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# *Mounting Power Semiconductors*

**I. Mounting Surface Preparation**

**A. Surface flatness** in the device mounting interface area should be .001 inch per inch. Generally, commercial extruded heat sinks require spot facing and cast sinks; rough plates, etc. require additional machining to meet the required surface flatness requirements.

**B. Surface finish** in the device mounting interface area should be equivalent to that of the semiconductor device or 32 microinches maximum for disc and 63 microinches maximum for stud. Finer finishes add undue cost with little or no improvement in thermal performance.

**C. Care** should be taken in **handling** devices as well as the heat sinks so as to minimize voids, nicks, deep scratches, and other imperfections in the mounting interface area. While minor scratches, etc. are not desirable, one should realize that surface flatness is much more critical than surface finish in achieving a good thermal interface.

**D. Treated heat sink finishes** should be removed from the device mounting interface area. Black anodizing or paint on heat sinks **must** be removed from the mounting area. Also, irridite or chromate acid dip finishes must be removed from the mounting area for optimum performance. Nickel and tin-plated finishes are acceptable and even desirable in many applications where corrosion could be a problem.

**E.** Mounting interface areas should be **free of all foreign material, oxides, and films.** Since most heat sinks are stored and are not assembled immediately after machining, a cleaning operation is recommended. A satisfactory cleaning technique is to lightly polish the mounting area with a 3M Scotch Brite® pad or No. 000 fine steel wool, followed by a Semiconductor Cleaning Solvent wipe. As freshly bared aluminum forms an oxide layer in a matter of seconds, Alcoa #2 electrical joint compound may be used to clean aluminum heat sink mounting surfaces, followed by a Semiconductor Cleaning Solvent wipe. Surface should not be touched after cleaning. Parts may be placed on a lint-free surface until final assembly. After cleaning, an appropriate thermal interface compound should be immediately applied and the semiconductor device attached thereafter to prevent the thermal compound from collecting dust and metal particles.

**F. Powerex recommends the use of a thermal interface compound for all power semiconductors.** With the proper application of a thermal interface compound to fill the voids, scratches and imperfections in the device/heat sink mounting area, a twenty-fold improvement in device case-to-sink thermal resistance is possible. This is especially important for high power semiconductors.

**General Purpose Thermal Interface Compound Comparison Chart**

| | Maximum Continuous Heat Sink Temperature | Advantages | Disadvantage | Stud | Disc | Suggested Applicator(s) |
|---|---|---|---|---|---|---|
| **DC 340**① | 150°C | | •Difficult to apply<br>•Contains filler particles which can indent mounting surfaces slightly | OK | OK | •Rubber squeegee |
| **Alcoa #2**② | 95°C | •Removes oxides | •Temperature limited<br>•Mildly toxic | OK | •Preferred for bare aluminum heat sink surface | •Q-Tip③<br>•Rubber squeegee |
| **DC 200**① | 150°C | •Easy to apply<br>•Good control of film thickness | •Migrates | OK | OK | •Q-Tip③<br>•Rubber squeegee |

① Product of Dow Corning Corporation.
② Product of Aluminum Company of America.
③ Check to see that no cotton threads are left on the mounting interface surfaces.

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**II. Mounting Tips for Stud Devices**

**A. Mount studs to a heat sink through a clearance hole** by means of (1) hex nut and a lockwasher or pal nut or (2) hex nut-belleville washer combination or hex tenz nut.

**B. Diameter of the mounting clearance hole** should not exceed the diameter of the stud by more than 1/64″ and should be accurately drilled perpendicular to the mounting surface.

**C. Remove projections from mounting clearance hole.** Punched and drilled holes should be carefully deburred. The edge of the hole may be deburred with a chamfer not exceeding .01″ radius.

**D.** Avoid drilling and tapping holes for stud devices. Thermal ratcheting which tends to unscrew the stud from the hole can occur, and the 1/10 of a degree perpendicularity tolerance necessary between the hole and mounting surface is difficult to achieve.

**E. Apply appropriate thermal interface compound** in a very thin film to the mounting area only of the device as well as to the mounting surface of the heat sink. Rotate the stud device on the heat sink to spread compound and to seat the device. The threads of the stud and nut must **not** be lubricated as this will drastically alter the recommended mounting torque and cause undue stress on the stud device.

**F. Always use a torque wrench** when mounting stud devices. Refer to the individual device data sheet for the correct torque to be used. A good quality torque wrench, accurate in the specified range, should always be used. The torque should always be applied on the hex nut while holding the semiconductor stationary.

**G. Do not exceed maximum recommended torque limits.** Application of excessive torque is a major cause of stud device mounting problems. Semiconductors can be mechanically damaged by too much torque or thermally damaged by too little.

**III. Mounting Tips for Disc Devices**

**A. Machine or spot face the heat sink mounting surface areas to a diameter larger than that of the disc pole face to be mounted.** Keep spot face shallow to prevent interference with other parts of the disc package.

**B. Use locating pins (or alternative method) to center the disc** for optimum load distribution. Preassemble roll pins with a light hammer into center dowel hole in each heat sink. A gauge block is useful to prevent excessive pin length. Improperly mounting disc off center or using a locating pin too long and/or wrong diameter, resulting in improper device seating and possible fracturing of the silicon element, are major causes of disc device mounting problems.

**C. Apply appropriate thermal interface compound** in a very thin film to the mounting surfaces of the device, as well as to the mounting surfaces of the heat sinks. Rotate the disc to spread the compound and to seat the devices.

**D. Check the polarity of the device** prior to assembly to insure the device is installed in the desired direction. Also position SCR gate leads, etc. prior to assembly.

**E. Follow Clamping Tips**

1. Use a self-leveling type mounting clamp to assure parallelism and even distribution of pressure.
2. Select the proper size clamp; be aware of clamp insulation temperature limitation (less than 130°C for most clamps).
3. Coat clamp threads for large area discs with Never-Seez® or equivalent type compound, in order to prevent nut and clamp thread binding when high clamping forces are being applied.
4. Take necessary safety precautions to prevent bodily harm as high load forces can result in clamp breakage resulting in the broken bolt becoming a flying projectile.
5. Prestressing the clamp to its rated force prior to actual use in the application can help to seat clamp springs and to screen out defective clamps.
6. Preset indicators to zero before assembly on clamps that have deflection type indicators.
7. Apply clamping force smoothly, evenly, and perpendicularly to the disc.
8. Advance nuts onto clamp bolts equal length and finger tight before tightening with a wrench.
9. Apply the correct force as described on the device data sheet. Should too much force be applied to the clamp, do **not** attempt to back down to correct force — start clamping procedure all over again.
   a. Manual method — using an appropriate wrench, alternately advance nuts 1/4 turn each until either the clamp indicator gauge reads the desired force or the required number of turns are applied, depending on type of clamp used.
   b. Hydraulic press method — apply the calibrated force to the assembly with press. Using a good quality torque wrench, torque each nut 1/4 turn alternately to 10 ft. lbs. torque. Release press.

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**F. Install disc assemblies in such a way that the clamping force will always be centered on the semiconductor** so as not to be affected by electrical connections or supports. Only one of the two heat sinks may be rigidly attached to a bus bar or a mounting bracket; cable and bus bar connections that tie to the other heat sinks must be flexible or have stress relief built in.

**G. Develop a thorough disc mounting procedure** as attention to each and every detail in mounting a disc is much more critical than in mounting a stud device. Successful and reliable device operation depends on it!

## IV. Application of Thermal Compounds

Powerex recommends the use of a thermal interface compound for all power semiconductors. With the proper application of a thermal interface compound to fill the air voids, scratches, and imperfections in the device/heat sink mounting interface area, one can achieve up to a twenty-fold improvement in device case-to-sink thermal resistance as well as retard oxidation or corrosion. The General Purpose Thermal Interface Compound Comparison Chart included in this application information presents a comparison of three different types of thermal interface compounds. These compounds are typical of those that are commercially available; they have been evaluated and tested by Powerex and have been found to exhibit good field performance. When properly applied and mounted per the recommendations included herein, the use of these compounds will allow the user to meet the case-to-sink thermal resistance values published on the Powerex device data sheet.

## V. Tips For Applying Thermal Interface Compounds

**A. Always perform the necessary mounting surface preparation** prior to application of the thermal interface compound.

**B. Select the appropriate thermal interface compound for your application.** Note the temperature limitations, advantages, disadvantages, etc. to see that they are compatible with your needs.

**C. Apply appropriate thermal interface compound in a very thin film** to the device mounting interface (s) as well as to the heat sink mounting surface(s). Rotate the device on the heat sink(s) to spread compound and to seat the device. Thermal interface compound may be applied to the device mounting interface(s) **only** provided device/heat sink flatness, finish, and surface cleaning have been properly performed. Compound should still be applied in a very thin film and then device rotated on heat sink per previous directions.

**D. Wipe away excess compound from edges of the contact area** with a Semiconductor Cleaning Solvent and a lint-free towel after mounting the device. Otherwise, thermal compound on the insulator (glass or ceramic) housing could collect dust and metal particles and cause arc-over.

**E. Use thermal interface compound sparingly.** Applying too much compound is a major cause of device mounting problems. The thermal interface compound should appear only as a thin, moist film when properly applied to a mounting surface.