PRECAUTIONS FOR PHYSICAL HANDLING OF POWER PLASTIC TRANSISTOR [TO-220, ISOWATT220, TO-218 (SOT-93), ISOWATT218, TO-126 (SOT-32), SOT-82, SOT-194]

When mounting power transistors certain precautions must be taken in operations such as bending of leads, mounting of heatsink, soldering and removal of flux residue. If these operations are not carried out correctly, the device can be damaged or reliability compromised.

1. **Bending and cutting leads**
   The bending or cutting of the leads requires the following precautions:

1.1. When bending the leads they must be clamped tightly between the package and the bending point to avoid strain on the package (in particular in the area where the leads enter the resin) (fig. 1). This also applies to cutting the leads (fig. 2).

1.2. The leads must be bent at a minimum distance of 3 mm from the package (fig. 3a).

1.3. The leads should not be bent at an angle of more than 90° and they must be bent only once (fig. 3b).

1.4. The leads must never be bent laterally (fig. 3c).

1.5. Check that the tool used to cut or form the leads does not damage them or ruin their surface finish.

2. **Mounting on printed circuit**
   During mounting operations be careful not to apply stress to the power transistor.

2.1. Adhere strictly to the pin spacing of the transistor to avoid forcing the leads.

2.2. Leave a suitable space between printed circuit and transistor, if necessary use a spacer.

2.3. When fixing the device to the printed circuit do not put mechanical stress on the transistor. For this purpose the device should be soldered to the printed circuit board after the transistor has been fixed to the heatsink and the heatsink to the printed circuit board.

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**Fig. 1 - Bending the leads**

**Fig. 2 - Lead forming or cutting mechanism**

**Fig. 3 - Angles for lead wire bending**
3. Soldering
In general a transistor should never be exposed to high temperature for any length of time. It is therefore preferable to use soldering methods where the transistor is exposed to the lowest possible temperatures for a short time.

3.1. Tolerable conditions are 260°C for 10 sec or 350°C for 3 sec. The graphs in fig. 4 give an idea of the excess junction temperature during the soldering process for a TO-220 (Versawatt). It is also important to use suitable fixes for the tin baths to avoid deterioration of the leads or of the package resin.

3.2. An excess of residual flux between the pins of the transistor or in contact with the resin can reduce the long-term reliability of the device. The solvent for removing excess flux must be chosen with care. The use of solvents derived from trichloroethylene is not recommended on plastic packages because the residue can cause corrosion.

Fig. 4 - Junction temperatures during soldering

4. Mounting at heatsink
To exploit best the performance of power transistor a heatsink with $R_{th}$ suitable for the power that the transistor will dissipate must be used.

4.1. The plastic packages used by SGS-THOMSON for its power transistor (SOT-32, SOT-82, SOT-194, TO-220, ISOWATT220, TO-218, ISOWATT218) provide for the use of a single screw to fix the package to the heatsink. A compression spring (clip) can be sufficient as an alternative (fig. 5).

The screw should be properly tightened to ensure good contact between the back of the package and the heatsink but should not be too tight to avoid deformation of the copper part (tab) of the package causing breaking of the die or separation of the resin from the tab.

4.2. The contact $R_{th}$ between device and heatsink can be improved by inserting a thin layer of silicone grease with fluidity sufficient to guarantee perfectly uniform distribution on the surface of the tab. The thermal resistance with and without silicone grease is given in fig. 6. An excessively thick layer or an excessive viscosity of the grease can degrade the $R_{th}$. 

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5. **Heatsink problems**

The most important aspect from the point of view of reliability of a power transistor is that the heatsink should be dimensioned to keep the $T_j$ of the device as low as possible. From the mechanical point of view, however, the heatsink must be realized so that it does not damage the device.

5.1. The planarity of the contact surface between device and heatsink must be <25μm for TO-220, ISOWATT220, TO-218, ISOWATT218, TO-126 (SOT-32), SOT-82, SOT-194.

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5.2. If self threading screws are used there must be an outlet for the material that is deformed during formation of the thread. The diameter $d$ 1 (fig. 7) must be large enough to avoid distortion of the tab during tightening. For this purpose it may be useful to insert a washer or use of the type shown in fig. 8 where the pressure on the tab is distributed on a much larger surface. Sometimes when the hole in the heatsink is formed with a punch, around the hole or hollow there may be a ring which is lower than the heatsink surface. This is dangerous because it may lead to distortion of the tab as mentioned before.

5.3. A very serious problem is that of the rigidity between heatsink, device and printed circuit board. Once the device and the heatsink are mechanically connected, and the heatsink is fixed to the apparatus frame, the device and the PCB are bound together by the leads of the devices. A solution of this type is extremely dangerous.

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5.4. **Device mounting**