



# Technical White Paper

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# HP Performance Control Modes for Z Desktop Workstations



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## Introduction

This paper provides detailed information about performance control modes on HP Z Desktop Workstations. The F10 menu in the HP BIOS allows customers to prioritize variations of acoustics over performance, or performance over acoustics, depending on their needs and work loads.

Each mode contains its own cooling and performance algorithms based on temperature sensors, wattage available to the CPU, and acoustic target ranges. The benefits of each mode vary based on additional variables such as processor, memory and graphics card configurations, the environment the machine is running in, the workload, and the length of time the workload is sustained.

On the HP Z2 G9 desktop workstations, performance improvements of up to 41%<sup>3</sup> on multi-threaded workloads are achievable with reasonable acoustic ramifications using High Performance Mode. These gains are equivalent to two generations of processor upgrades simply by changing the Performance Control Mode setting in the BIOS. High Performance Mode is also available on Z4, Z6, Z8 and Z8 Fury desktop workstations.

## How HP Achieves These Results

The dramatic performance increase of up to 41%<sup>3</sup> with multi-threaded applications/workflows is achieved through a combination of Intel<sup>®</sup> Adaptix™ Technology (including the Dynamic Tuning Technology or DTT framework) combined with HP's proprietary cooling and power designs.

## How to Set HP Performance Control Modes

In the F10 BIOS Menu, the setting titled "Performance Control" is adjustable to either Rack Mode, High Performance Mode, Performance Mode, or Quiet Mode depending on the platform. These modes are choice points for optimizing performance and acoustics based on user needs.

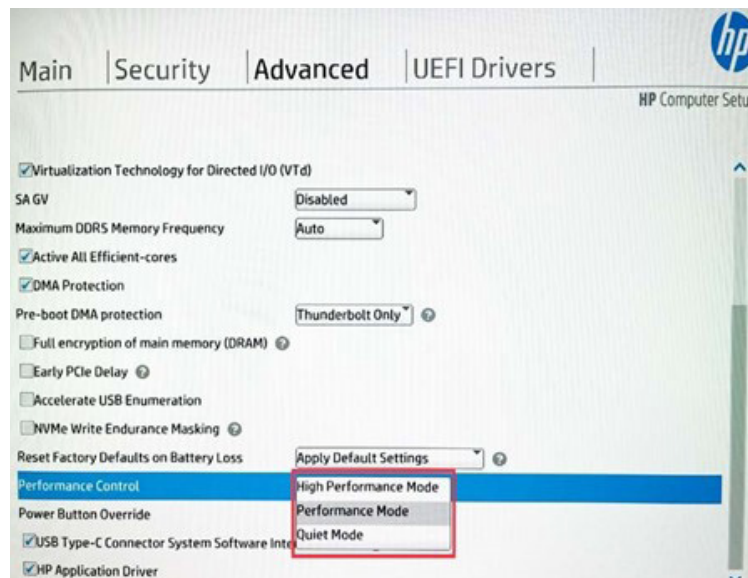


Figure 1: Performance control settings are adjustable in the F10 BIOS Menu.



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At startup, push the F10 key while the system is booting to get to the BIOS Menu.

Go to --> Advanced --> System Options --> scroll down and choose “Performance Control”.

Set the Performance Mode you desire and then go back to Main --> Save Changes and Exit --> Yes.

The machine will restart in the mode you’ve chosen.

You can change these modes anytime you prefer to prioritize acoustics (Quiet Mode), want a balance between performance and acoustics (Performance Mode), or prefer to prioritize performance (High Performance Mode and Rack Mode). Rack Mode sets the fan speeds to a higher level compared to High Performance Mode.

Z2 G9 systems are shipped in High Performance Mode.

## More About Performance Control Options

### Performance Mode

Z2 G9 systems with Intel® 14th generation Core™ processors are shipped in High Performance Mode. Z2 G9 models with Intel® 12th and 13th generation processors, and Z4, Z6, and Z8 G5 models with Intel® Xeon® processors all ship in Performance Mode by default but can be specially ordered in High Performance Mode.

Performance Mode delivers a balance between performance and acoustics assuming an open concept office environment. This mode balances acoustics, temperature, and performance to give users a great experience when using high-power workloads without maxing out the fans and power budget.

**Note that in certain platforms you can select High Performance Mode as the default setting if configured from the factory.**

In the subsection “High Performance Mode” below, we will discuss the benefits of High Performance Mode and why you would want to ship with this mode as the default from the factory. See Table 1 below for details on the default and other available modes by platform:

Table 1

Product	Generation	Default Mode	Modes Available
Z1 Tower	G9	N/A	Performance Modes are not available on the Z1
Z2 Tower	G9	High Performance	Quiet, Performance, High Performance
Z2 SFF	G9	High Performance	Quiet, Performance, High Performance
Z2 Mini	G9	High Performance	Quiet, Performance, High Performance, Rack
Z4	G5	Performance	High Performance, Performance, Rack



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Z6	G5	Performance	High Performance, Performance, Rack
Z8 Fury	G5	Performance	High Performance, Performance, Rack
Z8	G5	Performance	High Performance, Performance, Rack
Z4R	G5	Performance	High Performance, Performance, Rack

\*Note: The 14th generation processors for Z2 G9 are shipped in High Performance Mode, while 12th and 13th generation processors are shipped in Performance Mode by default.

## Quiet Mode

In Quiet Mode, fan noise is reduced to prioritize acoustics over performance.

Fans still ramp up during more intensive tasks, but the system will prioritize a lower acoustic target by managing the maximum fan speeds.

CPU fan operating speed may be reduced compared to when the device is in High Performance Mode and Performance Mode.

In some cases, like while performing very heavy workloads using a discrete graphics card, noise may not be noticeably reduced.

## High Performance Mode

High Performance Mode is the best choice when users want to prioritize performance over quiet operation. This mode increases performance by allowing the CPU to operate longer at a higher power level with an occasional increase in noticeable fan noise, especially at the start of workloads.

High Performance Mode utilizes Intel® Adaptix™ Technology (including the Dynamic Tuning Technology or DTT framework) combined with HP’s proprietary cooling and power designs to provide performance gains in multi-threaded applications/workflows.

The performance gains may vary depending on the system configuration as well as additional power and performance features, like power load balancing, which optimizes the power allocation between the components installed in the system.

Maximum performance gains are seen with the Intel® 14th generation Core™ i7 and Core™ i9 processors.

A composite of the benchmarks below resulted in 37% performance improvement<sup>2</sup>. The composite consisted of the following benchmarks using multi-threaded workloads:

- CINEBENCH R23 Multi-threaded
- Geekbench 6 Multi-Core
- Autodesk Arnold 2023
- SPECapc Autodesk Maya 2023
- SPECworkstation 3.1 FSI, rodiniaCFD, Convolution, FFTW
- Maxon Cinema 4D CPU Multi-Threaded & Batch Render
- Autodesk Revit 2024 RFO
- Vray 5 CPU
- SPECapc SOLIDWORKS 2022 CPU Raytrace
- Passmark 10 CPU Mark Composite
- Blender OpenData classroom CPU
- PTC Creo 9.0 SPECapc Render Studio CPU

High Performance Mode is not recommended when ambient temperatures are above 30°C/86°F. Higher ambient temperatures may increase fan noise and limit performance gains.



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## Rack Mode

Rack Mode increases system fan speeds to enable dense rack populations. The combination of system cables and external power supplies restricts the outlet airflow which can cause the internal system temperature to rise. The proximity to other systems can also cause an increase in temperature. The higher system temperatures can reduce the performance and life of some of the components, while the hot air exiting the system heats the power supplies, potentially reducing their efficiency and life. To compensate for this, Rack Mode increases the fan speeds, which enables systems to operate at “normal” temperatures, so they can maintain performance and reliability.

Rack Mode combined with a premium CPU cooler can enable higher clock speeds in all-core workloads. There is the potential for significantly higher acoustic noise, therefore it is intended to be used in a data center and not deskside.

Rack mode is available on Z2 G9 Mini, Z4 G5, Z6 G5, Z8 G5 and Z8 Fury G5. Please refer to Table 1 above for the list of available modes in each generation of Z Desktop Workstations.

The Rack Mode does not enable all the performance tuning features present in High Performance Mode, such as Intel DTT, but it can provide up to 15%<sup>5</sup> higher performance for high power, sustained, multi-threaded workloads such as CPU rendering. This performance increase has been validated with Cinebench R23 on the Z8 Fury G5 with the W9-3475X 36 Core™ processor.

Rack mode is not currently available for all form factors. It is recommended for use in data centers where the system is racked and acoustics are less important.

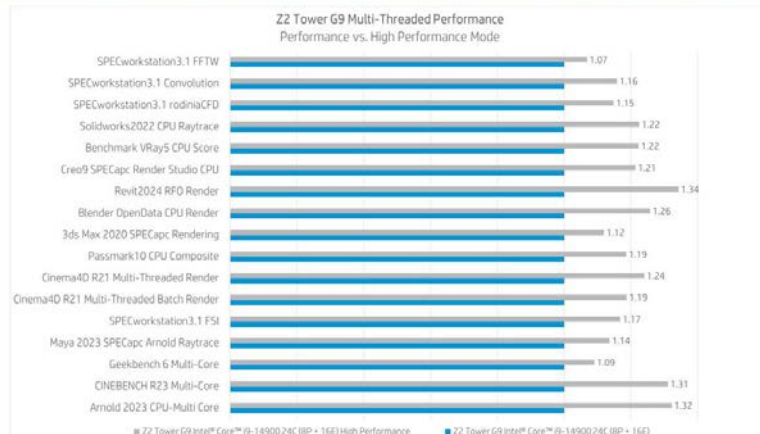
## Z2 G9 Tower

The highest performance gain on Z2 G9 Tower was using multi-threaded benchmarks with 65W processors. There was an improvement of up to 26% on Core™ i7-14700<sup>6</sup> when switching from Performance Mode to High Performance Mode. Composite benchmark results showed an average gain of 26% on Intel® Core™ i7-14700 and 20% on Intel® Core™ i9-14900.

The HP Z2 G9 Towers tested were configured with an NVIDIA RTX™ A4000 24GB graphics card.

See below results of individual benchmarks for Intel® 14th generation Core™ i7 and Core™ i9 processors:

## Z2 Tower G9 i9 Performance % Increases in Multithreaded Workloads



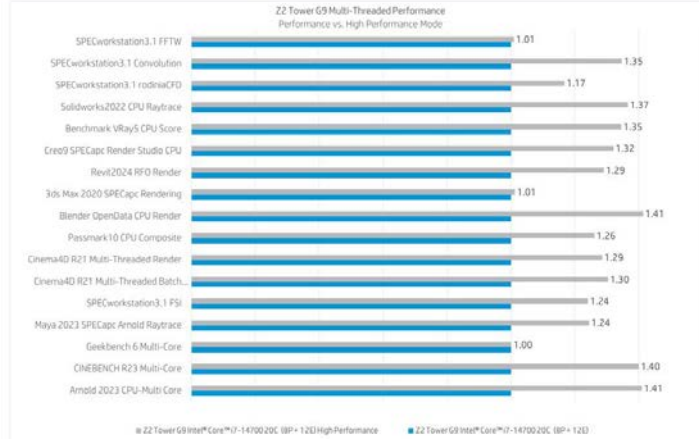


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## Z2 Tower G9 i7 Performance % Increases in Multithreaded Workloads

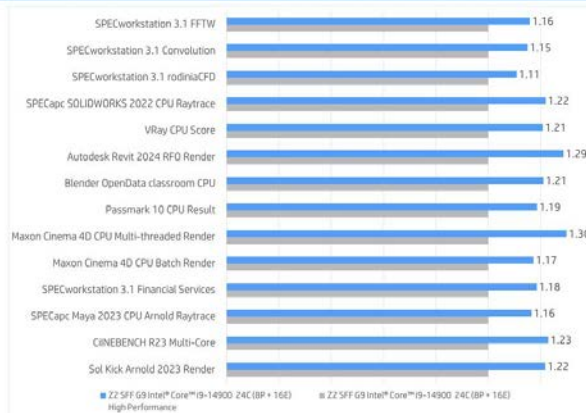


## Z2 G9 Small Form Factor

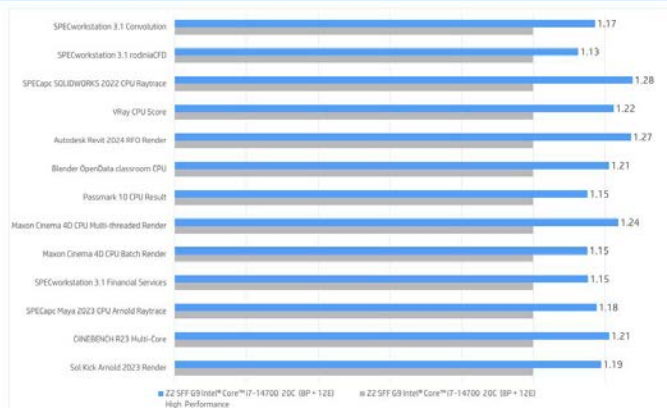
Testing of the Z2 G9 Small Form Factor was done on the full height graphics chassis, also called the riser chassis. Results were up to a 18% performance gain in High Performance Mode over Performance Mode with an Intel® Core™ i7-14700 processor and 20% improvement when tested with an Intel® Core™ i9-14900 processor<sup>3</sup>. Composite benchmark results showed an average gain of 18% on Intel® Core™ i7-14700 and 20% on Intel® Core™ i9-14900.

See below results of individual benchmarks for Intel® 14th generation Core™ i7 and Core™ i9 processors:

## Z2 SFF G9 i9 Multi-Threaded Performance % Increases



## Z2 SFF G9 i7 Multi-Threaded Performance % Increases





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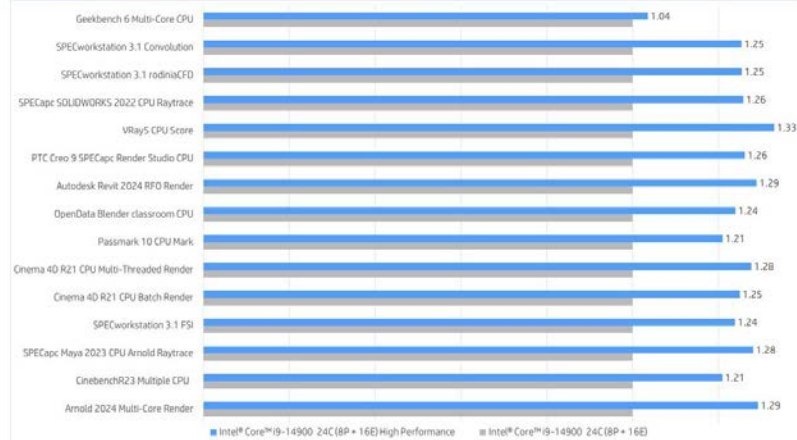
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## Z2 G9 Mini

Testing of the Z2 G9 Mini with the Intel® Core™ i9-14900 processor showed up to a 33% performance gain in High Performance Mode over Performance Mode. While composite benchmark results showed an average gain of 25%.

See below results of individual benchmarks for Intel® 14th generation Core™ i7 and Core™ i9 processors:

## Z2 Mini G9 i9 Performance % Increases



## Acoustic Impact

The following behavior was observed during HP internal benchmarking of High Performance Mode and Performance Mode using Cinebench R23 Multi-Core on machines with an Intel® Core™ i9-13900 and iGFX.

On the Z2 G9 Tower, the acoustics in High Performance Mode were noticeably higher during the first two minutes, increasing approximately 25 dBA. After the initial two minutes the noise decreased significantly and then remained lower - within 5 dBA (+/- 3dBA) of the Performance Mode.

For the Z2 G9 SFF, the High Performance Mode acoustics behaved differently. Using the same benchmark and configuration, the acoustics increase in the first 2.5 minutes was typically less than 20dBA. After the initial 2.5 minutes the noise decreased, but still remained 10-15 dBA (+/- 3dBA) higher than Performance Mode.

On the Z2 G9 Mini running the same benchmark and configuration as the Tower and SFF, there was a barely noticeable jump in acoustic - less than 5 dBA - with an occasional increase of 5 dBA (+/-3dBA ) during the workload.

## Interaction of Performance Control Modes and Microsoft Windows Power Plans

The performance mode selection in the HP F10 BIOS menu and the Microsoft Windows power plans are independent of one another but work together.

The HP BIOS Performance control mode sets the following:

- CPU power limits
- GPU power limits (where applicable)
- System power limits
- Thermal limits
- Fan control settings and acoustics



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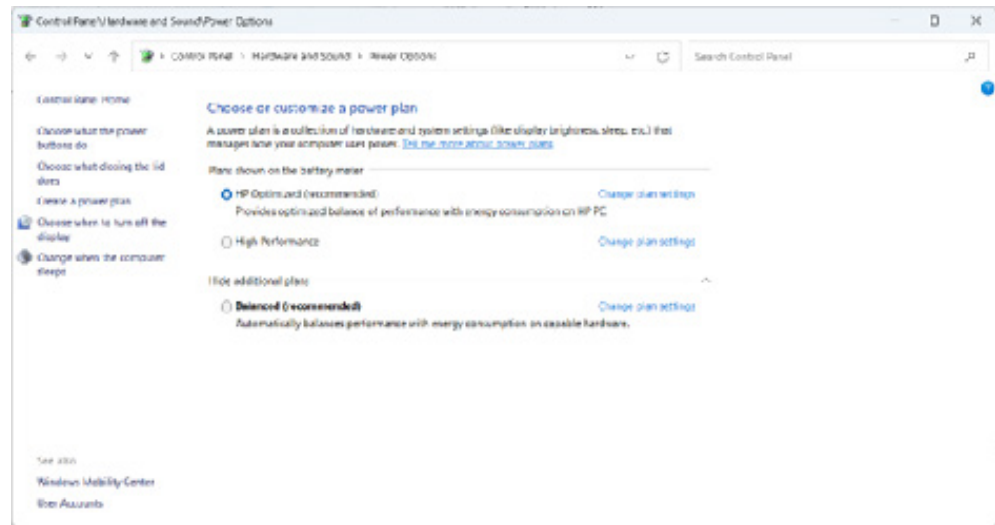
Windows power plans control settings such as:

- CPU power states (P-states)
  - When to idle
  - When to exit idle
  - When to use max Turbo frequency vs. saving power
  - When to use the max memory and I/O frequencies vs. saving power
- Thread scheduling and priorities

The Windows “Balanced” power plan favors lower power vs. higher performance. “HP Optimized” adds to “Balanced” some HP-specific settings to improve I/O and memory performance. While “High Performance” favors highest performance (CPU, I/O, and memory) instead of lower power. HP offers the “HP Ultimate Performance” power plan on workstations with an Intel® Xeon® processor. This power plan favors highest performance but reduces the power consumption when Windows is idle as compared to the Microsoft “Ultimate Performance” power plan.

HP recommends choosing the High Performance power plan in the Windows Control Panel. This offers maximum performance when combined with the HP BIOS Performance Control Mode set at High Performance Mode. On the Z4, Z6, and Z8 Xeon® systems, the HP Ultimate Performance power plan can be selected instead of the Windows default High Performance power plan. The difference is the HP Ultimate power plan gives highest performance when busy while reducing power when Windows is idle by as much as 50%. The High Performance power plan is still the recommended plan for highest performance on Z2 with the Core™ CPUs.

Note: To make changes to the Windows Power Options, you must go to Control Panel > Hardware and Sound > Power Options > “Choose or customize a power plan.”



In the Windows power plan options, choose High Performance.

For more information on Windows power plans, please refer to Microsoft documentation.

## Conclusion

HP’s Performance Control Modes allow users to prioritize what really matters to them based on workload, performance needs, and fan noise preferences on HP Z Desktop Workstations.

Performance improvements of up to 41%<sup>3,4</sup> are achievable using HP High Performance Mode with reasonable acoustic ramifications. These gains are equivalent to two generations of processor upgrades simply by changing the Performance Control Mode setting in the BIOS. Work continues to explore the benefits of these modes across all Z Desktop Workstations

HP recommends that customers use this paper to assist with considerations of purchasing and using HP machines, comparing HP performance against other brands, and to assist with planning their own benchmarking and testing to get the most performance for the price.





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## Disclaimers

1. Compared to Performance Mode. Performance increase of 34% based on Z2 Tower G9 with 64GB of memory, 1TB NVMe, Windows 11 22H2 OS, RTX A4000, Intel® Core™ i9-13900 CPU using SPECworkstation 3.1 benchmark.
2. Compared to Performance Mode. Composite performance increase based on Z2 Tower G9 with 64GB of memory, 1TB NVMe, Windows 11 22H2 OS, RTX A4000, Intel® Core™ i7-13700 and on Intel® Core™ i9-13900 using CINEBENCH R20 & R23, Geekbench 5.4.5, Autodesk Arnold 2023, Cinema 4D R21, SOLIDWORKS 2022 SPECapc CPU Raytrace, Blender OpenData, Revit 2022 Render, SPECworkstation 3.1 Financial Services, SPECworkstation 3.1 Convolution, Maya 2023 SPCapc CPU Arnold Raytracing and Adobe After Effects 2023 benchmarks.
3. Compared to Performance Mode. Performance improvement based on Z2 Tower G9 with 64GB of memory, 1TB NVMe, Windows 11 22H2 OS, RTX A4000, i7-14700 CPU using Blender OpenData CPU Render and Arnold 2023 CPU multi-core benchmarking.
4. Z2 G9 Mini testing based on configuration of 64GB of memory, 1TB NVMe, Windows 11 22H2 OS, RTX 4000 graphics and Intel® Core™ i7-13700 processor and Intel® Core™ i9-13900 processor. The 35% gain on the Mini was on the Cinema 4D Batch Render benchmark. Composite scores were calculated using the following benchmarks with the above configurations: CINEBENCH R20 & R23, Geekbench 5.4.5, Autodesk Arnold 2023, Cinema 4D R21, SOLIDWORKS 2022 SPECapc CPU Raytrace, Blender OpenData, Revit 2022 Render, SPECworkstation 3.1 Financial Services, SPECworkstation 3.1 Convolution, Maya 2023 SPCapc CPU Arnold Raytracing and Adobe After Effects 2023.
5. The 15% improvement in performance based on the Cinebench R23 benchmark on the Z8 Fury G5 with Intel® Xeon® w9-3475X 36C processor, 4x32GB (128GB) memory,<sup>1</sup> NVIDIA RTX™ A4000 graphics card,<sup>1</sup> 1TB M.2 SSD, running Windows 11 22H2.
6. Compare to performance mode - Z2 TWR G9, 64GB, 1 TB NVME, Windows 11, RTX A4000 with i7-14700.

