface only and less opportunity for cracking substrate during installation.

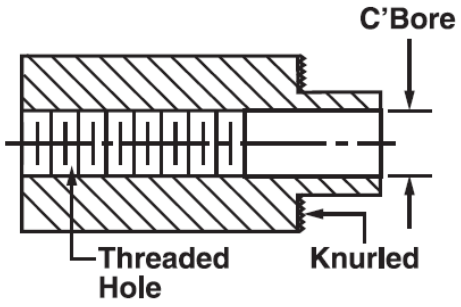


Figure 7. Face Knurled Swage Fit Standoff

High Torque Swage Fit

For higher gripping force to keep a swaged component from turning in bore hole, the High Torque Swage Fit option is used. At the base of the shank length the Hi Torque feature has 6 equally spaced barbs machined at the bottom of the flange area portion of the component. These barbs will slightly pierce into the substrate during the swage press fit process. This resulting grip force can be as high as 23in/lb. This feature can be added to most Hex press fit components. This option is not available on round components.

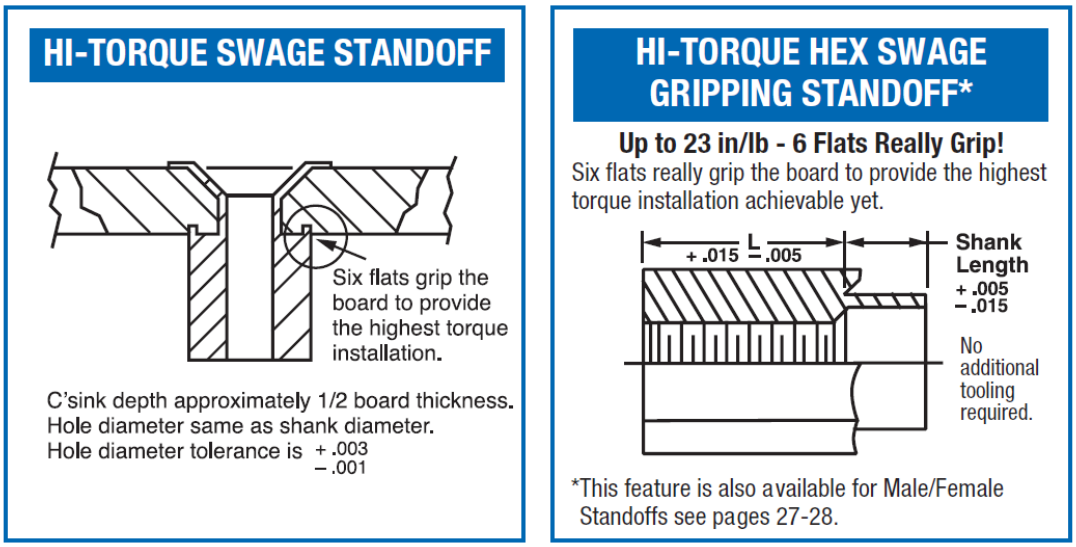


Figure 8. Hi-Torque Swag Fit Standoff

Snap-In Fit:

Snap-In Fit components are an inexpensive method to fasten a component to a substrate without the need for special installation tooling (only bore hole is required). The principle design used is a compressible shank which snaps into hole when shank is compressed and once shank is through bore hole, the diameter of shank snaps back to a larger uncompressed diameter. This component can be made of a multitude of materials. Generally these are designed for 1/16" and 3/32" PC Board thicknesses and used with Standoff components. However, custom designs can be accomplished with Snap-In Fit components if required.

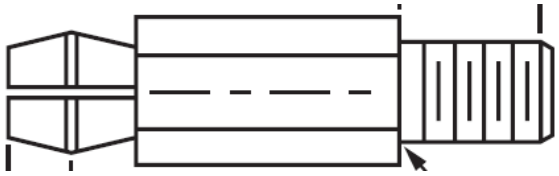


Figure 9. Male Snap-In Fit Threaded Standoff

For standard Snap-In Fit the bore hole diameter specification is .152" +/-.002 and the Shank length is predetermined based on board thickness. Installation is simple and is Snap-In without any additional tooling.

Snap-In Self Retaining-Aligning Fit:

Self-Aligning Snap-In Fit components are generally made of Nylon and used mainly on 1/16" PC Board substrate. They are similar to the Snap-In Fit above and are relatively easy to assemble. Specifically for the Self-Aligning Snap-In, the shank is designed with a step such that once snapped in, the component is retained in substrate.

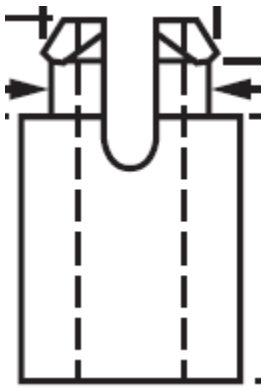


Figure 10. Snap In self Aligning-Retaining Spacer

For standard Snap-In Self-Aligning Fit components, the bore hole diameter specification is usually predefined by component diameter. The Shank length is predetermined based on 1/16" board thickness. Installation is simple without any additional tooling.