JUNE 2019

TECH SHEET

PEM® REF/ THREAD POSITION

SUBJECT: FACTORS TO CONSIDER IN DETERMINING THREAD POSITION OF INSTALLED SELF-CLINCHING FASTENERS RELATIVE TO MOUNTING HOLE CENTER

The most important point relative to this topic, and a matter which is frequently overlooked, is the fact that self-clinching fasteners are not inherently self-centering in a mounting hole into which they are installed. This results from the fact that the installation forces are so high relative to the force produced by the metal flowing into the undercut of the fastener, that friction between the face of the punch and anvil and the panel and fastener prevent the fastener from sliding sideways as would be required for it to center itself in the hole. This being the case, there are a total of five factors which must be properly accounted for if one is to do a thorough analysis of the tolerance between thread centers for two installed self-clinching fasteners. These five factors are listed below:

1) Mounting hole diameter tolerance
2) Fastener shank diameter tolerance
3) Concentricity between fastener shank and thread pitch diameter
4) Perpendicularity of fastener to sheet (long studs and standoffs only)
5) Hole to hole tolerance for the mounting holes in the sheet metal

Of these five factors, PennEngineering® has complete control over items 1, 2, and 3 and partial control over item 4. These four items are discussed and quantified on the following pages for three basic styles of self-clinching fasteners; nuts, standoffs and studs. Item 5 is not quantified because it is not controlled by PennEngineering, but it is a factor that must be included in the analysis.

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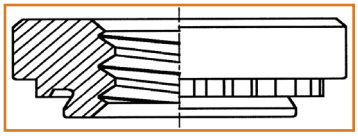
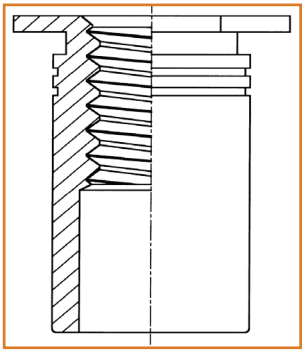
For PEM® S, SS, CLS, CLSS, CLA, SMPS, SMPP, SL, SH and SP plain round self-clinching nuts, one should assume a fastener shank diameter tolerance of .005". Maximum shank diameters for all of these parts are shown as the "C" dimension in the PEM catalog bulletin CL. You will notice that there is a nominal .001" clearance between the maximum shank diameter and the minimum mounting hole diameters shown in the catalog. Combining this .001" clearance with the .003" mounting hole diameter tolerance and the .005" shank diameter tolerance yields a worst-case diameter difference of .009" between the maximum mounting hole and the minimum shank diameter. This means that the center of the shank could be as much as .0045" from the center of the mounting hole. For these nuts we are able to hold the concentricity between the OD of the shank and the PD of the thread to no more than .005" TIR, or .0025" maximum eccentricity. Combining this eccentricity with the above mounting hole diameter difference yields a total worst-case position error of .007" from true center of the mounting hole to center of the thread PD.



For PEM® H and HNL nuts, all of the above applies except the mounting hole tolerance which is greater at +.005. This yields .008" worst-case error.

For PEM® SO, SOS, SOA, BSO, BSOS, BSOA, TSO, TSOS, TSOA, TSO4, DSO, DSOS, BSO4 and SO4 self-clinching standoffs, the PEM® catalog bulletin SO shows a barrel diameter (C dimension) tolerance of .005". You will notice that there is a nominal .001" clearance between the maximum barrel diameter and the .001" clearance with the .003" mounting hole diameter tolerance and the .005" barrel diameter tolerance yields a worst-case diameter difference of .009" between the maximum mounting hole and minimum barrel diameter. As above, this means that the center of the barrel could be as much as .0045" from the center of the mounting hole.



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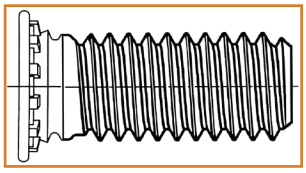
Thread concentricity can be held to no more than .005" TIR **for PEM® SO, SOS, SOA, BSO, BSOS, BSOA, TSO, TSOS, TSOA, TSO4, DSO, DSOS, BSO4 and SO4 self-clinching standoffs.** Combining this eccentricity with the above mounting hole diameter difference, yields a total worst-case position error of .007" from true center of the mounting hole to the center of the thread PD in the installed standoff. For long standoffs perpendicularity between the standoff barrel and the panel may also be a factor in position considerations. Our experience has shown that with all factors considered, the pitch diameter of the thread will generally be perpendicular to the sheet into which the standoff is installed within 2°. Two degrees is in fact a rather extreme situation which is rarely seen, and typical installations are much better, i.e., not more than one-half a degree out of square.

For PEM® FH, FHS, FHA, FH4, FHP, FHL, FHLS, TFH, TFHS, HFE, HFH, HFHS, HFLH, THFE, HFHB, FHX, HFG8, and HF109 self-clinching studs, you will note that there is no shank diameter given in PEM catalog bulletin FH. Studs are slightly better with regard to possible position errors than nuts and standoffs discussed above because the thread portion of the stud can be used to pilot the stud into the mounting hole. Therefore, it is possible for us to produce a larger diameter shank portion which, depending upon the tolerances may be an interference in the mounting hole. The minimum diameter in the clinching area of a stud will be only .001" below the minimum mounting hole. Therefore, with a .003" mounting hole tolerance, the maximum difference in diameters will be only .004". This means that the center of the stud head will be no more than .002" from the center of the mounting hole. Since a portion of the clinching feature is produced at the same time that the threads are applied to the studs, it is possible to hold these two elements concentric within .004" TIR. Combining this eccentricity with the above mounting hole diameter difference yields a total worst-case position error of .004" from true center of the mounting hole to center of the thread PD of the installed stud. As is the case with standoffs, perpendicularity should also be considered with long studs. Our experience has shown that the threaded portion of the studs will always be perpendicular to the sheet into which it is installed within 2°. As mentioned regarding standoffs, 2° is an extreme case, and most typical applications are much better, or within one-half degree.



The above comments completely address those factors which must be considered to determine the worst-case position error from the true center of the mounting hole to the center of the thread PD for the various types of self-clinching fasteners which you may be using. The resulting values, for both unified and metric units are summarized in the attached Tables. The only factor which must be added to a complete analysis for installed fasteners is the hole to hole tolerance for the mounting holes in the sheet metal. Since this is a factor which we do not control, you will need to add this factor as appropriate.

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We hope that you find this information adequate for performing the types of tolerance analysis that are necessary. If there are any questions about this information, or if additional technical assistance is required, please do not hesitate to contact us.

UNIFIED (dimensions in inches)

General Type	PEM® Types Include	Shank/Barrel Diameter Tolerance	Mounting Hole Diameter Tolerance	Nominal Hole to Shank Clearance	Max. Thread PD Eccentricity TIR	Worst-case Position Error (2)	Non Perpendicularity, Deg.	
							Typical	Worst-case
NUTS	S, SS, CLS, CLSS CLA, SMPS, SMPP, SL, SH and SP	-0.005	+0.003	0.001	0.005	0.007	N/A	N/A
	H and HNL	-0.005	+0.005	0.001	0.005	0.008	N/A	N/A
STANDOFFS	SO, SOS, SOA SO4, BSO, BSOS, BSOA, BSO4, TSO, TSOS, TSOA, TSO4 DSO and DSOS	-0.005	+0.003	0.001	0.005	0.007	0.5	2.0
STUDS	FH, FHS, FHA FH4, FHP, FHL, FHLS, TFH, TFHS, HFE, HFH, HFHS, HFLH, THFE, HFHB, HFHX, HFG8 and HF109	N/A	+0.003	0.001 (1)	0.004	0.004	0.5	2.0

METRIC (dimensions in millimeters)

General Type	PEM® Types Include	Shank/Barrel Diameter Tolerance	Mounting Hole Diameter Tolerance	Nominal Hole to Shank Clearance	Max. Thread PD Eccentricity TIR	Worst-case Position Error (2)	Non Perpendicularity, Deg.	
							Typical	Worst-case
NUTS	S, SS, CLS, CLSS CLA, SMPS, SMPP, SL, SH and SP	-0.13	+0.076	0.025	0.13	0.178	N/A	N/A
	H and HNL	-0.13	+0.13	0.025	0.13	0.203	N/A	N/A
STANDOFFS	SO, SOS, SOA SO4, BSO, BSOS, BSOA, BSO4, TSO, TSOS, TSOA, TSO4 DSO and DSOS	-0.13	+0.076	0.025	0.13	0.178	0.5	2.0
STUDS	FH, FHS, FHA FH4, FHP, FHL, FHLS, TFH, TFHS, HFE, HFH, HFHS, HFLH, THFE, HFHB, HFHX, HFG8 and HF109	N/A	+0.076	0.025 (1)	0.10	0.10	0.5	2.0

(1) For studs this value is the clearance between the minimum effective shank diameter and the minimum mounting hole diameter.
(2) These values do not include tolerance on true position of the mounting hole. This factor must also be appropriately accounted for by the user.