AN-6060

Guidelines on Leadforming, Trimming Lead Length, and Heatsink Mounting

Introduction

The ever-increasing demand for smaller consumer products often results in semiconductor designers manipulating package configurations to fit intended designs. More specifically, designs often require custom leadforming and module assembly practices for packages like the TO-262, TO-220, and TO-247. It is the intent of this application note to introduce general guidelines to ensure basic protection to the integrity of the package, both mechanically and electrically. Improper handling of devices can result in immediate or latent failures from cracked epoxy, epoxy delamination, die fractures, and bond-wire shearing.

Fairchild Semiconductor tests the electrical integrity of the devices as supplied. Once leads and/or package configuration is altered from its original state, the integrity of the device cannot be guaranteed. The reliability of the package within the application becomes the responsibility of the designer.

Leadforming

In an effort to continually supply the industry with reliable semiconductor products, Fairchild Semiconductor recommends contacting to local sales representative if a modification in package configuration is desired. Fairchild has to ability to leadform most straight-lead packages to common configurations and will consider custom leadforming options.

If it is necessary to perform leadforming processes, certain precautions should be taken to protect the integrity of the package. Failure to do so can have an adverse effect on the mold compound and lead interface. This initial damage combined with thermal stresses from soldering and operating conditions can damage the device. Such damage may include, but is not limited to; mold compound delamination (allowing for moisture ingression), fractured die, cracked mold compound, and sheared bond wires (resulting in intermittent or open connections). These failures could appear immediately at final test or may be latent and show up in the field. Some general guidelines to follow when leadforming are:

- Clamp all leads firmly and uniformly between the bend and the mold compound, ensuring that the clamp does not come in contact with the mold compound. The clamping area should be greater than the thickness of the leads. Clamp force should be greater than the force required to bend leads to desired form. Leads are normally deformed about 0.03mm to 0.05mm during clamping *(see Figure 1)*.
- The bend should take place beyond the seating plane area of the lead.
- The bend radius (R) should always be greater than the thickness (T) of the lead terminal *(see Figure 1)*.
- The leads should never be bent more than 90 degrees *(see Figure 1)*.

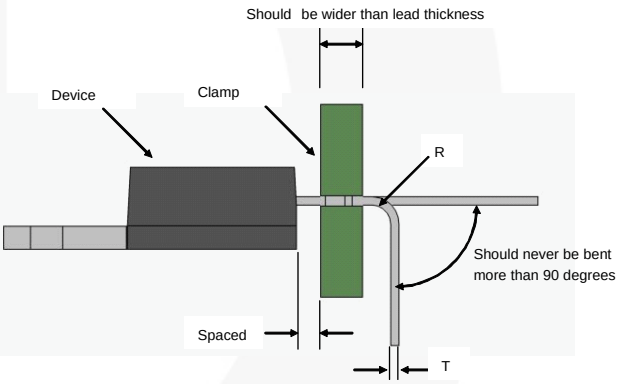

Figure 1. Leadforming

- Leadforming should avoid dambar cut area. The bend radius should be formed outside that area. Change of material stiffness by uneven cross-section prevents smooth radius forming at dambar area *(see Figure 2)*.

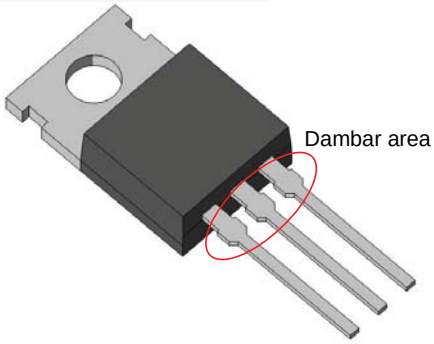

Figure 2. Leadforming Should Avoid Dambar Area

- The leads should never be bent laterally (sideways) *(see Figure 3)*.

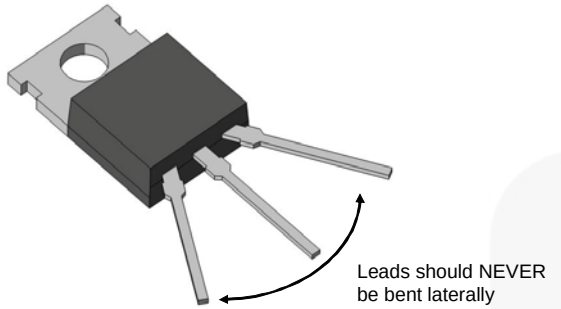

Figure 3. Leadforming Should Avoid Lateral Bends

- The leads should never be bent more than once; this weakens the lead and has a thinning effect in that area.
- Ensure the body of the device is allowed to float free during the bending process. Failure to do so induces mechanical shock into the package through the leads. This can be verified through finite element analysis. When clamps come in contact with molding compound and clamping force is not strong enough to grip lead tightly (Figure 5), high stress is applied at lead and molding compound (Figure 7), while normal clamping does not create any stress in molding compound and adjacent lead (Figure 4 and Figure 6).

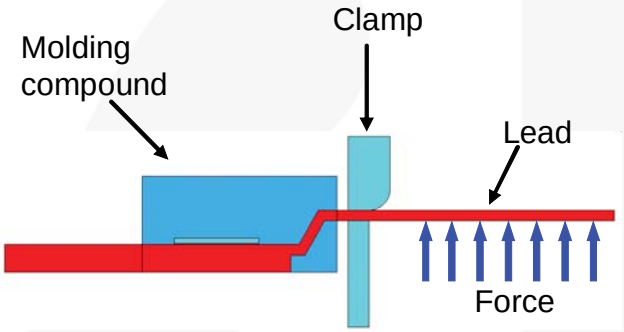

Figure 4. Normal Leadforming

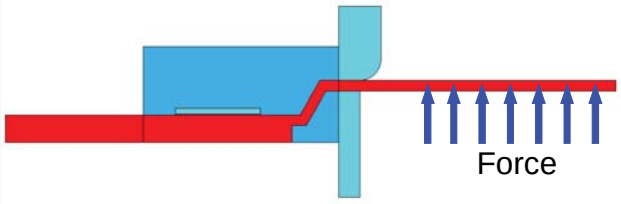

Figure 5. Abnormal Leadforming (Clamps Contact Molding Compound)

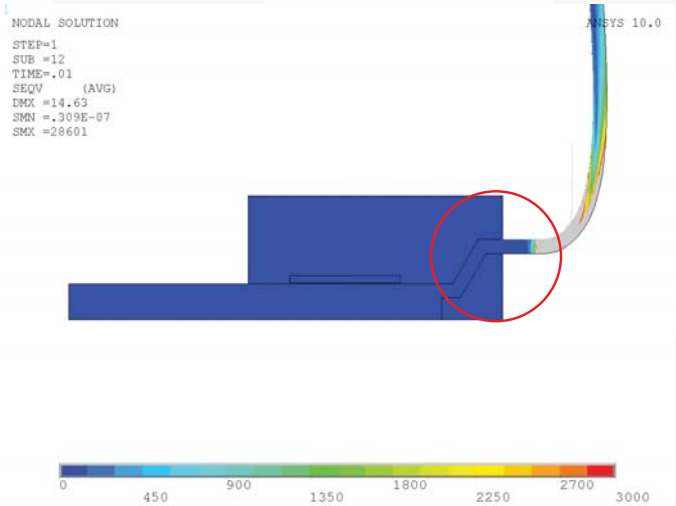

Figure 6. Stress Distribution, Normal

Figure 7. Stress Distribution, Abnormal

- Leads must be formed prior to fixing them to a printed circuit board or heatsink. No additional bending of the leads should occur when the device is being inserted into the circuit board. *(see Figure 8, Figure 9, Figure 10)*.

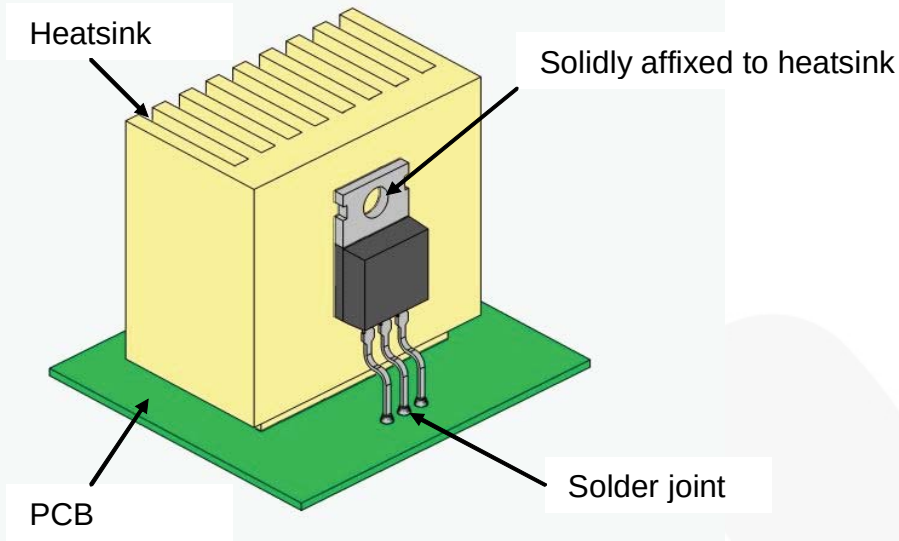

Figure 8. Package Mounted on Heatsink and PCB

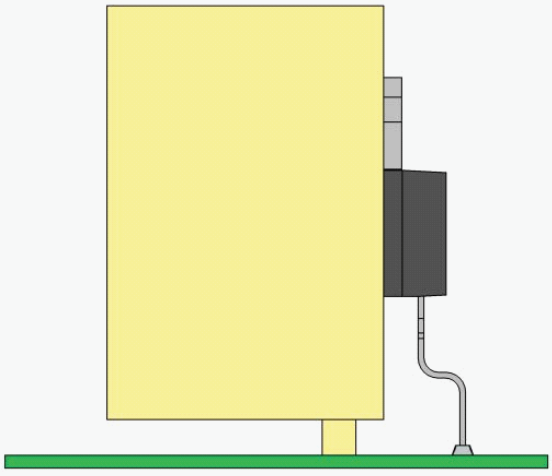

Figure 9. Correct Placement

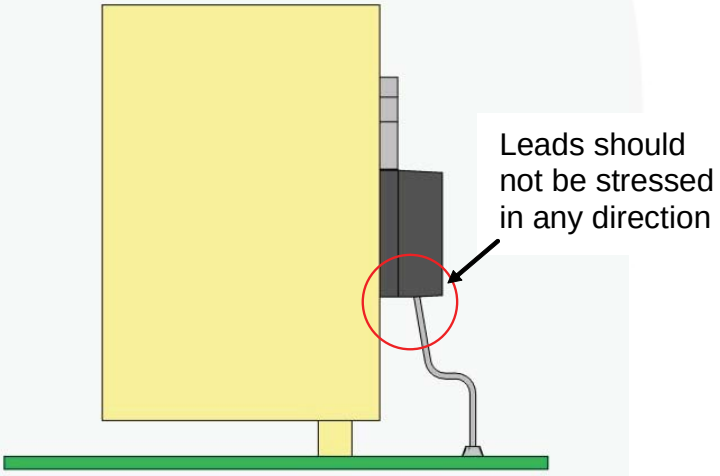

Figure 10. Incorrect Placement

- Manually bending leads should be avoided. If necessary, all rules above apply. The use of smooth jaw, non-tapered needle-nose pliers is recommended.
- Equipment utilized to perform bending should be properly maintained to ensure all rules are followed.
- Ensure the dimensions of the leadform allow the device to rest against the heatsink (if used) with no stress applied to the leads. Ensure allowance is made for sil pad or thermal compound.
- Large packages, such as the TO-247, are not recommended for applications requiring leadforming.

Trimming Lead Length

Just as precautions should be taken during the leadforming process, similar guidelines need to be followed when cutting the leads.

- Clamp leads firmly and uniformly between the cut and the mold compound, ensuring the clamp does not come in contact with the mold compound *(see Figure 11).*
- Ensure the body of the device is allowed to float free during the cutting process. Failure to do so induces mechanical shock into the package through the leads.
- Equipment utilized to perform trimming should be properly maintained to ensure all points above are followed. Cutting tool life should be known. A cutting count should be in place and tool edges replaced after recommended life span.

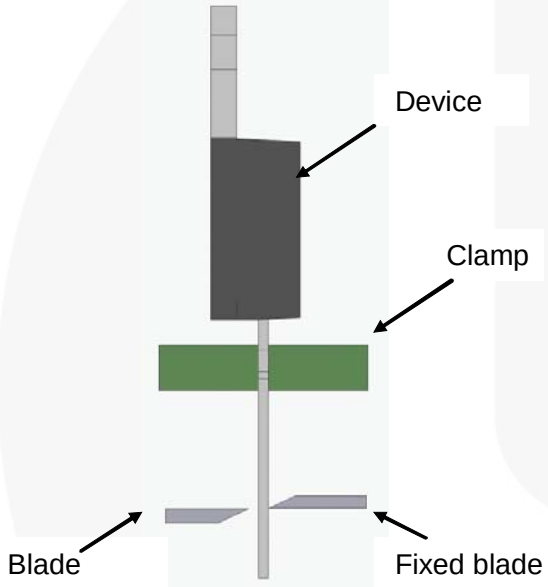

Figure 11. Trimming

Heatsink Mounting

The use of heatsinks is often required to maintain thermal stability within an application. This section addresses precautions that should be taken to avoid mechanical damage to the device.

- The surface of the heatsink should be smooth, flat (within 2 mils across mounting surface), and clear of foreign material.
- The mounting hole in the heatsink should be free of burrs and have no cratering occurring around the hole.
- Proper application of thermal grease should be applied to fill in any irregularities and decrease the thermal resistance.
- Caution should be used when using sil-pads or pads of other materials. Thick pads used along with screws can cause uneven torquing and result in die stress/fractures.
- When using screws on tabbed devices (T0-220) it is advisable to use a torque-spreading mechanism to spread pressure across the entire tab. As a minimum, a washer is acceptable as long as it does not make contact with the mold compound of the device.
- When the device is mounted on the heatsink and is in position on the circuit board, there should be no strain on the leads of the device in any direction *(see Figure 8, Figure 9, Figure 10).*
- Proper care should be taken not to over-torque the device. Over-torquing provides no additional thermal gains and can have adverse effects on the silicon within the package.
- Spring clips can be utilized for attaching devices to heatsinks. Proper care should be taken when installing clips. Sudden shock, by snapping the clip on the device, can cause damage to the silicon within the package.
- The heatsink should be rigidly mounted to the circuit board so the weight of the device/heatsink combination is not supported by the leads.
- Devices should be mounted to heatsink prior to soldering leads to the circuit board.
- Leadforming, if needed, should be done prior to mounting.