Technical white paper

HP Z4 G4 Workstation

Expand your power

Take your business to the next level of performance, expandability, and no compromise reliability in one complete package. The HP Z4 G4 Workstation features a perfect mix of HP Z DNA in a performance workstation package with up to 18 discrete processor cores, up to 256 GB of RAM, and multiple storage and PCIe configuration options.

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Chassis and system highlights

The HP Z4 G4 Workstation is HP's high performance single processor workstation, delivering outstanding value in a newly redesigned, expandable mini-tower with integrated front and rear handles. The innovative HP Z4 G4 Workstation architecture offers a choice of the Intel® Xeon® W or Intel® Core™ X-series processors and supports the latest professional graphics and single socket multicore processor technology. With a choice of 465 W, 750 W or 1000 W 90% efficient power supplies, the new HP Z4 G4 workstation supports a vast selection of hardware configurations.

Tool-free design

The HP Z4 G4 Workstation continues in the tradition of providing tool-free access for ease of configuration and serviceability. With clearly marked blue touch points and tool-free serviceability, upgrading components is as easy as ever. The HP Z4 G4 offers tool-free access to many of the user-serviceable components such as: internal hard drives, PCIe expansion slots, and external device bays. In addition, the unique approach HP takes to cable management presents a clutter-free environment for ease of access with the added benefit of improved airflow for enhanced thermal and acoustic performance.

Intel® Xeon® W Processors
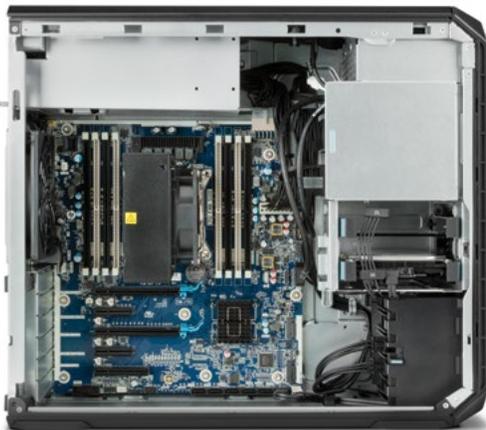
Intel® Core™ X-Series Processors
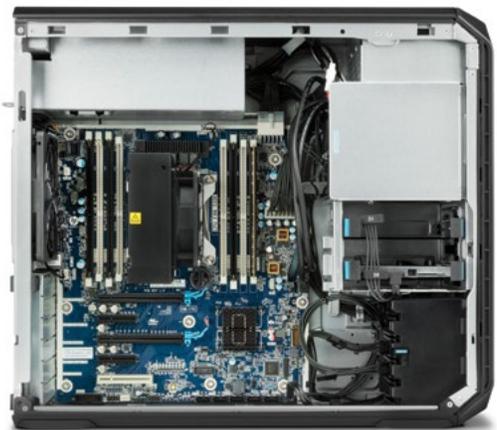
Security

HP understands the importance of system and component security and has incorporated several security features into the HP Z4 G4 Workstation. New for the HP Z4 G4 is an optional side access panel barrel key lock, providing customers with an integrated security solution. Additionally, the side access panel continues to offer the security features of its predecessor: the HP BPC Security Lock mounting feature, a security slot, and a padlock loop—allowing customers to select the right level of security. For customers with remote security needs, a system intrusion switch and a remote/centrally controlled solenoid lock are available as optional accessories.

The HP Z4 G4 Workstation also features HP SureStart Gen 3, HP Secure Erase, which enables the ability to overwrite data five times over ensuring complete data removal; and HP's Manageability Integration Kit.

Expandability and performance

The HP Z4 G4 delivers enhanced expandability and I/O performance where it matters. The new architecture features eight memory slots, with support for the latest DDR4 memory, and up to five[1,4] high-performance 3rd-generation PCI Express expansion slots. To help eliminate bottlenecks with external devices, HP Z4 G4 also provides six rear accessible SuperSpeed USB 3.1 Gen 1 ports[1].

New with this generation of premium workstations, the Front IO-User Interface is now modular and configurable with two options to choose from. Both modules feature the power button/LED, HDD activity LED, audio jack, USB charging port, and optional SD card reader. The Entry module features 4 USB 3.1 Gen 1 Type-A ports, while the Premium module provides 2 USB 3.1 Gen 2 Type-C ports and 2 USB 3.1 Gen 1 Type-A ports. The HP Z4 G4 has the power and features needed to quickly get the job done.

With two internal storage bays and two standard 5.25" external device bays—the HP Z4 G4 delivers flexibility for storage and accessory options. The internal storage bays feature tool-free drive trays which have been designed to minimize drive vibration, ensuring silent operation. The drive trays are compatible with industry standard 3.5" storage devices, and can be easily adapted to accept the smaller 2.5" form-factor. The HP Z4 G4 also provides tool-free accessibility to the external device bays. Expanding storage capabilities or attaching additional I/O can be easily completed in just a few easy steps.

Quiet and reliable

Acoustic performance is essential to HP Workstations and our customers—because a noisy environment increases user fatigue and reduces productivity. HP has extended its leadership in this area with the new HP Z4 G4. With the additional performance and capabilities, one might expect the HP Z4 G4 to be louder than its predecessor. However, through innovations in engineering, the HP Z4 G4 Workstation continues to improve acoustic performance. Fans are strategically placed to provide optimum system cooling, and by using advanced algorithms to control fan speeds, based on system configuration and key component temperatures, the HP Z4 G4 delivers an extremely quiet system without compromising reliability. The HP Z4 G4 also supports the HP Premium Cooler, which delivers acoustic improvements under even the most extreme processor workloads using cutting edge cooling technology.

While low acoustics, thermal management, expandability, and performance are all high priorities—it is essential that the system reliably withstands extreme conditions and workloads. Rigorous climatic and dynamic testing help ensure that HP Workstations are highly reliable in a wide variety of demanding conditions, while delivering uncompromising performance.

Designed with the environment in mind

HP is committed to environmental sustainability and energy efficiency. To reduce energy consumption, HP Workstations offer ENERGY STAR®[2] qualified configurations with a choice of 90% efficient power supplies-1000 W[1,3,4], 750 W[1], or 465 W[1]. The HP Workstation design team has taken a proactive approach (beyond industry regulations) to recyclability and selecting materials that reduce the impact on the environment. HP Z4 G4 configurations are available with low-halogen materials.[5]

Processor List

Intel® Xeon® W-2195 2.3 GHz 2666 MHz 18C 140 W CPU

Intel® Xeon® W-2155 3.3 GHz 2666 MHz 10C 140 W CPU

Intel® Xeon® W-2145 3.7 GHz 2666 MHz 8C 140 W CPU

Intel® Xeon® W-2135 3.7 GHz 2666 MHz 6C 140 W CPU

Intel® Xeon® W-2133 3.6 GHz 2666 MHz 6C 140 W CPU

Intel® Xeon® W-2125 4.0 GHz 2666 MHz 4C 120 W CPU

Intel® Xeon® W-2123 3.6 GHz 2666 MHz 4C 120 W CPU

Intel® Xeon® W-2104 3.2 GHz 2400 MHz 4C 120 W CPU

Intel® Xeon® W-2102 2.9 GHz 2400 MHz 4C 120 W CPU

Intel® Xeon® W-2175 2.5 GHz 2666 MHz

Intel® Core™ i9-7980XE 2.6 GHz 2666 MHz 18C 165 W CPU

Intel® Core™ i9-7960X 2.8 GHz 2666 MHz 16C 165 W CPU

Intel® Core™ i9-7940X 3.1 GHz 2666 MHz 14C 165 W CPU

Intel® Core™ i9-7920X 2.9 GHz 2666 MHz 12C 140 W CPU

Intel® Core™ i9-7900X 3.3 GHz 2666 MHz 10C 140 W CPU

Intel® Core™ i7-7820X 3.6 GHz 2666 MHz 8C 140 W CPU

Intel® Core™ i7-7800X 3.5 GHz 2400 MHz 6C 140 W CPU

PCI-Express Optimizations on HP Z4 G4 Workstation

The HP Z4 G4 Workstation utilizes PCI-Express 3.0 technology with high performance over a variety of conditions. This paper provides guidance on optimizing the performance of your system when using PCI-Express cards.

Integrated PCI-Express 3.0

The HP Z4 G4 uses the Intel® Xeon® W Processors and Intel® Core™ X-series Processors[6], with integrated PCI-Express 3.0 controllers delivering a peak bandwidth of 16 GB/s per direction for each x16 slot (1 GB/s per lane). PCI-Express 3.0 is backward compatible with 1.0 and 2.0, and slots will train to the highest common speed. PCI Express 3.0 slots will initialize at 1.0 and then transition to 3.0 through a training sequence that involves four adaptive training phases. It is recommended to carefully evaluate and validate PCI-Express 3.0 devices that are not available or supported from HP. PCI-Express options vary by processor selection. There are differences on the motherboard tied to the processor family, therefore motherboards are not interchangeable between the Intel® Xeon® W Processors and Intel® Core™ X-series Processors.

PCI-Express Performance

The HP Z4 G4 integrates several features within the processor: three PCIe 3.0 controllers, DMA caching, and two 2-channel memory controllers (2 DIMMs per channel). This produces excellent performance in I/O bandwidth, and latency.

Figure 1. HP Z4 G4 Workstation Block Diagram
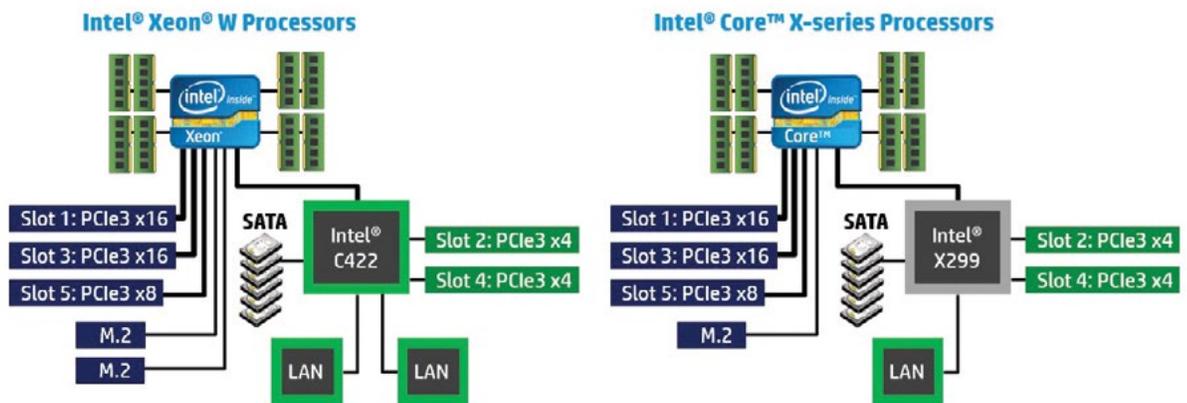
Figure 2. x16 Peak Bandwidth per Direction-GB/s
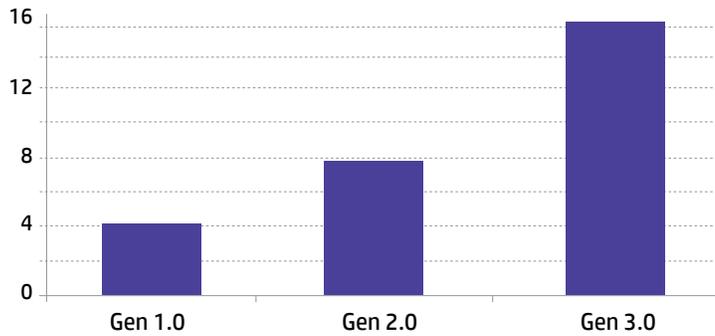
PCI-Express Slot Options

The HP Z4 G4 provides a total of five high-performance Graphics and Expansion slots and supports up to two PCIe 3.0 graphics cards. Two M.2 slots are also available at PCIe 3.0 speeds. An additional bulkhead allows for a sixth mechanical-only Expansion card. The HP Z4 G4, depending on system configurations, can support up to two 250 W cards.

Figure 3. PCIe slot layout
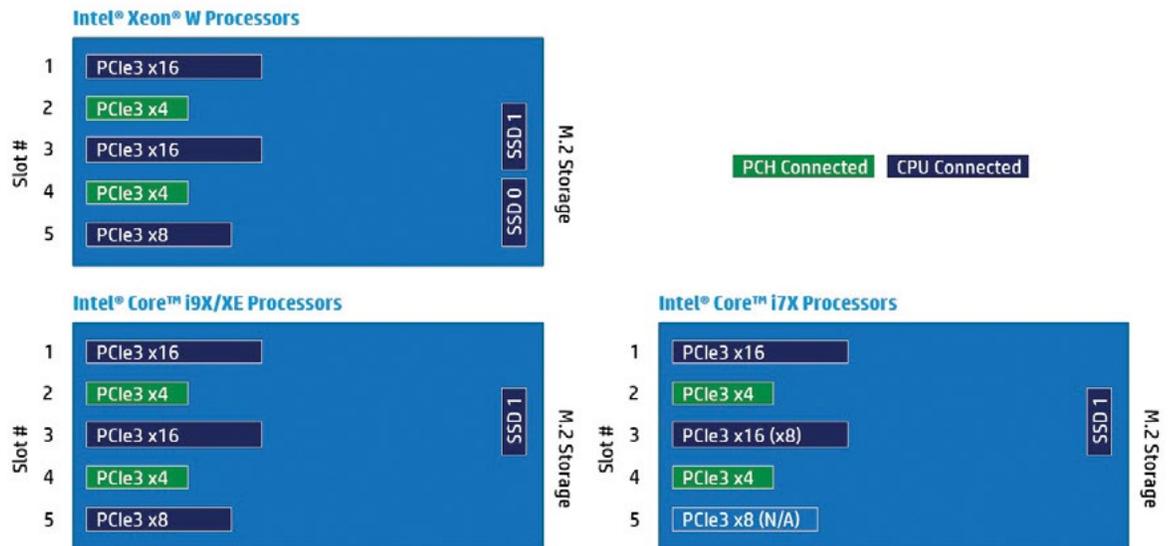
Recipe for Optimizing PCI-Express I/O Performance

For high I/O bandwidth applications, the choice of slot loading, processor, and memory configuration can be optimized to ensure maximum bandwidth available. Applications and cards sensitive to I/O latency may benefit as well from some of the tips below.

Recommended Configuration Steps
1. Place GPU and graphics cards first, following the slot order listed in Table 1.
2. Place Expansion cards next, from highest bandwidth to lowest, following the load priority listed in Table 1. This is the optimal load order for most applications.
3. Additional I/O bandwidth refinements may be possible. If necessary, refer to the tips below.

Table 1. HP Z4 G4 Expansion Slot Recommended Load Order

Intel® Xeon® W Processors

Load Priority	Card Description	Slot 0 Mech	Slot 1 x16	Slot 2 x4	Slot 3 x16	Slot 4 x4	Slot 5 x8
1	1st Graphics	NA	Only				
2	HP Z Turbo Drive Quad Pro (4x M.2 card)	NA			Only		
3	2nd Graphics*	NA			1		2
4	SAS Controller	NA			2		1
5	Thunderbolt™ 3 (2-port)	NA				Only	
6	Network Interface (LAN, WLAN, etc.)	NA		1	4	2	3
7	eSATA (2x port cable)	4			3	2	1
8	Serial port (1x port cable)	4			3	2	1

Intel® Core™ i9X/XE Processors

Load Priority	Card Description	Slot 0 Mech	Slot 1 x16	Slot 2 x4	Slot 3 x16	Slot 4 x4	Slot 5 x8
1	1st Graphics	NA	Only				
2	HP Z Turbo Drive Quad Pro (4x M.2 card)	NA			Only		
3	2nd Graphics*	NA			1		2
4	Thunderbolt™ 3 (2-port)	NA				Only	
5	Network Interface (LAN, WLAN, etc.)	NA		1	4	2	3
6	eSATA (2x port cable)	4			3	2	1
7	Serial port (1x port cable)	4			3	2	1

Intel® Core ™ i7X Processors

Load Priority	Card Description	Slot 0 Mech	Slot 1 x16	Slot 2 x4	Slot 3 x8	Slot 4 x4	Slot 5 MECH
1	1st Graphics	NA	Only				NA
2	Thunderbolt™ 3 (2-port)	NA				Only	NA
3	Network Interface (LAN, WLAN, etc.)	NA		1	3	2	NA
4	eSATA (2x port cable)	4			3	2	1
5	Serial port (1x port cable)	4			3	2	1

Intel® Core™ i7X Processors have fewer available PCle lanes, leaving only one x16 slot for graphics. Configurations with additional PCle cards utilizing 16 lanes are no supported.

*Double-wide 2nd graphics is not supported when HP Z Turbo Drive Quad Pro is installed.

Additional Tips

If possible, make sure all I/O cards are loaded in slots that have a PCI-Express Lane Width at least as wide as the card (see Table 1).
For cards that are latency sensitive, load these cards in processor slots.
Ensure Idle Power Savings BIOS setting is set to Normal (`BIOS setup menu -> Advanced -> Power Options -> Idle Power Savings = Normal`).
Use the latest system BIOS version available on hp.com.
Check for updates in the latest performance optimization white papers (link below).

Storage configurations and RAID

The HP Z4 G4 Workstation includes a 6 port, 6 GB/s Intel® SATA RAID controller.

SATA Storage Features

Controller interfaces and supported drive types.
The controllers support the following drive types and max link speeds:

Controller	Number of ports	Max link speed	Interface type	Drives supported*
SATA	6	6 GB/s	SATA	SSD, SED, HDD, and ODD

*Key management software used with SED drives requires that SATA emulation mode be set to AHCI.

RAID Levels

The RAID levels supported are shown in the table below:

Controller	Number of ports	RAID levels	Max RAIDs
SATA	6	0, 1, 5, 10	2

Option ROM Launch Policy

In the Pre-OS environment, HP Workstations can use either Option ROM (OROM) or a Unified Extensible Firmware Interface (UEFI) driver for configuration and management of the RAID controllers. The default shipping configuration is set to **All UEFI**. This can be changed in BIOS Setup under "Advanced", "Option ROM Launch Policy". Select the desired Option ROM Launch Policy from the pull down menu. The OROM or UEFI driver is not available when the SATA controller is set to AHCI.

Main | Security | **Advanced** | UEFI Drivers

Option ROM Launch Policy

Configure Option ROM Launch Policy   All UEFI

Mini OROM Display   Enable
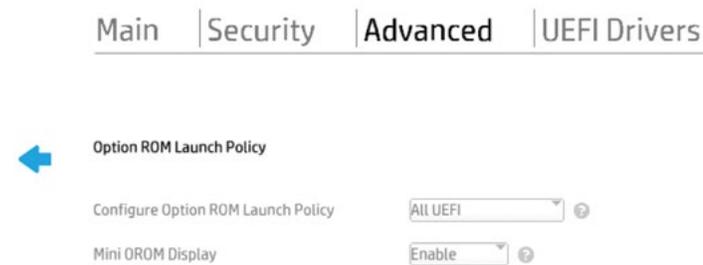
If the setting is grayed out, it will be necessary to change Secure Boot Configuration in BIOS setup under "Advanced", "Secure Boot Configuration", "Configure Legacy Support and Secure Boot".

Main | Security | **Advanced** | UEFI Drivers

Secure Boot Configuration

Configure Legacy Support and Secure Boot   Legacy Support Enable and Secure Boot Disable
Legacy Support Disable and Secure Boot Enable
Legacy Support Disable and Secure Boot Disable

Secure Boot Key Management

Options that include "Legacy Support Disabled" will enforce All UEFI Option ROM Launch Policy.
"Legacy Support Enabled" will allow setting Option ROM Launch Policy to "All Legacy" or "All UEFI Except Video".

When the Option ROM Launch Policy is set to All Legacy, the SATA OROM will only display at power on if there are two or more RAID capable devices attached to the controller, or a single device is attached that contains RAID metadata. In the latter case, the OROM will show that the RAID is failed or degraded.

When the Option ROM Launch Policy is set to UEFI, the legacy OROM will not display and management of RAID can be performed in **BIOS Setup under UEFI Drivers**.

Controller Enable/Disable

The SATA controller can be Disabled or Enabled from the BIOS menu under "Advanced", "System Options". Uncheck or check the box in front of the controller that you would like to Disable or Enable.

SATA emulation modes

The SATA controller is capable of being set to two different SATA emulation modes. Controls are provided for SATA Emulation Mode in the BIOS under "Advanced", "System Options". Check the Controller RAID Mode box for RAID or uncheck the box for AHCI.

• RAID (Default; ACHI + RAID capability with greatest flexibility for most users)

• AHCI (Required when using SEDs)

The following shows the settings for Controller Enable/Disable and SATA emulation mode.
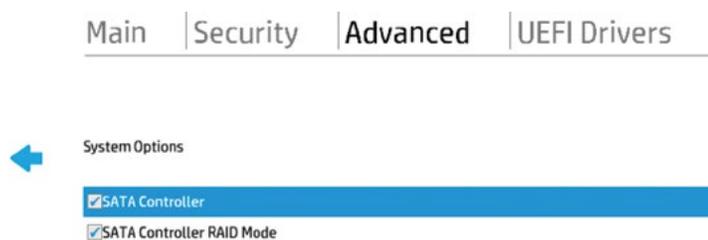
Per port Enable/Disable of SATA ports

Individual SATA ports can be Disabled or Enabled individually from the BIOS menu under "Advanced", "Port Options". Select Enable Disable, or eSATA from the pull down menu for the Port that you would like to Enable Disable or designate as eSATA. Setting the port to eSATA will enable the port and mark it as an external port that can be ejected.

External SATA (eSATA)

External SATA (eSATA) is supported on the SATA controller with an optional eSATA bulkhead adapter.

Ports can be configured individually as eSATA in the BIOS under "Advanced", "Port Options". Select eSATA from the Enabled/eSATA/Disabled pull down menu for the desired port. When a port is designated as eSATA, the port link speed may be limited to 3 GB/s. An option to eject the drive will be available from the "Windows Taskbar Safely Remove Hardware and Eject Media" applet. Disks included in a RAID array will not be visible in the Eject applet. The current OS disk may be visible in the Eject applet but cannot be ejected. External drives can be hot plugged if the drive is compatible with hot plugging.

Hot plug or Hot unplug and surprise removal/insertion of internal drives is not recommended.

TRIM support for SSDs

TRIM keeps track of files that have been deleted but not erased on the drive to improve performance and help extend the life of the SSD. TRIM is not an acronym, but is a command specific to SSDs and is typically represented by TRIM in all upper case. TRIM is supported on individual non-RAIDed SSDs and is supported on RAID 0, 1, and 10 on the SATA controller.

AHCI and RAID Technology

The default SATA emulation mode on HP Workstations is RAID (RAID + AHCI) unless SEDs are installed. If SEDs are installed, the SATA emulation mode will be set to AHCI. The SATA emulation mode can be changed in BIOS setup under "Advanced", "System Options", but changing the mode is not recommended and can result in boot failure or data loss if the SATA emulation mode is changed after the OS is installed or if a volume already contains data. Always back up your data before making any storage system changes.

RAID

RAID provides all of the benefits of AHCI with the added flexibility of RAID for configurations needing performance or data redundancy. Even if you don't use RAID today, setting the SATA mode to RAID makes your system RAID ready for the future. RAID is the preferred mode and default storage configuration SATA mode set in HP Workstation BIOS.

AHCI (Advanced Host Controller Interface)

AHCI is a technical standard developed by Intel® for the hardware mechanism that allows software to communicate with SATA (Serial ATA) devices. It is enumerated as a PCI device and transfers data between system memory and SATA devices.

AHCI provides many benefits over the legacy IDE (Integrated Drive Electronics) hard drive interface. Some of the benefits include:

- Elimination of master/slave handling
- Native Command Queuing (NCQ) that allows a SATA device to internally optimize the order of command execution for increased performance
- TRIM command support for SSDs which keeps track of files that have been deleted but not erased on the drive. This improves performance of the drive and helps extend the life of the SSD by preventing unnecessary writes

Supported RAID levels

RAID provides a method of combining multiple disks into a single logical volume to increase performance or create data redundancy.

RAID 0 – Creates a single volume that has data striped across two or more drives on the same controller. The size of the volume is based on the size of the smallest capacity drive times the number of drives in the RAID 0 configuration. RAID 0 is typically used to improve performance or create a larger volume from smaller drives. There is no data redundancy or parity in a RAID 0 configuration.

RAID 1 – Creates a single volume that is a mirror image of identical data on two physical drives on the same controller. The size of the mirror is limited by the smallest drive used in the RAID 1 configuration. This configuration provides data redundancy protection against a single drive failure, does not use parity, and does not improve performance. If a drive fails, the drive can be replaced by a drive of the same capacity or larger capacity to rebuild the RAID array.

RAID 5 – Creates a single volume from three or more physical drives on the same controller. RAID 5 uses striping with parity data in distributed blocks across all member disks. A RAID 5 volume is tolerant of a single disk failure. RAID 5 has performance attributes similar to a RAID 0 and reliability of RAID 1, however parity calculations can reduce the performance relative to a RAID 0.

RAID 10 – Creates a mirror of a pair of drives, and then stripes the data on the mirrored pairs. A RAID 10 must contain two or more drive pairs, with a four drive minimum. A RAID 10 is fault tolerant to one drive per mirrored pair.

Creating RAID Arrays on the SATA controller

RAID arrays on SATA controller can be created through Option ROM (OROM) at power on, BIOS Setup under UEFI Drivers, DOS utilities, EFI shell utilities, Windows command line utilities, or from a graphical user interface (GUI) within the Windows OS.

Pre-OS RAID creation through the Option ROM (OROM)

In order to use the OROM for configuration of RAID arrays, the Option ROM Launch Policy in BIOS must be set to **All Legacy**. This can be changed in BIOS Setup under "Advanced", "Option ROM Launch Policy".

To access the OROM, press Ctrl-I as soon as you see Intel® Rapid Storage Technology enterprise Option ROM.

The OROM will only display at power on if there are two or more RAID capable devices attached to the controller, or a single device is attached that contains RAID metadata. In the latter case, the OROM will show that the RAID is failed or degraded.

Once in the OROM, you can Create RAID Volumes, Delete RAID Volumes, Reset Disks to Non-RAID, or Exit. The keys available for use are listed at the bottom of the screen.

Example: RAID volume creation on the SATA controller through OROM.

1. Use the Up/Down arrows to navigate to "1. Create RAID Volume" if not already selected.
2. Enter the desired volume name and press Tab or Enter.
3. Use the Up/Down arrows to scroll through available RAID levels. A description of the level will appear in the "HELP" box. Select the desired RAID level and press Tab or Enter.
4. Press Enter to open the "SELECT DISKS" window.
5. Use the Up/Down arrows to highlight a desired disk and press Space to select the disk. Press Enter after you have selected all of the disks that you want to be included in the RAID.
6. If you are creating a RAID array that is striped, you can use the Up/Down arrows to change strip size if desired. Press Enter when done.
7. Capacity will be automatically calculated for you based on the RAID type. The capacity shown may be around 95% of the actual available capacity. In a mirrored array, the reserved space helps to ensure that a failed drive can be replaced with another drive of the same listed capacity even if the actual capacity is slightly less than the listed capacity. Press Enter to accept the default capacity.
8. Press Enter to create the volume.

Similarly a user can Delete RAID volumes or reset disks to Non-RAID status by following the on screen prompts and using the keys listed at the bottom of each screen.

RAID creation using the UEFI driver in BIOS setup

In order to create RAID arrays using the UEFI, **the Option ROM Launch Policy** in BIOS must be set to **All UEFI** or **All UEFI Except Video**. This can be changed in BIOS Setup under "Advanced", "Option ROM Launch Policy".

Example: RAID volume creation on SATA controller using the UEFI Driver interface.

1. Use the Up/Down arrows to select "Create RAID Volume" and press Enter.
2. Use the Up/Down arrows to select Name and press Enter to enable editing the name. Change the name if desired and press Enter to close the edit box.
3. Use the Up/Down arrows to select RAID Level and press Enter to show available RAID levels. Use the Up/Down arrows to select the desired RAID level and press Enter to accept.
4. Use the Up/Down arrows to highlight a disk to be included in the array. Press Enter to activate the pull-down menu and use Up/Down arrows to change from blank to "X". Press Enter to accept. Continue selecting drives until you have selected all of the drives that you want to include in the RAID array.
5. Arrays that use striping, will have an option to select strip size. You can accept the default by navigating past it or press Enter and make a selection.
6. Leave the capacity as default.
7. Use the Up/Down arrows to select Create Volume and press Enter to create the array. This will take you back to the main screen for the current controller where you can create an additional RAID array (up to 2 arrays) or view already created arrays.

RAID creation from a DOS or EFI shell

RAID arrays can be created in a DOS or EFI shell by using the shell specific Intel® RAID Utility for the controller. This is useful in a deployment environment where an organization wants to configure multiple systems identically. The utilities can also be run from a DOS or EFI bootable USB key.

The utilities are specific to a particular driver version and are available with the driver package downloadable from hp.com.

The utilities are:

DOS Shell
• RCfgSata.exe (For the SATA controller)

EFI Shell
• RCfgSata.efi (For the SATA controller)

For the latest commands use "/?" option when executing the command.

RAID creation from a Windows Administrator Command Prompt

RAID arrays can be created by using the Intel® Rapid Storage Technology enterprise (RSTe) Command Line Interface (RSTCLI) for 32-bit and 64-bit Windows operating systems. RSTCLI is included in the Intel® RSTe driver package for your system, downloadable from hp.com. The RSTCLI must be executed from an administrator command prompt. If you attempt to execute the RSTCLI utility from a non-administrator command prompt, you will receive the following message: "Could not obtain system information to display middleware version."

See the **RSTe CLI Specification** included with the RSTCLI for specific usage instructions.

RAID creation from within the OS using the Intel® Rapid Storage Technology enterprise GUI

The RSTe GUI provides an easy method for creating RAID arrays. The RSTe GUI is pre-installed on systems shipped from the factory, and can also be installed from the latest driver package available on hp.com.

Launch Intel® Rapid Storage Technology enterprise GUI by navigating to it from the start menu, or press the Windows key and then start typing "Intel®" in the Box that appears. A short list should appear that contains "Intel® Rapid Storage Technology enterprise". Click this item with the mouse to launch the GUI.

Click the "Create Volume…" button to start the guided RAID array creation process. Additional help is available on each page of RAID creation process by clicking on "More help on this page" at the lower right corner of each page. A balloon with a question mark inside will be displayed if help or suggestions are available for a specific topic. Click on the balloon to display the help on the item in a new page.

HP Z Turbo Drive Storage Features

The HP Z4 G4 Workstation can support up to 6 HP Z Turbo Drives. All HP Z Turbo Drives qualified on HP Z4 G4 are NVMe storage devices.

There are two M.2 slots on the system board, and up to four additional M.2 modules may be added via a HP Z Turbo Drive Quad Pro carrier. The two M.2 slots on the system board can accommodate M.2 modules up to the 2280 form factor. The HP Z Turbo Drive Quad Pro can accommodate four modules up the 22110 form factor.

TRIM support for HP Z Turbo Drives
TRIM keeps track of files that have been deleted but not erased on the drive to improve performance and help extend the life of the SSD. TRIM is not an acronym, but is a command specific to SSDs and is typically represented by TRIM in all upper case. TRIM is supported on NVMe devices using the DATASET MANAGEMENT command.

Configuring RAID with HP Z Turbo Drives using Microsoft Windows

Once the HP Z Turbo Drives are installed in the system and the system has been rebooted, launch **Disk Management**. For Windows 7[1] systems, click **Start**, right-click on **Computer**, select **Manage**, select **Disk Management**. For Windows 8 and later systems, hit the **Windows+X** keys on the keyboard, select **Disk Management**. If the HP Z Turbo Drives are new, you will be asked to initialize the drives. Choose either **Master Boot Record** (MBR) or **GUID Partition Table** (GPT). You can use MBR or GPT for arrays smaller than 2.2 TB (e.g. the array size for two 512 GB drives in a RAID 0 is equal to 1 TB; the array size for two 512 GB drives in a RAID 1 is equal to 512 GB). GPT must be used for arrays larger than 2.2 TB (e.g. the array size for four 1 TB drives in a RAID 0 is equal to 4 TB). Click **OK**.

Figure 4. Initialize disk
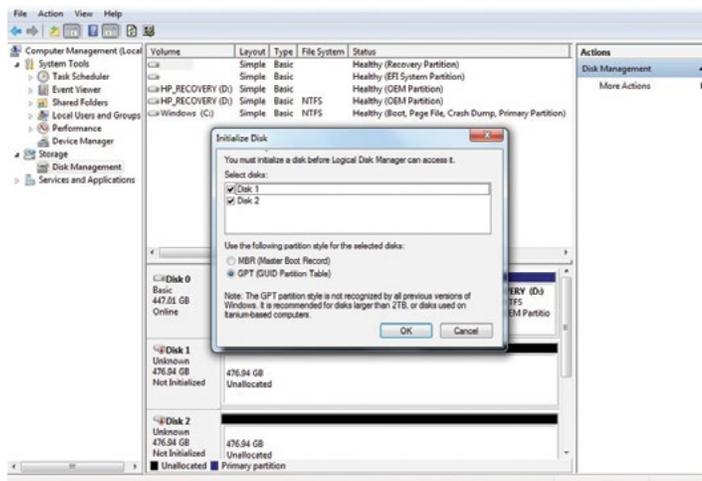
The drives are now initialized but unallocated.

Figure 5. Initialized but unallocated drives
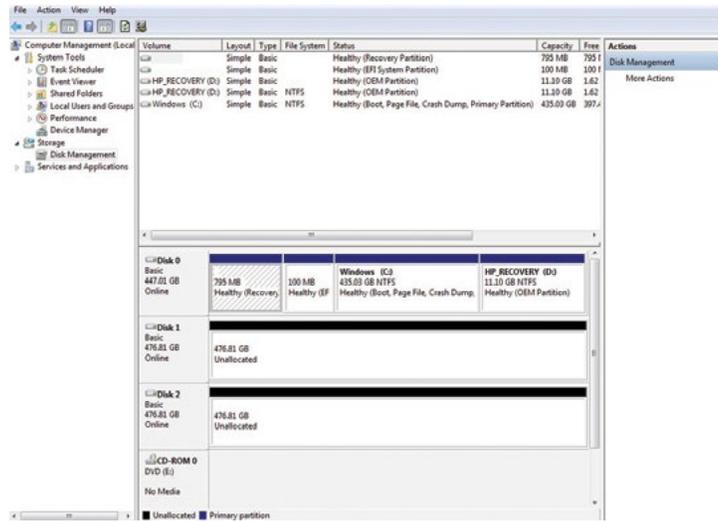
Mouse over one of the unallocated HP Z Turbo Drives and right-click. A menu will appear to configure a software RAID.

The software RAID modes are defined as follows:

• Simple volume: No RAID, single drive.

• Spanned volume: A single partition that includes multiple drives. Files are not deliberately broken up among the drives. A spanned volume does not include any performance or redundancy advantages.

• Striped volume (RAID 0): Data and files are deliberately broken up across multiple disks in an attempt to improve read and write performance. The resulting RAID volume size is the sum of the individual drives included in the configuration.

• Mirrored volume (RAID 1): Data is replicated between drives, providing data redundancy but no performance advantage. The RAID volume size equals the size of the smallest drive in the array.

• RAID 5 volume: A RAID 5 does not replicate data between multiple drives and is more efficient at storing the redundancy information necessary to restore the RAID when a drive fails. Instead of replicating all data to a second drive, it creates a smaller parity partition to allow data recovery. RAID 5 is not available on Windows 7[1] or Windows 10.

Figure 6. Disk Management screen and menu choices
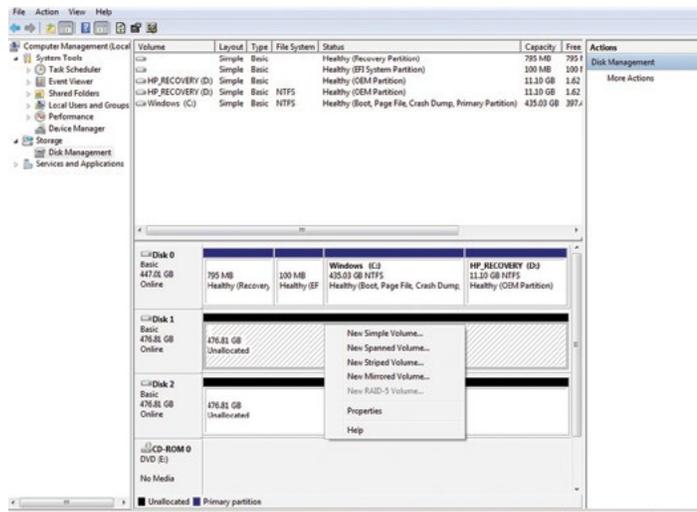
For this document, RAID 0 is selected using HP Z Turbo Drive G2s. Windows provides a wizard to help complete the process.

Figure 7 . Windows RAID Configuration Wizard
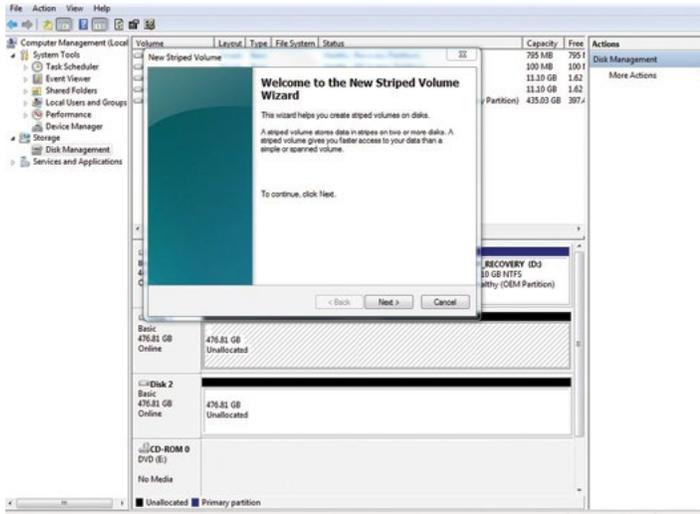
Click **Next.**

Choose the other drives to be included in the RAID array. For each drive to be added to the array:
Select the drive.
Click **Add.**

Figure 8. Drive selection
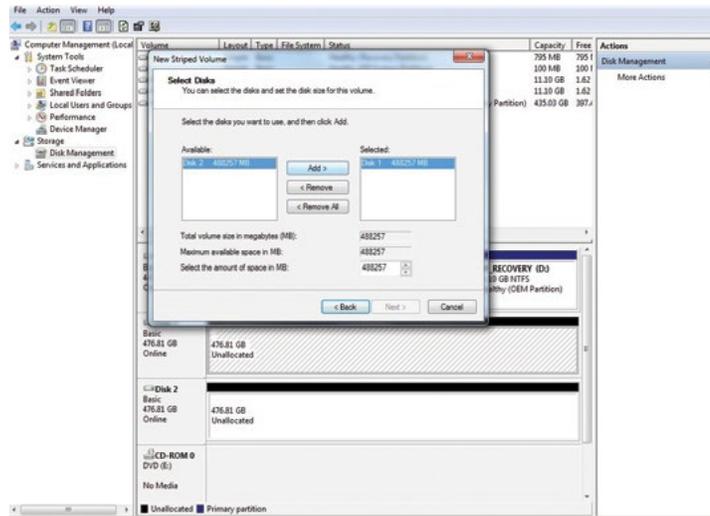
Once all drives have been added, click **Next.**

Figure 9. Drive selection
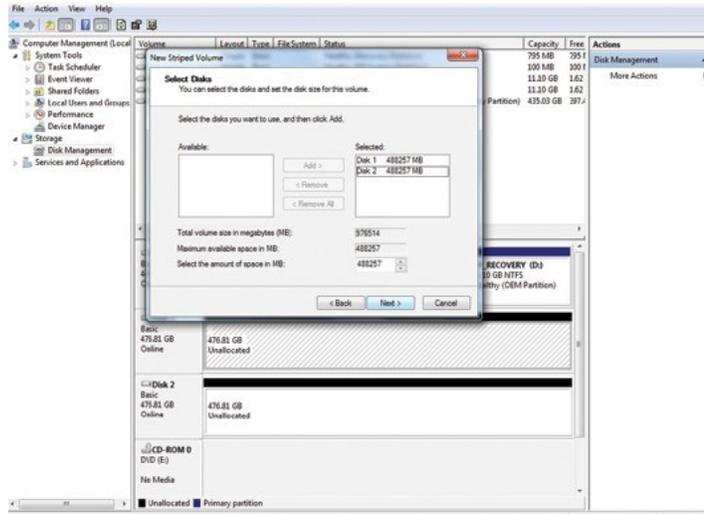
Assign a drive letter for the resulting RAID volume. Notice that the RAID can be assigned to an empty NTFS folder. Choose the appropriate option, then click **Next**.

Figure 10. Assigning a drive letter
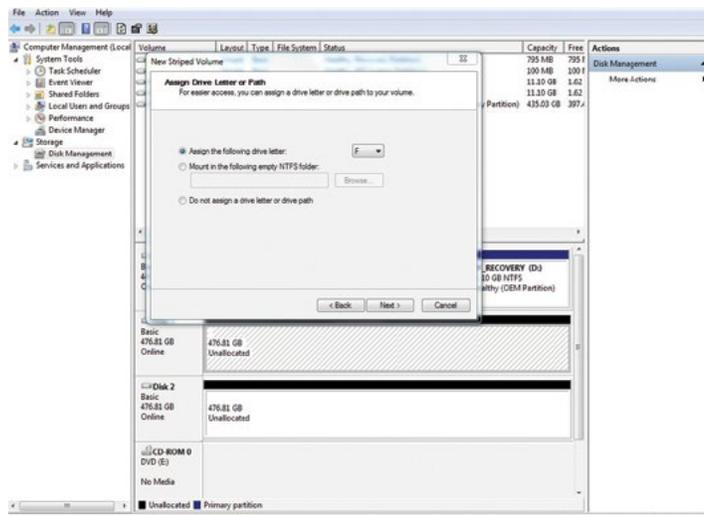
The OS will now format the RAID volume. Select either the default stripe size, or choose an alternative size. Click **Next** to continue.

Figure 11. Stripe size
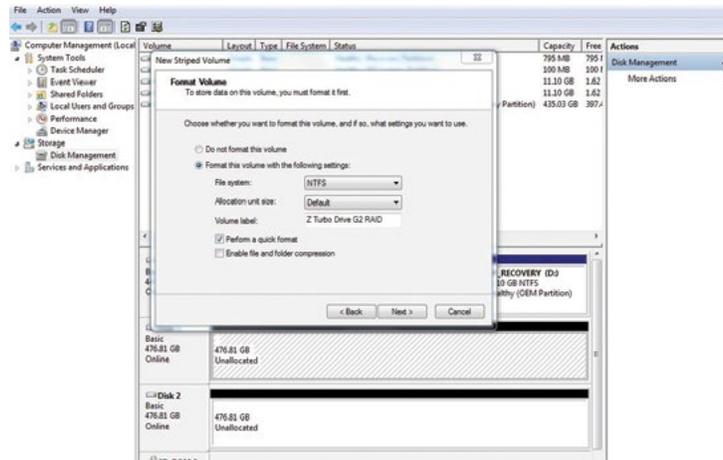
When the RAID configuration has completed, click **Finish**.

Figure 12. RAID configuration completion message
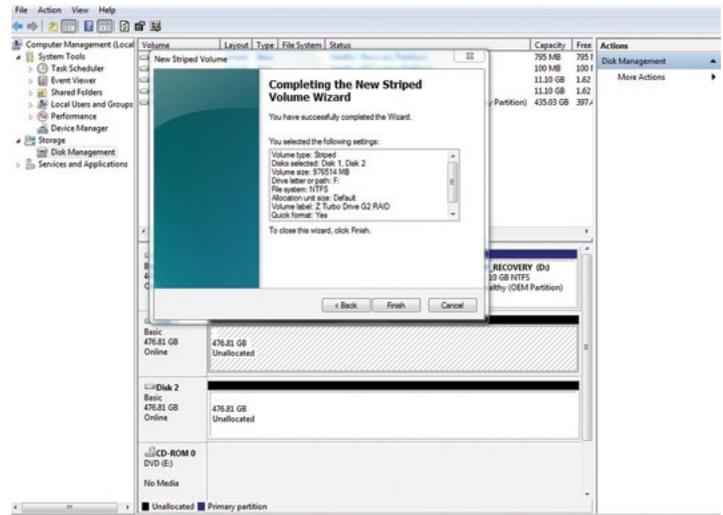
Click **Yes** to continue with the RAID configuration, or **No** to abort.

Figure 13. RAID configuration confirmation
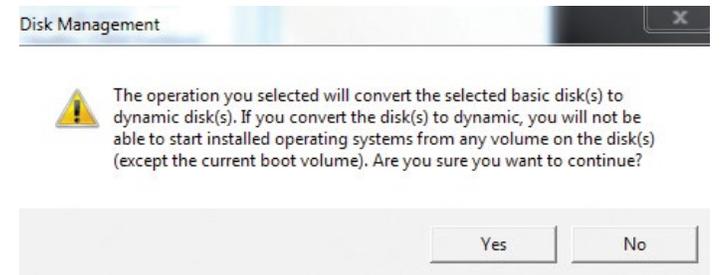
When completed, Disk Management will show all the disks configured using RAID, based on the name of the volume and the assigned drive letter. Note that in Disk Management, the volumes shown in the top pane relates to the overall size of the RAID while the disks listed at the bottom display the size of the individual drives.

Figure 14. Disk Management with HP Z Turbo Drives in a RAID 0 configuration
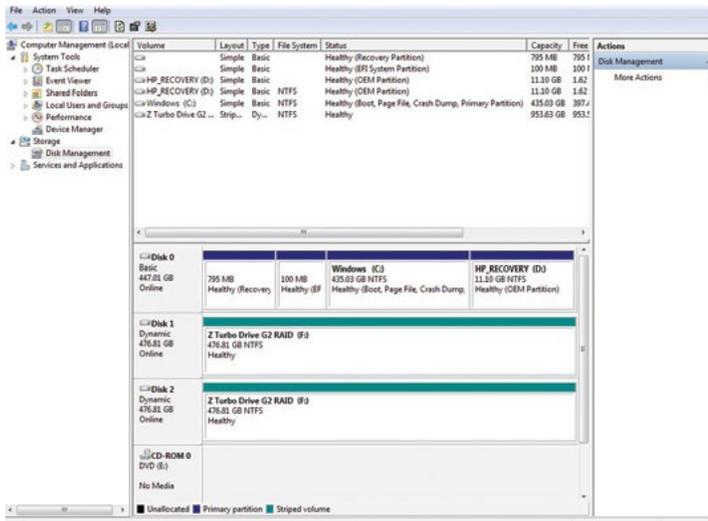
Note: On completion the OS will see a new drive and may generate an AutoPlay dialog. Either select **Open folder to view files** or close the dialog box.

Figure 15. AutoPlay dialog box

Performance considerations

Power settings

The default "Balanced" and "Power Saver" plans in Windows Power Options may result in power management settings that may adversely affect performance of your applications. If the workstation is being used for a high demand application, consider choosing the "High performance" power plan or choose custom settings that better fit your use model.

SSDs used in RAID configurations and TRIM support

TRIM keeps track of files that have been deleted but not erased on the drive to improve performance and help extend the life of the SSD. As the SSD is used, the controller within the SSD distributes data across the available FLASH on the SSD until all FLASH is used. After the FLASH has been used up, a block erase is required before subsequent writes can occur. The TRIM command normally frees up memory prior to being needed for the next write. If the TRIM commands are not sent to the drive and no unerased FLASH is available for writing, the SSD controller must erase a block of memory prior to writing. This can slow performance in applications that perform a lot of file write and file delete operations. One example is in compiling code where the compiler generates many intermediate files that then get deleted.

The table below shows which RAID arrays support TRIM:

Controller	TRIM supported	TRIM not supported
SATA	0, 1, 10	5
NVMe	0, 1, 10	

Storage caching options

HP Workstations ship with default storage cache settings that balance performance with data protection. The balance of performance and protection can be adjusted by changing one or more of these settings.

Create a backup of your data before attempting to change any storage related settings.

Windows Write-caching policy (Disk Properties in Disk Manager)

Write caching on the device: DEFAULT: Enabled
Improves performance by enabling write caching on the disk; however, a loss of power may result in loss of data that has not been committed to the storage media.

Windows write-cache buffer flushing: DEFAULT: Enabled
When enabled, Windows will periodically instruct the storage device to commit data in the devices cache to the non-volatile storage media. These periodic commands result in decreased overall system performance.

Note: If Windows write-cache buffer flushing is enabled, Intel® RSTe write-back cache is disabled. To enable write-back cache on volumes, you must disable Windows write-cache buffer flushing.

A user can choose to disable Windows write-cache buffer flushing to restore system performance, allowing the Intel® RSTe driver to handle all write-cache buffer flushing.

Intel® RSTe write-back cache [for RAID volumes] (Intel® RSTe GUI, Volume Properties)
DEFAULT: Disabled

When enabled the read and write performance of a RAID or recovery volume is improved. In write-back cache mode, the RAID controller acknowledges write I/O requests immediately after the data loads into the controller cache. The application can continue working without waiting for the data to be physically written to the hard drives.

Enabling Intel® RSTe write-back cache will enable Write caching on the device if not already enabled and will disable Windows write-cache buffer flushing.

Memory configurations and optimization

The purpose of this section is to provide an overview of the memory configurations for the HP Z4 G4 Workstation and to provide recommendations to optimize performance.

Supported memory modules

Types of memory supported on an HP Z4 G4 Workstation with Intel Xeon W Processors are:
• 8 GB, 16 GB, and 32 GB PC4-2666-R 2666 MHz DDR4 Registered DIMMs

• Single and dual rank 8 Gb based DIMMs are supported

Types of memory supported on an HP Z4 G4 Workstation with Intel Core X-Series Processors are:
• 8 GB and 16 GB PC4-2666-U 2666 MHz DDR4 Non-ECC Unbuffered DIMMs

• Single and dual rank 8 Gb based DIMMs are supported

Types of memory NOT supported on an HP Z4 G4 Workstation are:
• LR DIMMs

• DDR, DDR2, or DDR3 DIMMs

See Memory Technology White Paper for more memory module technical information.

Platform capabilities

Maximum capacity with Intel Xeon W Processors
• 256 GB

Maximum capacity with Intel Core X-Series Processors
• 128 GB

Total of 8 memory sockets
• 8 memory sockets available

• 4 channels per processor and 2 sockets per channel

Speed
• 2666 MHz, 2400 MHz, and 2133 MHz memory speeds are supported in this platform

• Memory will operate at the speed of the slowest rated installed processor or DIMM

Dynamic power saving is enabled
NUMA, Sub-NUMA and Non-NUMA modes are supported and user configurable

Memory features

ECC is supported on Registered DIMMs
• Single-bit errors are automatically corrected

• Multi-bit errors are detected and will cause the system to immediately reboot and halt with an F1 prompt error message

• By way of comparison, non-ECC memory does not detect or correct single-bit or multi-bit errors which can cause instability, or corruption of data, in the platform. See Memory Technology White Paper for more information

Command and Address parity is supported
• Command and Address errors are detected and will cause the system to immediately reboot and halt with an F1 prompt error message

Optimize performance

System performance is largely based on the applications being used. Generally, to obtain the best performance, it is advised that you follow the following guidelines:

- For best performance, it is recommended to load memory into all channels. Since these platforms have 4 channels, install memory in sets of 4.

- Proper individual DIMM capacity selection is essential to maximizing performance. Evenly distributing total desired memory across all operational channels and CPUs will deliver the best performance.

Loading rules

- Load the memory modules in order of size, starting with the largest module and finishing with the smallest module.

- Each channel includes two DIMM sockets; black and white connector pairs represent a channel. The DIMMs should be loaded first in the black sockets and then in the white sockets. The DIMMs should be loaded starting with the DIMM furthest from the CPU, with the first DIMM loaded in the top most socket and alternating sides of the CPU.

See figures below for loading order.

Figure 17. Loading order for single and dual CPU configurations
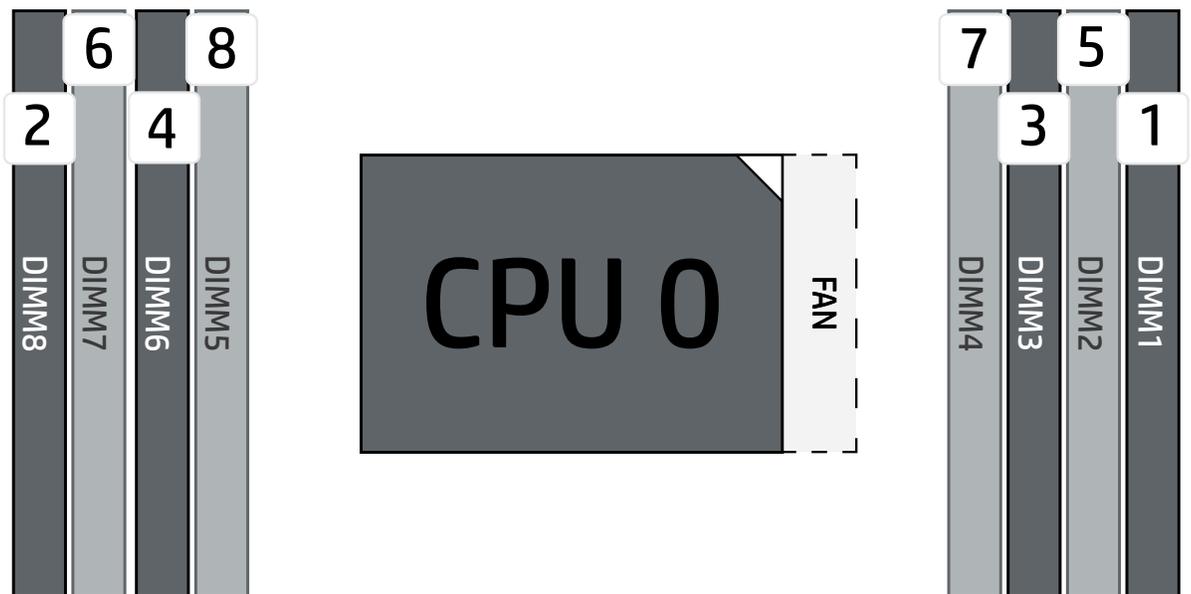
Resources, contacts, or additional link

hp.com/go/whitepapers
This site includes white papers on USB 3.0 Technology, Battery Charging technology, Thunderbolt™ 2 Technology, etc.

hp.com/support/Z4G4_manuals

Learn more at
hp.com/go/workstations

* Not all features are available in all editions or versions of Windows. Systems may require upgraded and/or separately purchased hardware, drivers, software or BIOS update to take full advantage of Windows functionality. Windows 10 is automatically updated, which is always enabled. ISP fees may apply and additional requirements may apply over time for updates. See http://www.windows.com

In accordance with Microsoft's support policy, HP does not support the Windows 8 or Windows 7 operating system on products configured with Intel® and AMD® 7th generation and forward processors or provide any Windows 8 or Windows 7 drivers on http://www.support.hp.com

1. Supported on Intel® Xeon® processor configs.
2. EPEAT® registered where applicable. EPEAT® registration varies by country. See www.epeat.net for registration status by country. Search keyword generator on HP's 3rd party option store for solar generator accessories at www.hp.com/go/options.
3. Supported on Intel® Core™ i7-X processor configs.
4. Supported on Intel® Core™ i9-X processor configs.
5. External power supplies, power cords, cables and peripherals are not low halogen. Service parts obtained after purchase may not be low halogen.
6. Multi-Core is designed to improve performance of certain software products. Not at customers or software applications will necessarily benefit from use of this technology. Performance and clock frequency will vary depending on application workload and your hardware and software configurations. Intel®'s numbering, branding, and/or naming is not a measurement of higher performance.
7. Optional or add-on feature.
8. For hard drives, GB= 1 billion bytes. TB= trillion bytes. Actual memory speeds dependent on processor capability.

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