HP recommends Windows® 7.

Liquid Cooling on the HP Z420 and HP Z820 Workstations

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 desk-side systems.

Along with the beneficial increases in capabilities have come increased power requirements and consequently higher heat dissipation. For instance, the previous generation Intel® Xeon® X5690 processor had six cores and a maximum thermal design power (TDP) of 130W. The new Intel® Xeon® E5-2687W processor has eight cores and a TDP of 150W -- a 15 percent increase in power.

In order to keep these processors and other critical components cool, traditional cooling systems add multiple fans to dissipate the heat to the environment outside of the cabinet. HP 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 quiet, the use of self-contained liquid cooling in the HP Z420 and HP Z820 Workstation products is the latest innovation from HP to further reduce noise levels while maximizing performance.

Figure 1 – HP Z420 Liquid Cooling

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 (ODDs), and other noises e.g., liquid cooling pumps, keyboards, etc. Fans and high speed (15K RPM) hard disk drives are typically the strongest sources 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, fans for memory cooling, and fans on the processor heat sink(s).

There are two ways to reduce fan speeds (and noise). Reduce the amount of heat produced or use more efficient cooling mechanisms. Reducing the generated heat, while possible, is typically unacceptable; for example, reducing heat by lowering the processor frequency or number of cores results in lower performance. And with the advent of Intel® Turbo Boost Technology, the processor can now spend more time at even higher frequencies, increasing the processor cooling demands. 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, the small CPU contact area of a heatsink is replaced with a cold plate with many micro-channels that quickly remove heat from the CPU. And a smaller heatsink surface area (fins) for transferring heat to the environment is replaced by the larger surface area of a radiator, with liquid providing an effective means of transporting the CPU heat to the radiator.

Acoustic benefits of liquid cooling

The increased thermal efficiency of liquid cooling delivers lower CPU-induced acoustic noise at high frequency, high power CPU operating states. 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 2 dBA (perceived as about 15 percent quieter) while running mainstream CPUs[1] at a heavy CPU load[2] level. And with the most extreme CPUs[1], liquid cooling allows the workstation to maintain the same acoustic noise level as when using a mainstream CPU. The reduced noise level 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 system at heavy workloads, the CPU fan(s) ramp quickly to keep the CPU cool. Under cyclic loading, the fan(s) ramp up and down with the workload. Because the LCS has higher thermal inertia, the associated fans do not ramp up and down as quickly.

Other benefits of HP liquid cooling

Typical Liquid Cooling Systems (LCS) are a complex assembly consisting 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 Z420 and HP Z820 Workstations combine all of these components into a self-contained assembly that mounts directly to the CPU socket, dramatically reducing the complexity over previous LCS solutions.

Figure 2 – HP Z800 Liquid Cooling

Figure 3 – HP Z820 Liquid Cooling

Self-contained LCS units provide the convenience of a traditional CPU heatsink with the efficient thermal performance of liquid cooling. These innovative designs improve service times by allowing for faster processor and system board replacement, and on the HP Z820 removing an LCS module is as simple as twisting it a quarter turn.

Environmentally friendly

HP is committed to environmental sustainability. The HP workstation design team has taken a proactive approach (beyond just industry regulations) to recyclability and selecting materials that reduce the risk to the environment and health. The HP Z420 and HP Z820 liquid cooling systems are no exception. They are recyclable, constructed with non-halogenated flame retardant (BFR/PVC-free) materials[3], and use non-hazardous propylene glycol and water as the working fluid.

Conclusion

As a technology leader, HP continues to innovate in the area of thermal management to improve the end user experience. HP is using its extensive experience in thermal management and workstation engineering to develop environmentally friendly, high-performance, quiet systems for today, and new innovations for tomorrow's more powerful systems.

Notes

1. A mainstream CPU is defined as having a Thermal Design Power (TDP) of 95W - 135W. An extreme CPU has a TDP ≥150W.
2. Heavy CPU load is defined as stressing the CPU to 90% 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 optimized for a specific CPU architecture.
3. Meeting the industry definition of 'BFR/PVC-free' per the iNEMI Position Statement on "Low Halogen" Electronics. Plastic parts incorporated into the chassis generally contain < 1000 ppm (0.1%) of bromine or chlorine. Printed circuit board and substrate laminates generally contain < 1500 ppm (0.15%) of total bromine and chlorine. Service parts after purchase may not be BFR/PVC-free. External accessories, including power supplies, power cords, and peripherals as well as the following customer-configurable internal components: SAS 3 ½" HDD, SAS ROM Upgrade (Patsburg), SAS RAID Card, Creative Audio Card, and Broadcom NIC are not BFR/PVC-free.

For more information

hp.com/go/whitepapers

Whitepapers with more depth on the capabilities and benefits of HP Z Workstations

hp.com/go/workstations

Information about HP Workstations

http://en.wikipedia.org/wiki/Sound

A useful resource explaining sound measurements

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