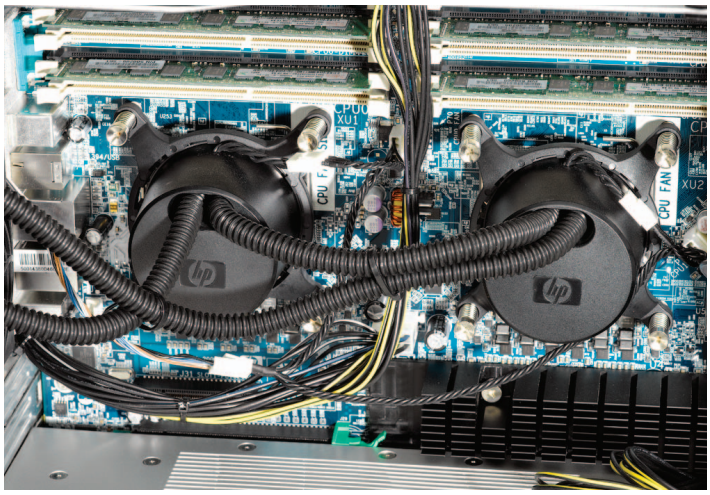
Liquid Cooling on the HP Z400/HP Z800 Workstation

Introduction: Personal workstations have provided users with substantial increases in processing power over the past decade. Increases in memory size, graphics capability and hard drive capacity, and much higher processor performance have all contributed to creating much more powerful desktop and deskside systems.

Along with the beneficial increases in capabilities have come increased power requirements and a corresponding increase in heat. Traditionally, cooling systems (mostly fans) have been added to dissipate the internal heat to the environment outside of the cabinet. Hewlett-Packard places great emphasis on employing the latest technology in personal workstations, and the realm of cooling systems is no exception. While the HP Z Workstations are already quieter than their predecessors, the introduction of liquid cooling in the HP Z400 and HP Z800 Workstation products is the latest innovation from HP to further reduce noise levels.



What is acoustic noise?

Acoustic noise is pressure waves produced by a vibrating source. The pressure waves are detected and translated into electrical signals by the human ear. Noise is generally regarded as an irregular vibration, as opposed to a tone (which is a sinusoidal wave) or a sound (which is a combination of several tones).

Acoustic noise in personal workstations

There are multiple sources of noise in personal workstations, including fans, hard disk drives (HDDs), optical disk drives, and other noises (e.g., liquid cooling pump, keyboards, etc.).

Fans and high speed (15K RPM) Hard Disk Drives are typically the strongest source of acoustic noise in a workstation. Workstations generally contain multiple fans—fans to exhaust air from the interior of the box, fans (blowers) on graphics cards, and fans on the processor and/or chipset heatsink(s).

There are two ways to reduce fan speeds (and noise). Reduce the amount of heat or use more efficient cooling mechanisms. Reducing the generated heat, while possible, is typically unacceptable. For example, reducing heat by lowering the processor frequency results in lower performance. Consequently, more efficient cooling mechanisms are typically the most effective way to get lower acoustics. This can include material changes, additional ducting, or heatsinks with larger surface area. In the case of liquid cooling, a small amount of surface area available on a heatsink is replaced by a large surface area on a radiator. Liquid provides an effective means of transporting the heat to the radiator.

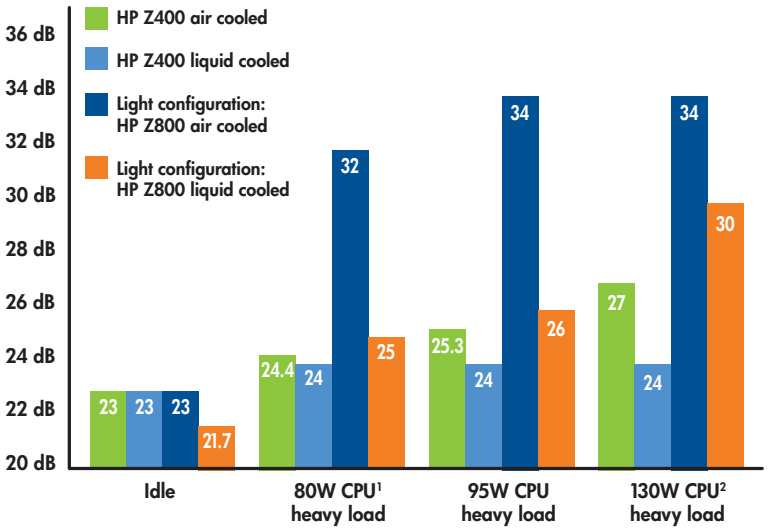


Figure 1—Acoustic comparison between air and liquid cooled systems

1 Heavy CPU load is defined as stressing the CPU to 80% of its maximum power level. Note that this corresponds to an extremely heavy workload for 3rd party applications. Typically these power levels are only reached with code designed to stress a specific CPU architecture.

2 Configurations having 130 W Thermal Design Power Intel processor(s); fewer than five SATA HDD (no 15K SAS HDD); any Z400/Z800 approved graphics combination other than NVIDIA FX4800/FX5800 or TESLA C1060; and less than or equal to 96GB total memory (Z800) should see similar results.

Liquid Cooling on the HP Z400 and HP Z800 Workstation

Acoustic benefits of liquid cooling

Liquid Cooling Systems (LCS) typically consist of a fluid, one or more pump(s), tubing, a reservoir, one or more cold plate(s) (to cool a specified component or location), a radiator, and one or more fans. The LCS used on the HP Z Workstations combines the pump, reservoir and cold plate into a single assembly that mounts to the top of the CPU, dramatically reducing the complexity over a traditional LCS.

The increased efficiency of liquid cooling delivers a significant benefit: lower CPU-induced acoustic noise at all CPU operating states. The reduction in noise is accomplished through the use of a liquid cooling assembly that eliminates CPU heatsink fans and moves heat away from the processors to a heat exchanger, located near the back of the enclosure, improving cooling efficiency, and leveraging the airflow of the rear system fans. This also prevents the hot air that normally exits the CPU heatsinks from being recirculated inside of the chassis.

In fact, in a laboratory comparison of results between the liquid cooled and non-liquid cooled systems, the reduction in acoustic noise was measured at 0.5 and 5 dB on the HP Z400 and HP Z800 respectively at idle, 3 and 8 dB on the HP Z400 and HP Z800 respectively running the CPU at a heavy CPU load with high power processors. These tests were run using the Intel Power and Thermal Utility (Figure 1). The reduced noise levels can make users more comfortable and productive, without sacrificing application performance.

In addition, studies have also shown that certain kinds of acoustic noise are more distracting than others, especially higher frequencies and irregular modulations. In an air-cooled PC at heavy workloads, the CPU fans ramp to keep the CPU cool. Under cyclic loading, the fans ramp up and down with the workload. Because the LCS has high thermal inertia, the associated fans do not ramp up and down quickly.

Conclusion

As a technology leader, HP continues to innovate in the area of thermal management to improve the end user experience. As workstation power consumption continues to increase, the demand for liquid cooling is likely to extend beyond CPUs to other components in the system. HP is using its extensive experience in thermal management and workstation engineering to develop high-performance, quiet systems for today, and new innovations for tomorrow's more powerful systems.

For more information

Full white paper with more depth on the benefits from liquid cooling on HP Z Workstations
http://h20219.www2.hp.com/Hpsub/cache/286520-0-0-225-121.html#Personal_Workstations

Information about HP personal workstations: www.hp.com/go/workstations

A useful resource for explaining sound measurements http://en.wikipedia.org/wiki/Sound

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