Technical White Paper

Contents & navigation
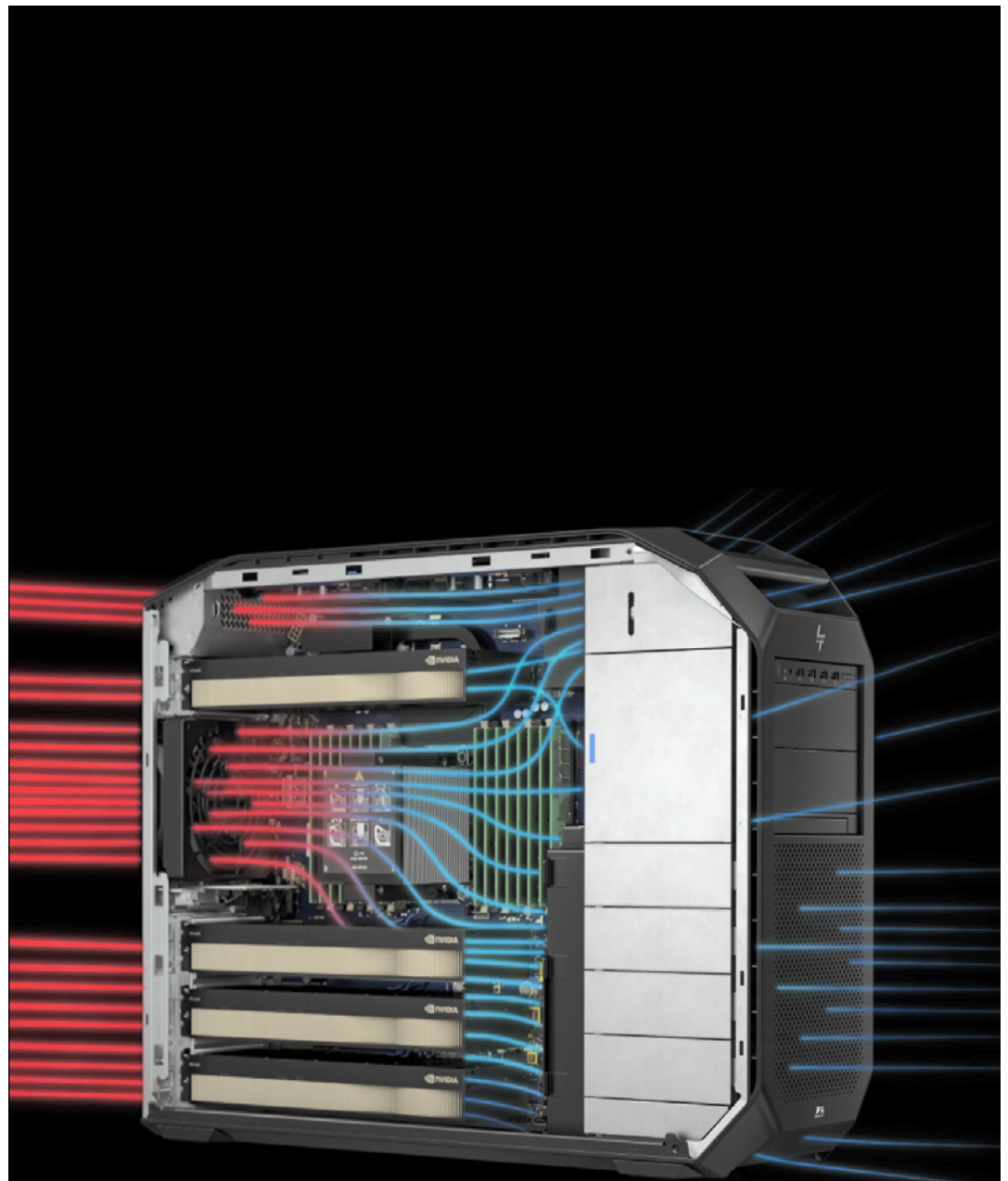
HP G5 Performance Workstations: Thermal Management and Acoustics

Technical White Paper

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Contents & navigation

Introduction

The HP G5 high-end desktop workstations are designed to deliver high-level reliability expected from HP workstations while maintaining quiet operations for end-users. In G5 workstations, HP added additional thermal sensors and fan control methods compared to our G4 products to maintain high reliability and quiet operation even as component power levels continue to increase. Additionally, Z4 and Z6 G5 offers optional cooling assemblies to support higher power configurations.

Z by HP's Thermal and Acoustic Management Principles

Workstation customers demand products that deliver performance, safety, reliability, and low noise. Monitoring and maintaining component temperatures is vital to performance, safety, and reliability. Quiet acoustics (through effective thermal management techniques) allow workstation customers to stay focused and in the zone as they work on critical and demanding workflows. Low noise is essential to reducing user fatigue, maximizing productivity, and minimizing distractions.

Z by HP design principles aim to ensure all system components operate safely and reliably. As a result, the temperatures of internal components are maintained within the component supplier's specified operating limits and target at least a 5-year lifetime, while enabling the configuration to operate at high performance. HP Workstation engineers designed G5 workstations by separating the system into cooling "zones" to manage where heat is added and removed from the system. The system directs cool air to where it is needed, and exhausts hot air outside the chassis.

Each zone has one or more fans dedicated to cooling the components in that region. Acoustic noise is managed by starting all fan speeds low and ramping them in a controlled way to minimize the perceived noise. To keep noise levels low, the fans in each zone can be controlled independently and run only as fast as necessary. The fan settings are also configuration aware, adapting to what is installed to provide more cooling for higher power and greater numbers of components. An array of sensors is used to continuously monitor temperatures.

HP G5 Performance Workstations: How Does HP Achieve Quiet Acoustics?

HP's design principles ensure quiet acoustics while enabling the system to operate at high performance. Impressively quiet workstation operation is enabled by smart fan control and efficient temperature management:

Isolated Cooling Zones

Isolated cooling zones and fan placement manage where cool air is added to the system and hot air is removed. Each zone has one or more fans dedicated to cooling components in that region.

HP maximizes fresh air inlets and directs cool air where needed by considering techniques to separate the CPU airflow from memory airflow, such as:
• Optional memory fans/ducting for higher memory configurations requiring more airflow (for Z4 and Z6 G5)
• Multi-channel memory airflow design to cool both front and rear DIMMS with cool, fresh air (for Z8 G5)
• Prevent preheated, exhausted air from the front CPU cooler from entering the rear CPU cooler (for Z8 G5)

Fan(s) for cooling these areas are ramped based on the cooling requirements for the devices/ components sensed by the Adaptive Fan Control sensors.

NOTE: Not all fans are standard offerings, the inclusion of some fans is configuration dependent.
See section: Z4 G5 and Z6 G5 Optional Cooling Assemblies.

Adaptive Fan Control

Adaptive fan control utilizes up to 28 fan speed algorithms and an array of up to 32 sensors to continuously adjust fan speeds to maintain appropriate system temperatures. Each zone has multiple sensors to manage temperatures.

Health Management Controller

Health management controller adapts to your specific system configuration, operating environment, and workload to better tune the fan speeds (delivering optimum performance and extremely low noise levels).

Configurable PCIe Slot Dividers

Configurable PCIe slot dividers enable more open area for hot air to exit the rear of high-end graphics cards. "PCIe slot dividers" are sheet-metal inserts on the back of the chassis that have been specifically designed to be removed when double-wide graphics are installed. Removal of the insert greatly improves the airflow to the GPUs and overall system cooling.

Optimized PCIe Slot Spacing

On Z8 Fury G5, optimized PCIe slot spacing maximizes the open space between multiple graphics cards to improve airflow to GPUs. HP designed the system board using a split PCIe layout design to position PCIe slots on both above and below the CPU enabling us to offer 3x Gen 5 slots for 3x double-wide Gen 5 graphics cards. HP grouped the PCIe slots below the CPU and increased slot distance by 50% compared to the industry standard to enable more efficient cooling (note: industry standard PCIe width is 1x, Z8 Fury G5 is designed using 1.5x PCIe slot spacing between groupings). HP also organized slots so that it would have four x16 PCIe slots to enable 4 double wide graphics cards.

HP Z Cooler - 3D Vapor Chamber Technology

HP Z Cooler uses 3D Vapor Chamber Technology to efficiently cool the processor, translating to impressively low acoustic levels and full processor performance. HP Z Cooler's use of low-halogen material and de-ionized water delivers an environmentally conscious and fully recyclable cooling solution. HP Z Cooler's phase-change design uses de-ionized water to transport water from the processor area (gets evaporated) to the heat exchanger (to condense). Compared to G4, the Z Cooler offered in G5 has been improved to support the much higher power processors used on G5 systems.

Z Turbo Drive Cooling

HP's Z Turbo Drives are designed and tested to ensure effective performance and reliability. The latest generation of high-performance NVMe SSDs offer higher data transfer rates and provide greater processing capability. Therefore, to facilitate effective cooling of SSDs, HP includes heat sinks on various Z Turbo drives to facilitate more effective cooling
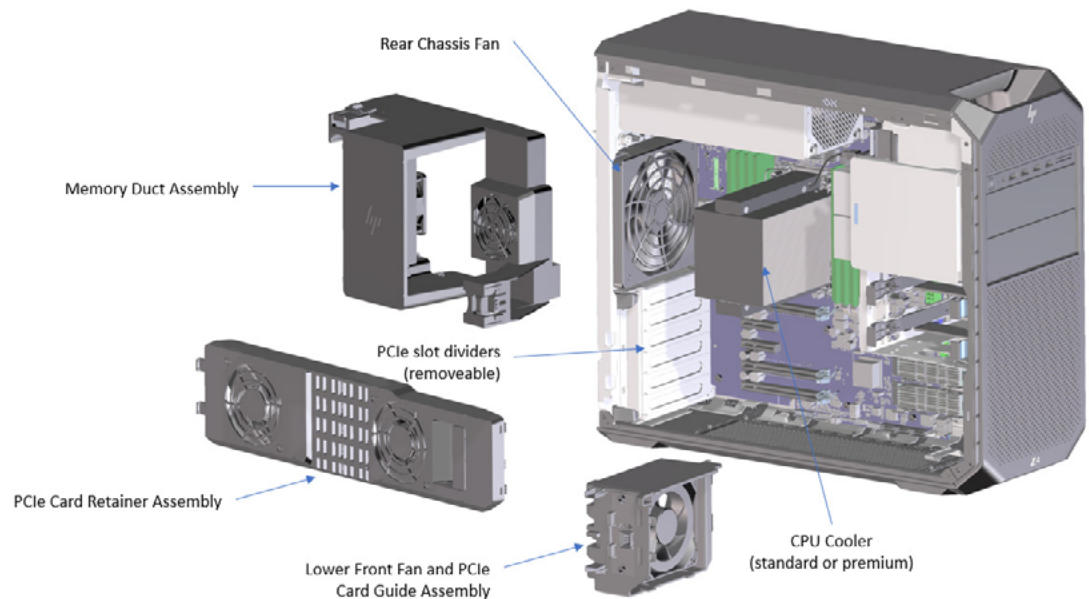
Z4 G5 and Z6 G5 Optional Cooling Assemblies

Figure: Z4 G5 exploded view

Card Guide and Lower Front Fan Assembly

The card guide assembly contains the lower front fan. The lower front fan is required for certain higher-end graphic card configurations to ensure proper cooling to meet the graphic card vendor reliability requirements. This assembly is an optional part not required for single entry-level cards. Please review the Quick Specs document for more information.

Memory Duct Assembly

The memory fan assembly is required for higher-end memory configurations to provide improved cooling and reliability. This assembly is required for any memory configuration with a 32GB DDR5 module or higher capacity configuration installed in the system. This optional memory duct assembly is not required for 16GB DDR5 modules or lower configurations.

PCI Card Retainer Assembly

The optional PCI Card Retainer Assembly contains dual fans to provide even more cooling to high-end graphics card assemblies. This optional assembly is required to provide sufficient cooling for several multiple graphic card configurations.

Standard and Premium CPU Coolers

The Standard CPU Cooler provides quiet cooling for processors up to 220W thermal design power (TDP). The HP Z Cooler provides the next level of CPU cooling required for processors above 220W. These both were designed to provide quiet performance under even the most demanding loads.

Summary

The HP G5 high-end workstations are engineered to deliver under the most demanding of workflows. The G5 desktop workstations provide advancements compared to previous G4 workstations to ensure high-level reliability of system components and quiet operations allowing customers to stay focused while working on critical workflows.

Resources, Contacts, or Additional Links

Visit **HP's White Paper site** to learn more about the innovation in HP Workstations and the latest technologies offered in the products.

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