Title: LOWERED PRESSURE POINT FOR HEAT SINK RETENTION HARDWARE

Abstract: A heat sink assembly includes a heat sink with a base plate having a top surface with fins for dissipating heat and an opposed bottom surface for placing against an electronic device mounted on a printed circuit board, and at least one connecting device for loading the heat sink against the electronic device. The connector includes a mechanical fastener such as a push pin having an end which engages the circuit board, a compression spring received against a shoulder on the fastener, and a cup member which is installed in an aperture in the base plate so that a floor of the cup member provides a bearing surface for the spring which is below the bottom surface of the base plate. An alternative connector utilizes a conical spring received through the base plate and receiving the fastener therein to load the spring in tension against the electronic device.
Lowered Pressure Point for Heat Sink Retention Hardware

PRIORITY CLAIM

This application claims priority under 35 U.S.C. §119 from U.S. Provisional Application Serial No. 60/508,460, filed October 3, 2003.

BACKGROUND OF THE INVENTION

1. Field of the Invention
The invention relates to an assembly of a heat sink and a connecting device for mounting to an electronic package on a printed circuit board, wherein the connecting device includes a fastener and a spring which loads the heat sink against the electronic device when the fastener is attached to the printed circuit board.

2. Description of the Related Art
U.S. Patent No. 5,384,940 discloses a heat sink assembly of this type, wherein the heat sink has a top surface provided with fins and a through hole which receives the shank of a "push pin" fastener having a first end provided with a head, and a second end provided with prongs which engage a hole in a printed circuit board (PCB). A coil spring is provided around the shank between the surface of the printed circuit board and a shoulder formed by the head of the fastener. This spring is compressed when the second end engages
the PCB, thereby loading the heat sink against the electronic device mounted on the PCB.

Figure 1 shows a heat sink assembly of the prior art, including a heat sink 10 and a connecting device 2, as mounted to an electronic device 4 on a PCB 6. The heat sink 10 includes a base plate 11 having a top surface 12 provided with fins 13, a bottom surface 18, and an aperture 15 which is surrounded by a counterbore. The connecting device 2 includes a fastener 20 having a first end 21 provided with a head 22, a second end 24 received in a hole 7 in the PCB, a shank 28 extending between the ends 21, 24, and a coil spring 40 received around the shank in the counterbore. The fastener is retained to the heat sink by a C-clip 50 which engages the shank below the base plate. The end 24 may be threaded for retention in a threaded insert in the board.

Notwithstanding the use of a counterbore in the top surface, the fastener and spring extend to a considerable height above the surface. While this is not a problem where the cooling fins are equally high, when the height of the heat sink is kept short (under 0.3") due to taller components and tighter vertical board spacing, there is no room for a typical push pin. The height available after installation of the
compressed spring and the head of the push pin above the base plate is not sufficient to allow an acceptable amount of deflection together with the necessary spring force. This creates a need for a heat sink assembly including a connecting device having sufficient deflection length to accommodate variations in component size while providing the necessary spring force for good thermal contact.

**SUMMARY OF THE INVENTION**

According to the invention, the spring has a first portion which is received against a bearing surface fixed relative to the circuit board, and a second portion received against a shoulder formed on the fastener, wherein one of the first and second portions is located below the bottom surface of the heat sink base plate.

According to preferred embodiments, a cup member or thimble having a floor is fixed in an aperture of the base plate so that the floor provides a bearing surface below the bottom surface of the base plate. The spring is a compression spring having a first end which bears against the floor and a second end which bears against a shoulder formed by the head of the fastener. The spring therefore extends through the heat sink base thickness and below the bottom surface of the heat sink, so that
very little of the fastener extends above the top surface of the base plate.

By placing most of the mounting hardware below the top surface of the base plate, blockage of air flow to the cooling fins is minimal. By allowing for taller hardware than could otherwise be provided, the springs may be longer to provide the same force with a lower spring rate, so that larger stack up tolerances can be accommodated. Likewise, greater force may be applied using a longer spring with the same spring rate.

According to one preferred embodiment, the lip of the cup member is surrounded by a flange which is received against the top surface of the base plate. The top surface of the base plate may be countersunk around the aperture so that the flange is flush with or below the top surface of the base plate. The cup member is preferably drawn from sheet metal but may also be cast or molded of other material.

According to another preferred embodiment, the lip is not provided with a flange, and is press fit or otherwise fixed in the aperture through the base plate. Preferably, a countersink is provided in the bottom surface to limit travel of the cup member as it is pressed upward, and to provide a bore of uniform diameter for the spring. Alternatively, the cup member
may be provided with an annular shoulder which abuts the bottom surface of the plate to limit travel. In every case the compression spring bears against a bearing surface surrounding an aperture in the floor of the cup member.

In a variation, the aperture is closed off at the top surface but for a small hole located coaxially with the aperture. This provides a pocket which contains the head of the fastener, so that it cannot extend above the top surface of the base plate. In this embodiment the length of the spring is limited, but the fins may remain intact above the hole, access to the fastener head being provided by locating the hole between two fins. Where the fastener is a push pin, it is only necessary to push against the head of the fastener to compress the spring until the prongs engage the PCB. Where the fastener has screw threads at the second end, a turning tool such as a hex key may be inserted in the hole.

In yet another embodiment, the cup member is eliminated and a conical tension spring is used. A coil at the big end of the spring bears against a bearing surface surrounding the aperture on the top surface of the base plate, and a shoulder on the fastener engages a coil located below the bottom surface of the base plate. When the second end of the fastener engages the printed
circuit board, the heat sink is loaded against the electronic component by tension in the spring. This embodiment offers the advantage of fewer parts and lower cost.

Other objects and features of the present invention will become apparent from the following detailed description considered in conjunction with the accompanying drawings. It is to be understood, however, that the drawings are designed solely for purposes of illustration and not as a definition of the limits of the invention, for which reference should be made to the appended claims. It should be further understood that the drawings are not necessarily drawn to scale and that, unless otherwise indicated, they are merely intended to conceptually illustrate the structures and procedures described herein.

**BRIEF DESCRIPTION OF THE DRAWINGS**

Figure 1 is an elevation view of a heat sink mounted with a connecting device of the prior art;

Figure 2A is an exploded perspective view of a heat sink and a first embodiment of connecting device according to the present invention;

Figure 2B is an elevation view of a heat sink mounted with the device of Figure 2A;
Figure 3A is an exploded perspective view of a heat sink and a second embodiment of connecting device according to the invention;

Figure 3B is an elevation view of a heat sink mounted with the device of Figure 3A;

Figure 4A is a perspective view of an alternative heat sink and a third embodiment of heat sink according to the invention;

Figure 4B is an elevation view of the alternative heat sink mounted with the device of Figure 4A; and

Figure 5 is an elevation view of a heat sink mounted with a fourth embodiment of connecting device according to the invention.

**DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENTS**

Figures 2A and 2B show a first embodiment of connecting device 2 for fastening a heat sink 10 against an electronic device 4 mounted to a printed circuit board 6. The heat sink 10 includes a base plate 11 having a top surface 12 provided with fins 13 which are interrupted around a mounting aperture 15. The opposed bottom surface 18 is received against the electronic device 4. The heat sink is preferably made of aluminum, copper, graphite, or thermally conductive plastic, and may be extruded, machined, cast, or molded.
The connecting device 2 includes a mechanical fastener 20, a cup member 30, and a spring 40. The mechanical fastener 20 has a first end 21, a second end 24, and a shank 28 extending between said ends. The first end 21 is provided with a head 22 which forms a shoulder 23 facing the second end 25. The second end 24 is provided with resilient mounting prongs 25 having barbs 26 which engage the printed circuit board 6. The fastener may be made of steel, brass, or aluminum, but may also be made of plastic where electrical isolation is necessary. The fastener may be made by cold heading, machining, casting, or injection molding.

The cup member 30 has a lip 32 surrounded by a flange 33, a floor 34, and a cylindrical wall 37 extending between the lip and the floor. The floor 34 forms a bearing surface 35 surrounding a central aperture 36 which receives the shank 28. The flange 33 rests against the top surface 12 of the base plate 10 when the cylindrical wall 37 is received in aperture 15 of the base plate 11. Where it is desired to minimize the height of the connector above the top surface 12 of the base plate 11, a countersink may be provided around the aperture 15 so that the flange 33 is flush with the top surface. The cup member 30 may be made of metal or plastic, if electrical isolation or specific corrosion
resistance properties are needed. The cup member 30 may be manufactured by sheet metal stamping, drawing, metal spinning, cold heading, machining, casting, or injection molding.

The spring 40 is a coil spring having a first end 42 which is received against the bearing surface 35 on the floor 34 of the cup member 30, and a second end 43 which is received against the shoulder 23 formed by the head 22 of the fastener 20. The fastener 20 is dimensioned so that the spring 40 is compressed to load the heat sink 10 toward the printed circuit board 6 when the prongs 25 engage a hole 7 in the printed circuit board. Fasteners are preferably available in a variety of sizes so that heat sinks of varying heights may be accommodated while maintaining the proper spring force. The advantage of the invention may readily be seen in Figure 2B, where the first end of the fastener does not extend above the top of the heat sink fins 13. A desired spring force is therefore achieved without increasing the overall height of the heat sink assembly, thereby improving the stacking tolerance of the PCB's. The spring is typically made of metal with the desired spring characteristic unless electrical isolation and/or specific corrosion resistance requirements dictate otherwise, in which case an elastomeric material could
be used. The spring may be wire formed, stamped, or molded.

Pre-assembly of the fastener 20, cup member 30, and spring 40 is achieved easily by pressing the fastener 20 through the aperture in the floor of cup member 30, thereby compressing the spring 40 until the barbs 26 engage the bottom of the cup member 30. The cup member 30 may then be seated in the aperture 15 of the base plate 11, the base plate 11 may be assembled to the device 4 on a PCB 6, and the first end 21 of the fastener pressed down until the second end 24 passes through the hole 7 in the PCB 6. This fixing may be achieved mechanically, for example by the radially resilient prongs 25, or by soldering, in which case it is not necessary to provide prongs. The spring 40 loads the heat sink 10 against the electronic device 4 for efficient heat transfer and heat dissipation.

Figures 3A and 3B show a second embodiment of the connecting device 2, wherein the cup member 30 is not provided with a flange around the lip 32. Rather, the bottom surface 18 of the heat sink base plate 11 is provided with a countersink 19 around the aperture 15, and the lip 33 is fit into the countersink 19. Alternatively, the cylindrical wall 37 of the cup member 30 may be provided with a shoulder which limits travel
in aperture 15 in the base plate 11. The cup member 30 may be press fit, threaded, soldered, brazed, glued, or otherwise attached to the bottom surface of the base plate. The features of the fastener 20 and spring 40 are essentially as described in conjunction with the embodiment of Figures 2A and 2B. A retainer 50 in the form of a C-clip is provided to hold the fastener 20, cup member 30, and spring 40 together as a unit which may be pre-assembled to the heat sink 10 prior to assembling to the PCB 6.

Figures 4A and 4B show a third embodiment of connecting device which is substantially similar to the second embodiment, but modified for use with an alternative printed circuit board 6 having an aperture 15 which is substantially closed at the top surface 12. Here the shank 28 and spring 40 are somewhat shorter than in the connecting device used with the heat sink 10 of Figures 2A and 2B. The first end 21 of the fastener is located in a pocket below the top surface and accessible only via an access hole 16 located centrally of the aperture 15. The advantage here, is that the heat sink fins 13 need not be interrupted above the connector, which can be accessed by a tool received between the fins 13. The fins may, however, be provided with at least one notch 14 to provide
sufficient clearance for the tool, which may be a hex key.

Figure 5 shows a fourth embodiment of connecting device which utilizes a conical tension spring 45 with a first portion 47 formed by a coil at the big end, and a second portion 48 formed by a coil remote from the big end. The first portion 47 bears against a bearing surface 17 on the top surface of the base plate 11 surrounding the aperture 15, and the second portion 48 bears against a second shoulder 29 formed on the shank 28 remote from the head 22. When the fastener 20 is pushed downward so that the second end 24 engages the hole 7 in the PCB 6, the spring 45 is under tension and thus loads the heat sink 10 against the electronic device 4. This embodiment offers the advantages of a very low profile with respect to the top surface 12 of the base plate 11, and a reduction in the number of parts in the connector, insofar as both the cup member and the retainer are eliminated.

Thus, while there have shown and described and pointed out fundamental novel features of the invention as applied to a preferred embodiment thereof, it will be understood that various omissions and substitutions and changes in the form and details of the devices illustrated, and in their operation, may be made by those skilled in the art without departing from the spirit of the invention. For example, it is expressly
intended that all combinations of those elements and/or method steps which perform substantially the same function in substantially the same way to achieve the same results are within the scope of the invention. Moreover, it should be recognized that structures and/or elements and/or method steps shown and/or described in connection with any disclosed form or embodiment of the invention may be incorporated in any other disclosed or described or suggested form or embodiment as a general matter of design choice. It is the intention, therefore, to be limited only as indicated by the scope of the claims appended hereto.
CLAIMS

What is claimed is:

1. A heat sink assembly for connecting to an electronic device mounted on a printed circuit board, said assembly comprising:

   a heat sink comprising a base plate having a top surface and an opposed bottom surface for placing against an electronic device;

   a bearing surface which is fixed with respect to said heat sink;

   a mechanical fastener having a first end, a second end for fixing said fastener to a printed circuit board, a shank extending between said first end and said second end, and a shoulder on said shank, said shoulder facing said second end; and

   a spring having a first portion received against said bearing surface and a second portion received against said shoulder, one of said first and second portions being located below said bottom surface of said base plate, said spring loading said heat sink toward said printed circuit board when said second end of said fastener is fixed to the printed circuit board.

2. The assembly of claim 1 wherein said bearing surface is located below said bottom surface of said base plate, said spring being a compression spring which
loads the first end of the fastener away from said bearing surface.

3. The assembly of claim 2 wherein said spring is a coil spring through which said shank passes, said coil spring having a first end forming said first portion and a second end forming said second portion.

4. The assembly of claim 3 further comprising a cup member having a lip, a floor, and a wall extending between said lip and said floor, said lip being positively positioned with respect to said base plate, said floor forming said bearing surface and having a central aperture through which said shank passes.

5. The assembly of claim 4 wherein said wall is substantially cylindrical.

6. The assembly of claim 4 wherein said lip is formed by a flange extending radially outward from said wall, said flange being received against said top surface of said heat sink base plate, said base plate having an aperture through which said wall passes.

7. The assembly of claim 4 wherein said base plate comprises a recess in said bottom surface, said lip being fixed in said recess.

8. The assembly of claim 7 wherein said lip is fixed in said recess by one of a press fit, threads, brazing, solder, and glue.
9. The assembly of claim 7 wherein said recess is
countersunk around an opening in said base plate, said
head of said fastener being received in said opening.

10. The assembly of claim 9 wherein said head of
said fastener does not extend above said top surface of
said base plate, said opening being constricted to
prevent passage of said head.

11. The assembly of claim 4 further comprising a
retainer fitted to said shank below said cup member,
said retainer preventing withdrawing of said fastener
from said cup member prior to fixing said second end of
said fastener to said printed circuit board.

12. The assembly of claim 1 wherein said fastener
is formed with a head at said first end, said head
forming said shoulder.

13. The assembly of claim 1 wherein said bearing
surface is located at said top surface of said base
plate, said spring being a tension spring which loads
said shoulder toward said bearing surface.

14. The assembly of claim 13 wherein said spring
is a coil spring having a coil which forms said bearing
surface.

15. The assembly of claim 14 wherein said coil
spring is a substantially conical spring.
16. A device for connecting a heat sink to an electronic device mounted on a printed circuit board, said device comprising:

   a mechanical fastener having a first end, a second end for fixing said fastener to a printed circuit board, a shank extending between said first end and said second end, and a shoulder on said shank, said shoulder facing said second end;

   a cup member having a lip, a floor, and a wall extending between said lip and said floor, said floor forming a bearing surface and having a central aperture through which said shank passes; and

   a compression spring having a first portion received against said bearing surface and a second portion received against said shoulder, said spring loading said shoulder away from said bearing surface.

17. The device of claim 16 wherein said compression spring is a coil spring having a first end forming said first portion and a second end forming said second portion, said shank being received through said coil spring.

18. The device of claim 16 wherein said lip is formed by a flange extending radially outward from said wall.
19. The device of claim 16 further comprising a retainer fitted to said shank below said cup member, said retainer preventing withdrawing of said fastener from said cup member prior to fixing said second end of said fastener to said printed circuit board.

20. The device of claim 16 wherein said fastener is formed with a head at said first end, said head forming said shoulder.