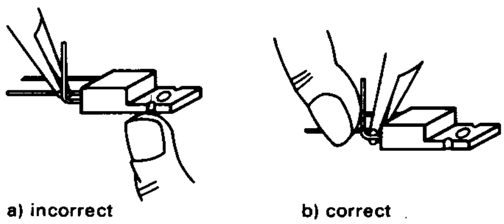
Handling and Mounting Instructions

Handling and mounting of thyristors in TO-220
The thyristors (SCRs, TRIACs) can withstand high mechanical strains. Nevertheless, some elements can be damaged by wrong handling or mounting. This damage can be revealed either at once or after a variable delay.
These damages can be easily avoided if some caution is taken by handling and mounting. As a rule, exaggerated strain on the element has to be avoided.

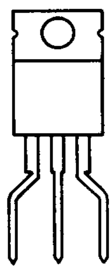
Lead bending
The leads can be bent to meet the requirements of a specific application. During bending, the strength applied along the axis of the leads should not exceed 20N (4,5lb). The best way to form the leads is using a lead bending fixture designed for this operation.
If no bending fixture is used, a long nose plier can be used. Minimal distance between case and bending point is 0.080". The lead must be firmly held between case and bending point during lead bending operation. Fig. 1 shows incorrect (a) and correct (b) method.

Fig. 1



When the bend is made in the plane of the leads (spreading), bend only the narrow part of the leads (Fig. 2).

Fig. 2



Mounting on printed circuit or heatsink
The thyristors are mounted on printed circuit or heatsink to be firmly held and with a good contact thermal resistance (in the case of heatsink).
If thermal resistance is not significant, the thyristor can be pressed or cemented onto the printed circuit.
If thermal resistance between junction and ambient has to be low, the thyristor must be mounted on a heatsink. It is very important that the thermal resistance between case and heatsink is low.
In order to ensure a low value of the contact thermal resistance, the contact surfaces of thyristor and heatsink must be flat, clean and free of scratches.
Use of a thermal compound (Dow Corning 340 or similar) ensures a very good contact between thyristor and heatsink and a very low contact thermal resistance.

There are various methods which can be used for mounting the TO-220 case:

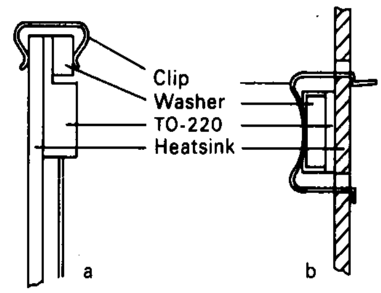
- **Sticking**
- **Soldering, welding**
- **Clip**
- **Screw**
- **Rivet**

Sticking allows mounting with minimal mechanical strain, but presents a rather high contact thermal resistance.

Soldering or welding seem to be a very good mounting way, giving good mechanical contact and low thermal resistance, but the thyristor is put under high strain during mounting process. FAGOR cannot recommend any soldering or welding process.

Clip fastening is fast and easy.
Various types of clips can be used. It is recommended to use a washer between tab and clip to spread the pressure over the whole tab surface (Fig. 3).

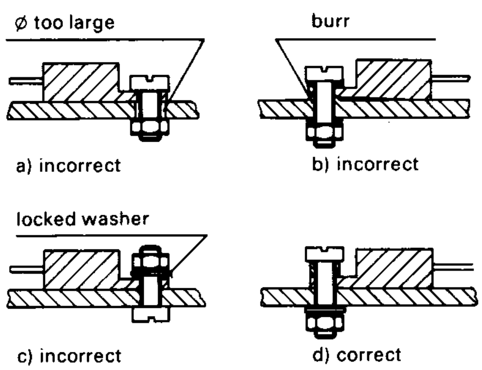
Fig. 3



The **screw** mounting is very widely used; the contact thermal resistance is good as long as the thyristor is properly mounted.
Heatsink thickness must be min. 0,080" for aluminium and 0,050" for copper heatsink. For mounting with screw and nut, the mounting hole should not exceed 0,140" (screw 6-32).
A rectangular washer (0,200"x 0,400") with a 0,140" hole on its center must be put between screw and tab to avoid excessive tab distortion which could damage the thyristor.
If no rectangular washer is used, a round washer fitting to the screw has to be used. No spring washer is allowed on the tab side; the nut has to be put on the heatsink side and not on the tab side.

Recommended screw is ISO M3,5 or 6-32 UNF or 1/8" W. Recommended torque should not be exceeded. Fig. 4 shows various incorrect and correct mounting methods.

Fig. 4



The thermal contact resistance is not depending directly on the torque used to fix the screw but on the force generated by this torque according to relation:

$$F = \frac{2\,\pi\,.\,M}{p}$$

F = contact force in N

M = Torque applied to the screw in N.m

p = pitch in m

The relation above shows that the force pressing the case on the heatsink is inversely proportional to the pitch of used screw.
(To convert anglo-american units into units of the new standard MKSA system, consider that:

1 in.lb = 0,113 N.m; 1 lb = 4,45 N; 1 inch = 0,0254 m).

European manufacturers recommend a torque of 0,6 N.m (5,3 in.lb) with a M3,5 screw (pitch: 0,6 mm); resulting force is 6280 N (1411 lb). American manufacturer recommend a torque of 4 in.lb (0,45 N.m) to 8 in.lb (0,9 N.m) with a screw 6-32 UNF (pitch = 1/32" = 0,79375 mm) resulting force is 3575 N (803 lb) to 7150 N (1606 lb).

Using only anglo-american unit, the force relation is:

$$F = 2\,\pi\,.\,M\,.\,n$$

F = Force in pound

M = torque in inch.pound

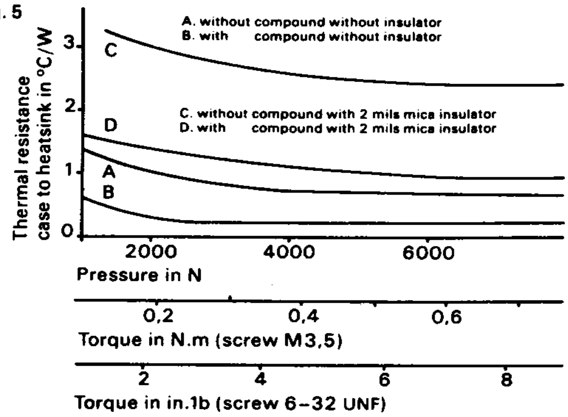
n = number of threads per inch

Using a silicon thermal compound reduces the contact thermal resistance.
Fig. 5 shows the relation between thermal resistance and torque for different types of screw or contact force.

The significant thermal resistance for thyristor use is the total $\Theta_{C\text{-}A} = \Theta_{C\text{-}H} + \Theta_{H\text{-}A}$.

The junction to case thermal resistance $\Theta_{J\text{-}C}$ lies between 1,5 to 2,5 °C/W, as the heatsink to ambient $\Theta_{H\text{-}A}$. The case to heatsink thermal resistance $\Theta_{C\text{-}H}$ lies between 0,2 °C/W if thermal compound is used on contact surface and 0,6 to 0,7 °C/W without compound.

Fig. 5



The total thermal resistance $\Theta_{J\text{-}A}$ is approx. 4 to 5 °C/W, and it is obvious that a difference of 0,1 °C/W or 2% of total only is not significant. Therefore, it is not necessary to apply the maximal torque to have a good cooling.

For a dissipated power of 15 W (ΔT = 60 °C with $\Theta_{J\text{-}A}$ = 4 °C/W) a difference of 0,1 °C/W of thermal resistance results in a change of 1,5 °C only of junction temperature.

The **rivet** mounting is fast and easy. This mounting system is very well suited to large series, but has to be used with caution. Tab distortion due to too high pressure or unadapted riveting tool must be avoided.
The minimum thickness of heatsink is 0,080" for aluminium and 0,050" for copper. Use 0,125" diameter tubular rivet with a washer.

Fig. 6