WORKING WITH

TUFFAK

polycarbonate sheet

MS CO.

VOL 6

MECHANICAL FASTENING

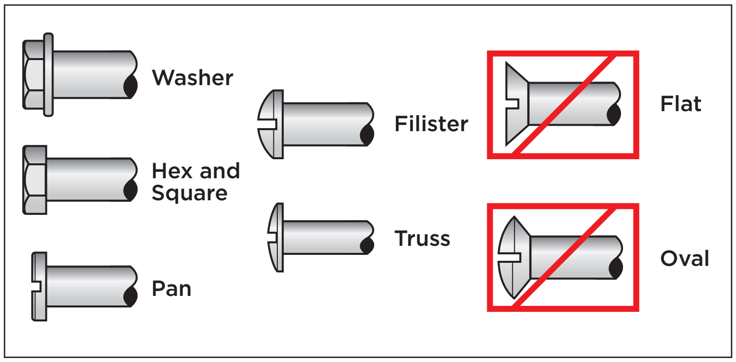
Mechanical Fastening

Mechanical fasteners

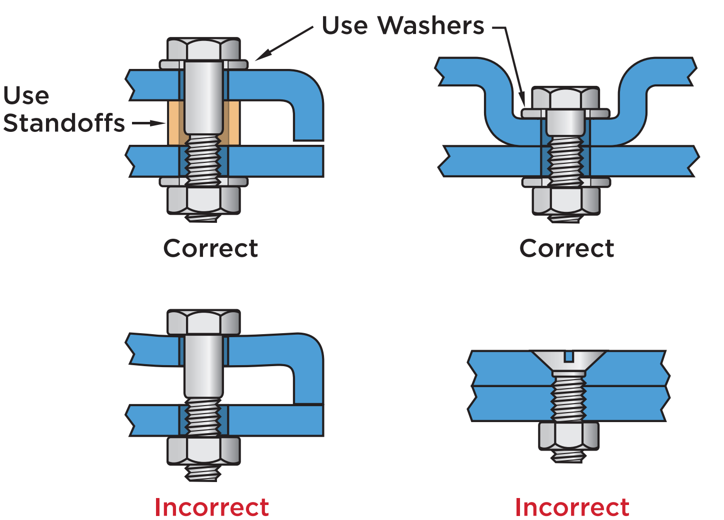
Due to their low cost and reliability, screws, bolts and rivets are common joining methods. Common practices and selection criteria are discussed within this section.

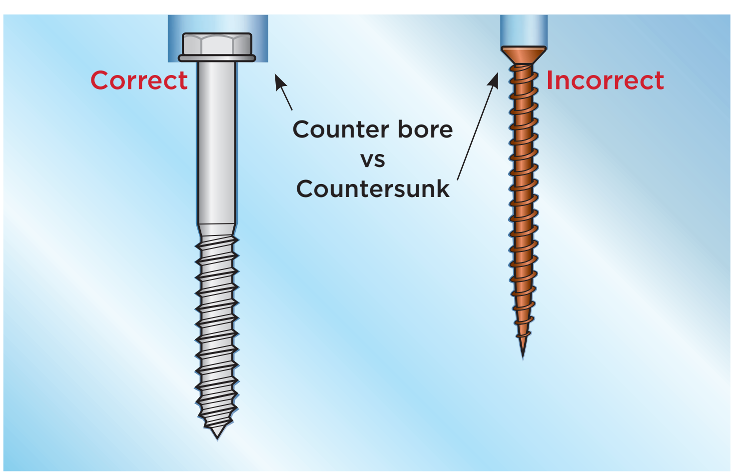
Common head styles of screws and bolts

Pay special attention to the fastener's head. Use bolt and screw heads that have a flat underside, called "pan" or "round" head. This bolt design imparts lower compressive stresses on the material. Conical heads, called flat or oval heads, produce undesirable tensile and hoop stresses and should be avoided.



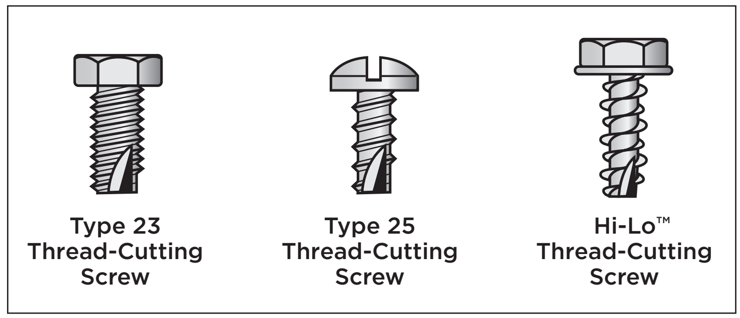
Fastening with bolts, nuts, and washers





Fastening with self-tapping screws

Use thread-cutting screws, which cut away material from a pre-drilled hole to form a mating thread and result in better long-term performance. Note the radial and hoop stresses imparted to the part by thread-cutting screws are lower after installation vs. thread-forming screws. Typically, thread-cutting screws are classified as ANSI BT (Type 25), ANSI T (Type 23). Thread-cutting screws may not be appropriate in all applications and environments. Cracks around the screw hole may form under conditions where the polycarbonate expands and contracts due to temperature variations.

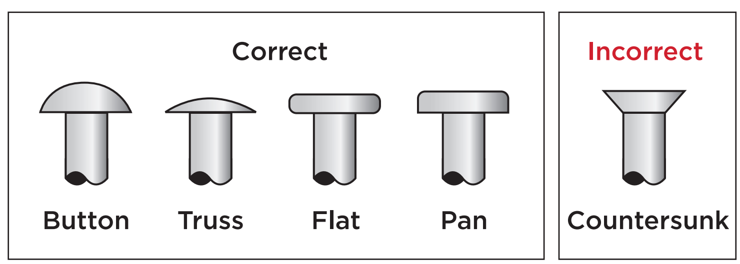


Hi-Lo is a trademark of ITW Shakeproof

Fastening with rivets

Rivets offer a low-cost and simple hardware solution for static parts. Aluminum rivets are preferred over harder materials. Select rivets with large flat heads and three times the shank diameter. Use of washers on the flared end are helpful in distributing loads, but be careful not to over-tighten as it can result in compressive stress and damage to the plastic.

Four standard rivet heads



Use flat aluminum or hard plastic washers under nuts and fastener heads to evenly distribute the applied force. Their ability to resist over-compression helps to prevent localized stressing of the joining part. Ensure there is sufficient distance between the edge of the fastener's hole and the part's edge: at minimum, two-times the diameter, and twice the part's thickness. Note: Slotted holes require more edge clearance.

TECH TIP:

Avoid thread locker products. They are generally incompatible with TUFFAK polycarbonate sheet, causing cracking and crazing.

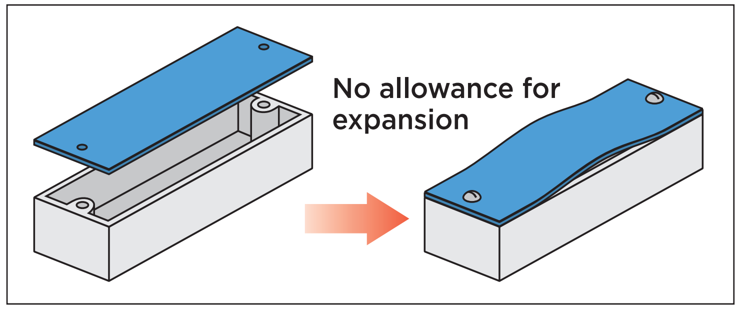
Mechanical Fastening

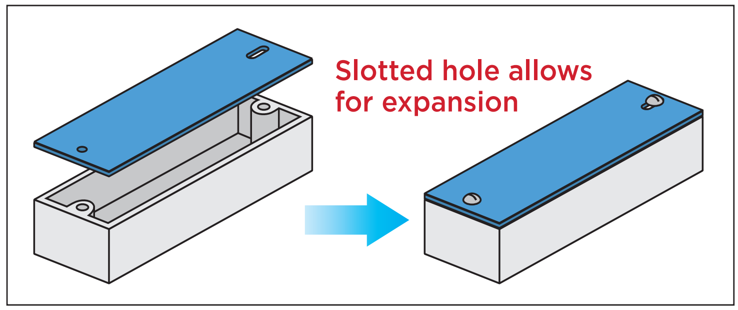
Joining dissimilar materials

For assemblies constructed of a combination of TUFFAK sheet and metal (two dissimilar materials), it is important to design for thermal movement behavior. When heated, the plastic may buckle, due to its higher thermal expansion rate. Conversely, when cooled, the greater thermal shrinkage of plastic will cause strain-induced stress and may exceed the plastic's working limit. This could lead to part failure.

The figure to the right shows a plastic part fastened to a metal component. As the ambient temperature rises, the plastic will expand more than the metal because the plastic's coefficient of linear thermal expansion is four times higher.

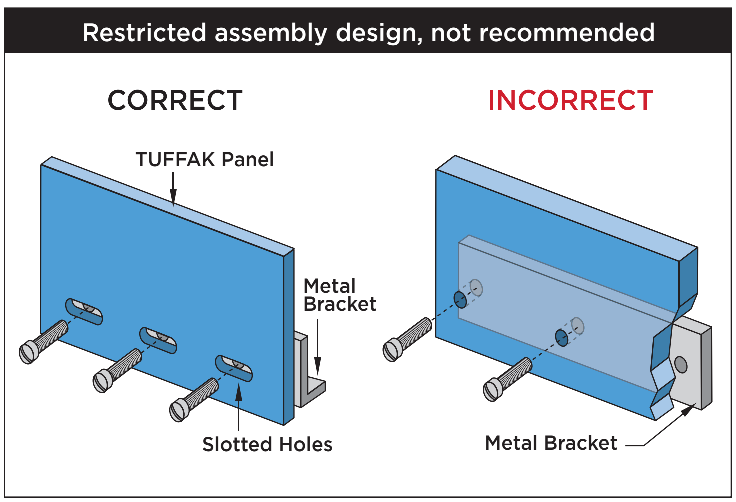
For applications where wide temperature variations exist, use slotted screw holes in the plastic part. When joining plastic and metal parts, do not tighten fasteners to the point where joint friction and compressive loads prevent relative movement. If the fasteners are too tight it negates the effect of the slotted holes.

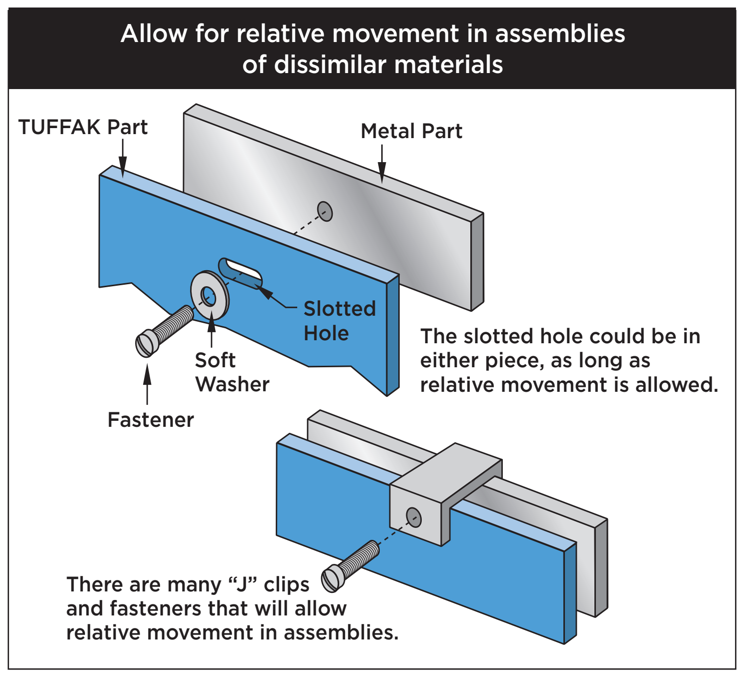




Factors to consider when joining plastic and metal parts:

- The size of the parts to be joined
- The magnitude of the temperature range
- The relative thermal expansion coefficients of the materials used in the part





Coefficient of Linear Thermal Expansion (CLTE) values for materials

Material	CTLE (10^5 in/in/°F)
TUFFAK	3.8
Aluminum	1.3

Example 1: Calculate the change in length for a 96 inch part that is constructed at 70° F, but will see operating temperatures up to 120° F

ΔL = (plastic CLTE – metal CLTE) * temperature change * length of part (0.000038 – 0.000013)*50*96 . . . . . ***ΔL = 0.120 inches***

Therefore, the design has to accommodate a growth of 0.12 inches.

Example 2: How much shrinkage will the same part see at -20° F

ΔL = (plastic CLTE – metal CLTE) * temperature change * length of part (0.000038 – 0.000013)*90*96 . . . . . ***ΔL = 0.216 inches***

Therefore, the design has to accommodate a contraction of 0.216 inches.

Mechanical Fastening

Ultrasonic welding

An ultrasonic welder has two primary parts: a horn and a nest. The horn typically presses down on the upper plastic part (of the two to be welded), clamping the two parts together. The nest supports the bottom plastic part to prevent it from moving. The horn is vibrated ultrasonically for a preset time. Friction from mechanical vibrations cause localized heating, resulting in plastic melting at the interface of the two parts. Pressure is then maintained after the vibrations are stopped until the melted plastic cools. Once the plastic has solidified, the clamping pressure is retracted and the two joined parts can be removed from the nest fixture.

The most important feature for a clean, ultrasonically welded joint is for one of the parts (to be welded) be designed with a triangular-shaped energy director. This minimizes the initial contact between parts. During welding, the ultrasonic energy is concentrated at the director tip, melting it and ultimately, joining the interface with molten resin.

Design energy directors with an apex angle from 60 to 90°. Generally, the base width of the energy director should not be more than 20 to 25% of the wall thickness supporting it.

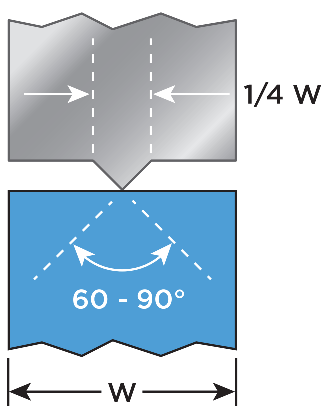
Troubleshooting

- Clean the mating surfaces with isopropyl alcohol to remove dust, fingerprints and grime prior to welding.
- Check to see if the horn is making proper contact to the welding surface. Non-uniform horn contact produces non-uniform weld lines. Carbon paper is useful to confirm uniform contact.
- Confirm sufficient energy is being supplied into the weld.
- Increase pressure/clamping force on the parts being welded.
- Increase the weld time.
- Increase the amplitude to the horn. Consult equipment suppliers for recommended welding amplitude settings for polycarbonate.

For ultrasonic welding machines, the converter, booster, and a properly maintained weld horn are all key factors for delivering a welding amplitude that produces a repeatable and robust weld joint. Confirm that routine maintenance, daily checks and calibration programs are in place. Set and document minimum energy output for the unit that ensures a reproducible welding joint.

For optimum welding:

- The horn, fixture and parts must be aligned properly
- The stationary part should fit snugly in the nest or fixture
- The height of the energy director should be approximately 0.020 inch
- Join parts made of the same resin



For more information on ultrasonic joining techniques contact:

Branson Ultrasonics Corp.
http://www.emersonindustrial.com/en-US/branson/Products/plastic-joining/Pages/default.aspx

Dukane Corp. http://www.dukane.com/us/PPL_upa.htm

Forward Technology Industries, Inc. http://www.forwardtech.com/plastic-assembly

Herrmann Ultrasonics, Inc. http://www.herrmannultrasonics.com/products-plastics.html

Ultra Sonic Seal Co. http://www.ultrasonicseal.com/upa/upa_tooling.html