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Adjustable Force Load Cell for Heatsink

ABSTRACT

This disclosure describes an adjustable force load cell that can be utilized in heatsinks with multiple load cells. Adjustable force load cells enable dynamic adjustment of the total force imposed by the heatsink onto a component. In addition to a screw, spring, and washers, the adjustable force load cell includes a collar and features to the screw that enables the collar to move along the axis of the screw and be set at multiple fixed locations. As the collar moves along the axis of the screw, it enables the spring to either compress or expand beyond an original set length. Graduation marks are provided to visualize and calibrate different settings and corresponding forces. A locking mechanism such as a jam nut is provided to fix the collar at a suitable position. Load vectoring can be utilized to improve hotspot thermal performance by providing increased contact pressure at hotspots.

KEYWORDS

- Heatsink
- Load cell
- Contact pressure
- Spring loading
- Load vectoring
- Jam nut
- Thermal management
- Chip cooling

BACKGROUND

Heatsinks are commonly utilized in thermal management of electronic components. For example, heatsinks are used to cool components such as application-specific integrated circuit (ASIC) chips that generate large quantities of heat during operation. Heatsinks utilize spring loaded screws commonly referred to as load cells which enable a heatsink to contact the component in a thermally optimal manner while providing a method to control an amount of mechanical force applied to the component.

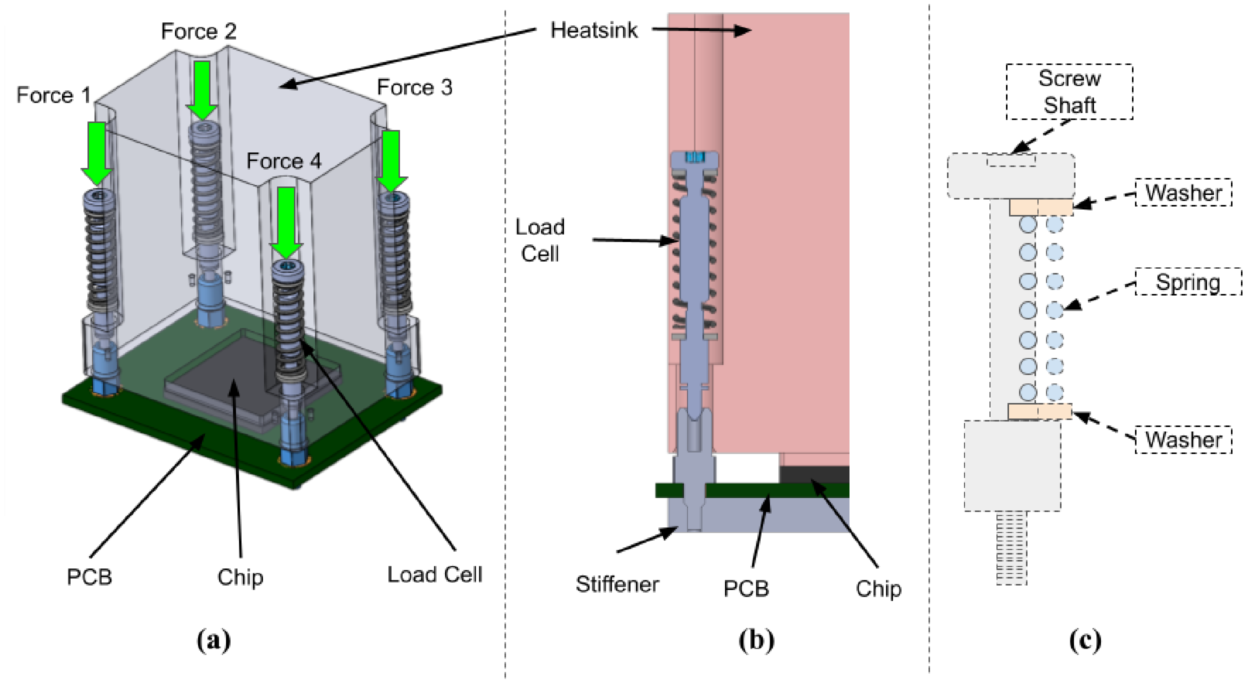


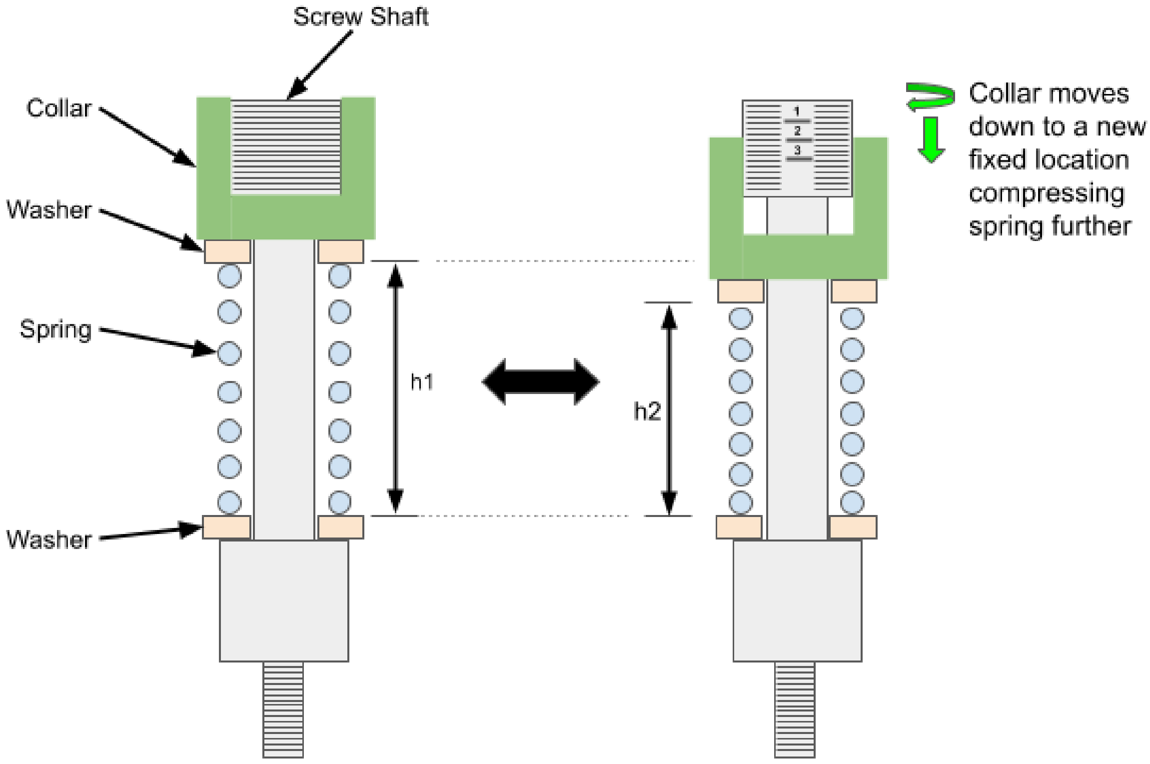
Fig. 1: A load cell enables contact between a heatsink and a component

Fig. 1 illustrates an example spring loaded heatsink configuration. As depicted in Fig. 1(a), four load cells are connected to a heatsink that is utilized for thermal management of a chip mounted on a printed circuit board (PCB). Each of the load cells is attached to the heatsink, as depicted in Fig. 1(b).

As depicted in Fig. 1(c), each load cell includes a screw, a spring, and washers that are utilized to apply suitable forces to the heatsink and enable its contact with the component being cooled. A problem with the current load cell design is that the amount of compression that the spring undergoes is fixed (constant). Consequently, only a fixed amount of force can be applied from the heatsink to the component. In operation, dimensional tolerances of related parts combined with the material property tolerances of the spring (such as the spring rate) can lead to variation in the actual force that is applied. Additionally, uneven surfaces of the heatsink and chip create variations in average pressure as well as variations in the center of force that is applied. This leads to suboptimal thermal performance of the heatsink and hot spots on the chip due to the separation between the heatsink and the component exceeding a designed separation.

DESCRIPTION

This disclosure describes an adjustable force load cell that can be utilized in heatsinks with multiple load cells. The adjustable force load cells enable dynamic adjustment of the total force imposed by the heatsink onto a component without needing to change the load cell design.



(a) (b)

Fig. 2: Force applied by the load cell can be adjusted by adjusting spring compression

Fig. 2 depicts an example adjustable force load cell, per techniques of this disclosure. Figs. 2(a) and 2(b) depict two different compression settings of the load cell. In addition to a screw, spring, and washers, the adjustable force load cell additionally includes an integrated collar and features to the screw that enable the collar to move along the axis of the screw and be set at multiple fixed locations. As the collar moves along the axis of the screw, it enables the spring to either compress or expand beyond an original set length.

In this illustrative example, Fig. 2(a) depicts the adjustable force load cell at a setting that corresponds to a particular spring length (h1) and a corresponding force that is exerted onto a component. By rotating the screw shaft, the collar moves downwards to a setting that corresponds to a different spring length (h2), with a greater compressive force being exerted onto the component. As depicted in Fig. 2(b), graduation marks may be included to visualize and calibrate different settings and corresponding forces.

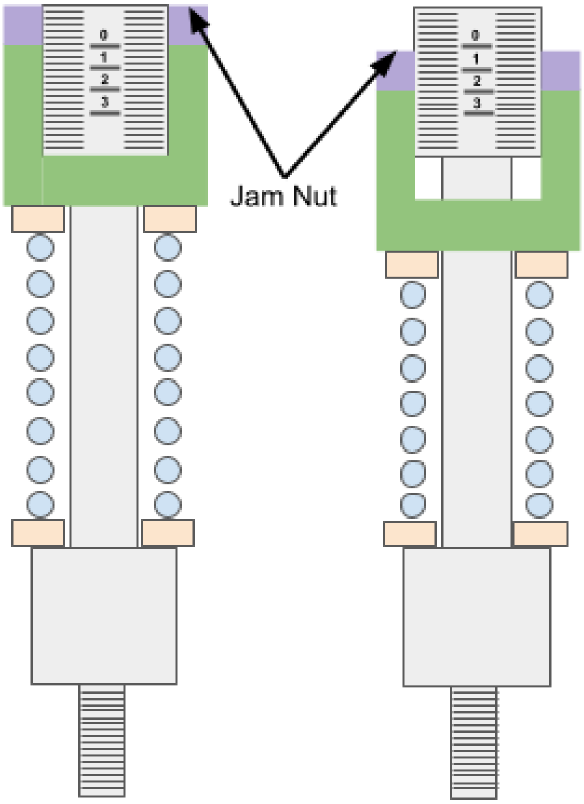
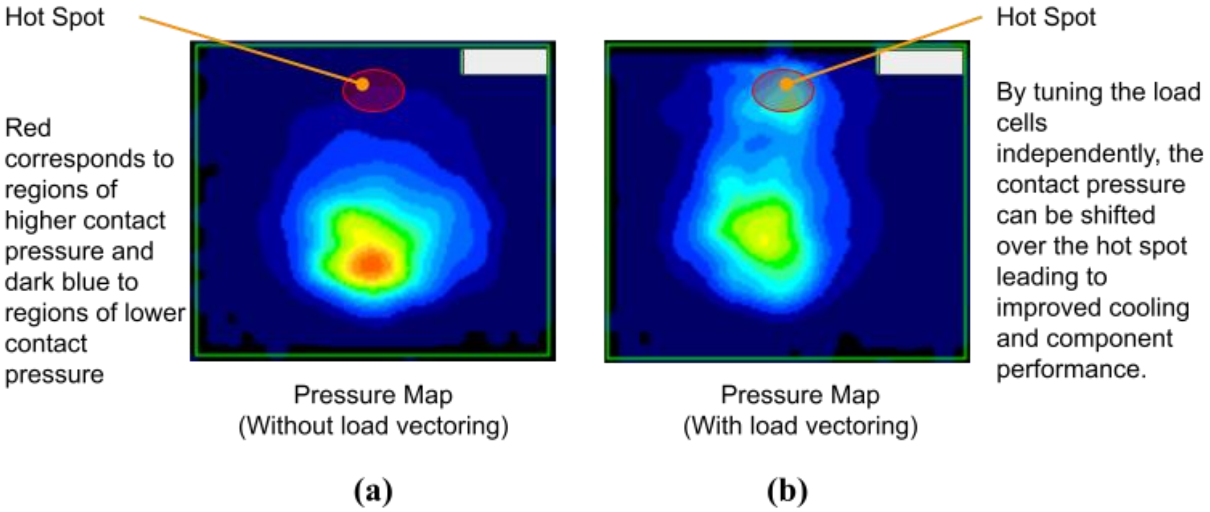


Fig. 3: Locking mechanism to fix the collar in a suitable position

Fig. 3 depicts another implementation of the adjustable force load cell that includes a locking mechanism. As depicted in Fig. 3, a locking mechanism such as a jam nut or a detent can be provided with the adjustable force load cell to fix the collar at a suitable position.

When multiple load cells are included in a heatsink, the average contact pressure on the chip can be increased or decreased uniformly by adjusting each of the load cells equally. However, in some implementations, the contact pressure distribution over a component surface may need to be adjusted in a non-uniform manner. For example, in some applications, different portions of a component surface may attain different temperatures and thus the component may need differential cooling across its surface. In such a scenario, each load cell or multiple load cells can be adjusted individually such that the load cells are set to different fixed positions of their collars (referred to as load vectoring). During load vectoring, different forces are applied (imposed) from each load cell which can help reposition the center of force/pressure to a location on the chip that is favorable from a cooling standpoint.



Red corresponds to regions of higher contact pressure and dark blue to regions of lower contact pressure

By tuning the load cells independently, the contact pressure can be shifted over the hot spot leading to improved cooling and component performance.

Pressure Map (Without load vectoring)

Pressure Map (With load vectoring)

Fig. 4: Load vectoring to provide improved performance at hotspots

Fig. 4 illustrates load vectoring to improve hotspot thermal performance, per techniques of this disclosure. Fig. 4(a) depicts a pressure map (pressure at different portions of a component surface) in the absence of load vectoring. Fig. 4(a) additionally depicts a location of a hotspot that can benefit from additional thermal performance. By tuning the load cells independently, e.g., by setting the collar in each load cell to different locations, the pressure map can be adjusted such that increased contact pressure is realized over the hotspot, leading to improved component performance. Fig. 4(b) depicts a pressure map when load vectoring is utilized.

The techniques of this disclosure can be utilized to improve thermal performance in multiple load cell heatsink configurations.

CONCLUSION

This disclosure describes an adjustable force load cell that can be utilized in heatsinks with multiple load cells. The adjustable force load cells enable dynamic adjustment of the total force imposed by the heatsink onto a component. In addition to a screw, spring, and washers, the adjustable force load cell includes a collar and features to the screw that enables the collar to move along the axis of the screw and be set at multiple fixed locations. As the collar moves along the axis of the screw, the collar enables the spring to either compress or expand beyond an original set length. Graduation marks are provided to visualize and calibrate different settings and corresponding forces. A locking mechanism such as a jam nut is provided to fix the collar at a suitable position. Load vectoring can be utilized to improve hotspot thermal performance by providing increased contact pressure at hotspots.