Technical white paper

HP ZBook 14u and 15u G4 Mobile Workstations

Ready to work from anywhere

Enjoy workstation performance in a low cost, compact package. The HP ZBook 14u with its 14.0" diagonal display and 15u with its 15.6" diagonal display are a superb combination of mobility and cost.

Table of contents

Chassis and system highlights

The HP ZBook 14u and 15u G4 Mobile Workstations deliver sleek Ultrabook™[1] style, impressive performance, and long battery life. HP's ZBook 14u and 15u redefine mobile computing.

Innovative design

Inspiration can strike any time—be ready with the HP ZBook 14u Mobile Workstation that starts at 3.61 lb and 19 mm thin and the HP ZBook 15u Mobile Workstation that starts at 4.19 lb and 22 mm thin. Both the 14u and 15u offer an optional touch screen[2], integrated numeric keypad, and impressive battery life with HP Fast Charge[16].

Figure 1. HP ZBook 14u and 15u G4

Professional performance

Get the performance you need with Windows 10[3], up to 32 GB memory, AMD FirePro™ professional graphics, optional HP Z Turbo Drive G2, 2 TB[2] of total storage, and optional FHD touch or UHD display.

Workstation reliability

Optimize your HP ZBook 14u and 15u G4 for peak performance with HP Performance Advisor[4] by automatically configuring your system with the most current settings and drivers. Be confident that your HP ZBook can withstand the demands of professional computing with workstation ISV application certifications; 120,000 hours of testing through the HP Total Test Process; and rigorous MIL-STD-810G testing standards[13]. Also, take advantage of HP Sure Start G4 to help ensure a proper boot-up thanks to corruption detection, a self-healing BIOS, and recovery that restarts where it left off if the update stalls, fails, or is corrupted.

Designed with the environment in mind

HP is committed to environmental sustainability and energy efficiency. To reduce energy consumption, HP offers ENERGY STAR® certified mobile workstation configurations and meets EPEAT® Gold standards[5].The HP Workstation design team has taken a proactive approach (beyond industry regulations) to recyclability and selecting materials that help reduce the impact to the environment.

System architecture

If you want value in a lightweight design, look no further. These workstations can be configured with up to 32 GB memory, AMD FirePro™ professional graphics, HP Z Turbo Drive G2, and 2 TB of total storage[9].

New technologies

New Intel® Processor Micro-architecture
The HP ZBook 14u and 15u G4 support Intel®'s 7th generation Core™ i5 and i7 processors[6], featuring an instruction set that includes AVX2 (Advanced Vector Extensions 2.0) and FMA (floating-point fused multiply add instructions) that help deliver fast computing performance with low energy consumption. The Mobile Intel® CM238 chipset, integrated with the processor, complements the HP ZBook 14u and 15u G4's core architecture.

Intel® vPro™ Technology Capable
Intel® Core i5 with vPro™ and Core i7 with vPro™ technology is a selectable feature that is available on units configured with select processors, a qualified Intel® Centrino® WLAN module, and a preinstalled Windows operating system. It provides improvements in remote manageability, security, energy efficient performance, and wireless connectivity. Intel® Active Management Technology (iAMT) offers built-in manageability and proactive security for networked mobile workstations, even when they are powered off* or when the operating system is inoperable. It can help identify threats before they reach the network, isolate infected systems, and update mobile workstations regardless of their power state.

Operating system

The HP ZBook 14u and 15u G4 are compatible with Windows operating systems. Windows has been designed to bring you one operating system that can handle all your work's toughest demands—no matter where you are.

The HP ZBook 15u G4 support the operating systems seen below.

Table 1. Supported operating systems

Preinstalled OS	Supported OS
Windows 10 Pro 64[3, 18]	FreeDOS 2.0
Windows 10 Home 64 for High End Devices[3, 18]	

I/O and storage

I/O
The HP ZBook 14u and 15u G4 come configured with two USB 3.0 ports (one charging), one USB 3.1 Gen 1 port, one VGA port, headset and microphone connections, an RJ-45 connection, a slide docking connector, a smart card reader, and a media reader slot that supports SD, SDHC, and SDXC.

The system ships with a WLAN/Bluetooth® card. The WLAN controller connects via a PCIe bus and the Bluetooth® controller connects via a USB 2.0 bus. Both controllers can be enabled or disabled in the BIOS F10 menu by enabling/disabling PCIe slot 1.

These mobile workstations are equipped with a dual-microphone array, Bang & Olufsen audio, and an optional 720p HD webcam[10].

Storage[9]
The HP ZBook 14u and 15u G4 support one M.2 drive and one 2.5" inch drive. Connecting NVMe SSDs directly to the PCIe bus enables significantly higher bandwidth and storage performance. By choosing the HP Z Turbo Drive G2 (M.2 NVMe PCIe SSD), sequential performance will be up to 6 times faster than traditional SATA SSDs. Random performance is also greatly enhanced due to the lower latency of the NVMe controller. For lower cost and high capacity storage solutions, HDDs are also offered. The M.2 slot can accept NVMe SSDs and SATA SSDs, both using the M.2 form factor. The 2.5" drive bay can accept a SATA HDD or a SATA SSD. Self-encrypting Drives (SEDs) are also supported.

Graphics

The HP ZBook 14u and 15u G4 support discrete graphics with AMD® FirePro™ W4190M with 2 GB dedicated GDDR5 video memory. The system supports integrated graphics with Intel® HD Graphics 620. Hybrid graphics is also supported with one of the discrete GPU options and one of the integrated GPU options.

Battery

The HP ZBook 14u and 15u G4 have an extended battery life. The HP 3-cell Long Life Polymer Battery (51 WHr) has enough power to keep your workstation running for up to 10 hours[7], depending on the configuration (FHD display, etc.)

Networking and security

Wireless networking
The HP ZBook 14u and 15u G4 support WLAN (Intel® 802.11 2x2ac) and Bluetooth® (BT 4.1) both vPro™ and non-vPro™.

Table 2. 802.11 Wireless LAN options[11]

Intel® Dual Band Wireless-AC 8265 802.11 a/b/g/n/ac (2x2) Wi-Fi + Bluetooth® 4.2 combo adaptor (vPro™)
Intel® Dual Band Wireless-AC 8265 802.11 a/b/g/n/ac (2x2) Wi-Fi + Bluetooth® 4.2 combo adaptor (non-vPro™)
Intel® Dual Band Wireless-AC 3168 802.11 ac (1x1) Wi-Fi + Bluetooth® 4.2 combo adaptor (non-vPro™)

Security
The HP ZBook 14u and 15u G4 support Integrated Smart Card Reader, Full Volume Encryption, a security lock slot, Trusted Platform Module (TPM) 2.0 security processor, and an optional fingerprint reader.

Display options

As a mobile workstation customer, we know that viewing your work precisely is critical to your success. You need the right display in order to accurately and efficiently get your work done. Our HP ZBook 14u and 15u G4 offer different display options to ensure you will get the best visual experience. This section will help you choose the display that is right for you. Our mobile workstations can also be docked to take advantage of our HP Z Displays.

Display technology background and information

There are many different measures used to understand or express the performance of a mobile workstation-level display. Although display resolution, the most obvious measure, is important for clarity, there are other measures of a display that contribute to your viewing experience such as screen brightness, viewing angle, response rate, and bit-precision.

IPS displays
Our displays contain In-Plane Switching (IPS) technology. While Twisted Nematic (TN) displays are common in the industry, IPS displays offer superior viewing angles, color accuracy and newer technology to create an immersive viewing experience.

Viewing angles
The viewing angle of a display represents how far left, right, down or up a display can be observed at with acceptable viewing performance. When looking at a TN screen from an angle, the images on the display often look faded or disappear completely. This is due to the TN displays' shallow viewing angle. Figure 1 below shows the effect different viewing angles have on a TN display. Alternatively, an IPS display has a larger viewing angle of up to 178 degrees that allows the screen to be viewed comfortably from several positions. Wider viewing angles are especially useful when several users are viewing one screen or the screen is not being viewed head-on.

Viewing angles are usually measured in a left/right/down/up format. This means they have an angle measurement for each viewing direction. A standard viewing angle (SVA) is 40/40/15/30. This means you can view it 40 degrees to the left, 40 degrees to the right, 15 degrees down, and 30 degrees up while still having adequate color and detail. The next step up, wide viewing angle (WVA), measures in at 60/60/50/50. The ultra-wide viewing angle (UWVA), which is available on our HP ZBook 14u and 15u G4 displays, measures at 85/85/85/85.

Figure 2. The effect different viewing angles have on IPS and TN displays
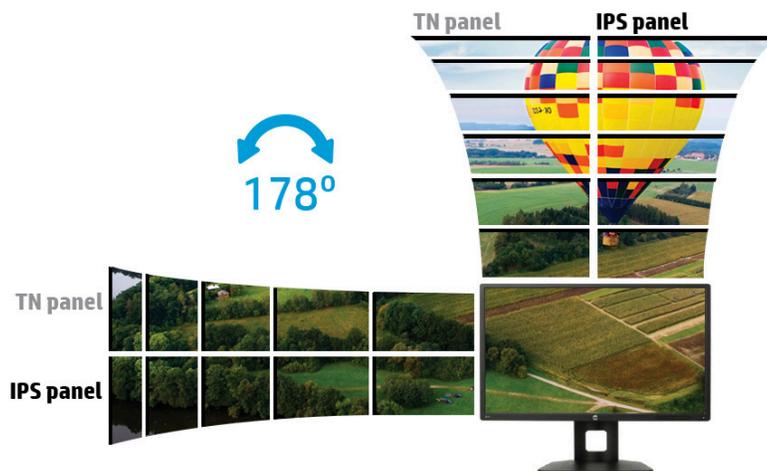
Brightness

Luminance and brightness, while being different terms and measurements, represent the same thing. While brightness is a relative measure, luminance is an exact measurement of light output from your display. Luminance is measured in candelas per square meter (cd/m^2) often referred to as cdm or, in the shorthand, nits. Simply put, a cdm measures the amount of light a screen produces relative to screen size, facilitating an easy comparison between differing screen sizes. Another benefit of measuring screen brightness in nits is how straightforward the scale is to understand: the more cdm, the brighter the screen.

While luminance is an important value to keep in mind, brighter doesn't always mean better. High luminance displays work great in bright environments but may not be suitable for lower light conditions. Be sure to assess your work location before selecting how bright your display will be.

Refresh rates

The refresh rate of a display measures the amount of times the display is updated every second. A higher refresh rate means decreased blurring and ghosting effects when using the display. Ghosting is the effect when an image or video moves on your display and leaves a faint trail. Having a good refresh rate, commonly around 60 Hz (60 images/second), assures video playback and display use is smooth.

Resolution

Screen resolution measures the amount of pixels a screen can display. Usually measured in the format "Width x Height", a display of 1920 x 1080 would contain 1920 pixels horizontally and 1080 pixels vertically for a total resolution of 2,073,600 pixels. A higher screen resolution means more pixels and more detail in the images on your display. Figures 2 and 3 illustrate the difference between a lower resolution display and a higher resolution display. A display with more pixels allows you to view more information on one screen due to increased pixel density. In theory, a display with more pixels should allow you to view more on your screen at once than a display with a lower pixel count.
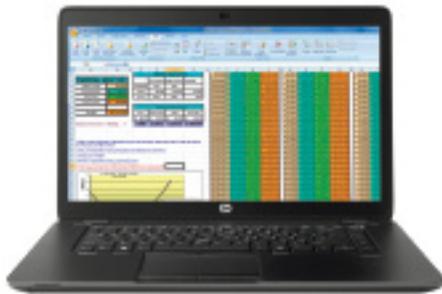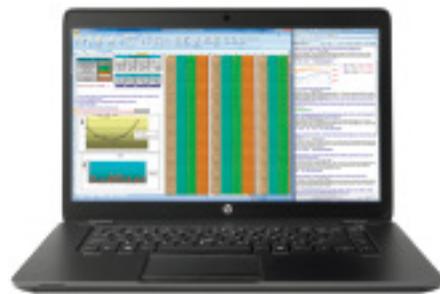
Figure 3. FHD

Figure 4. UHD

Similar to resolution, displays can be measured in pixels per inch (PPI). This simple measurement takes both screen size and resolution into account to define the amount of pixels per square inch present in the display. A display with a low PPI measurement has fewer pixels per inch and lower quality image production than a display with a high PPI measurement. Generally, image sensitive work requires a high PPI display.

Resolution types

Displays exist in several resolutions. Table 3, shown below, outlines the resolution differences of displays offered in the market.

Table 3. High definition video standards

Video standard	Full name	Resolution
HD[10]	High Definition	1280 x 720
HD+	High Definition Plus	1600 x 900
FHD	Full High Definition	1920 x 1080
QHD	Quad High Definition	2560 x 1440
QHD+	Quad High Definition Plus	3200 x 1800
UHD/4K[15]	Ultra High Definition	3840 x 2160
Cinema 4K[15]	Cinema High Definition	4096 x 2160
QQHD/5K	Quad Quad High Definition	5760 x 2880

HP display solutions

HP ZBook 14u and 15u G4 display options

The HP ZBook 14u and 15u G4 are crafted to maximize your productivity. The 14-inch and 15.6-inch diagonal screen sizes with a 16:9 aspect ratio provide a comfortable workspace and keyboard layout.

Table 4. HP ZBook 14u and 15u G4 display options

	Resolution	Refresh rate*	Brightness*	Viewing angle
14-inch and 15.6-inch diagonal FHD	1920 x 1080	60 Hz	300 cd/m^2	SVA
14-inch and 15.6-inch diagonal FHD Touch	1920 x 1080	60 Hz	300 cd/m^2	SVA
14-inch and 15.6-inch diagonal FHD	1920 x 1080	60 Hz	300 cd/m^2	UWVA
14-inch and 15.6-inch diagonal UHD	3840 x 2160	60 Hz	300 cd/m^2	UWVA

* All specifications represent the typical specifications provided by HP's component manufacturers; actual performance may vary either higher or lower.

HP Z Displays

We offer HP Z Displays for those times you need something bigger. Switching from an HP ZBook display to an HP Z Display is as simple as "click and go" when combined with a docking station. With sizes ranging from 22- to 34-inch diagonal displays, you can find the perfect size for your work. Choose from several different resolutions to best meet your display needs and even combine multiple displays side-by-side, so you can be as productive as possible.

All HP Z Displays and HP DreamColor Displays are supported on the HP ZBook G4 families. For more information, see hp.com/go/zdisplays.

When selecting a display, be sure to consider what the display will be used for. If visual details are important, a higher resolution display is a must. However, if you mainly use your computer for word processing and spreadsheets, a lower resolution display is a cost-effective option.

Recap

With different resolutions, response rates, viewing angles, bit precision, and display types, the choice of display can be overwhelming. However, understanding what these measurements mean and why they are important is helpful when choosing a display. Our HP ZBook 14u and 15u G4 display options are perfect for any workstation-worthy job and can benefit professionals in any field.

Multiple display support

The HP ZBook 14u and 15u G4 support up to a maximum of three independent displays[12] graphics when utilizing iGPU graphics with and without the use of the HP UltraSlim Docking Station.

The number of independent displays supported depends on a number of factors, including if a docking station is used and if a DisplayPort™ Hub or "daisy-chain" capable display is being used.

HP ZBook 14u and 15u G4 Integrated Graphics without ZBook Dock:
Without the use of a dock, the HP ZBook 14u and 15u G4 support up to three independent displays. These three displays can include a combination of the internal panel, HDMI 1.4, and the two Thunderbolt™ 3 ports on the system.

HP ZBook 14u and 15u G4 Integrated Graphics with HP Ultraslim Dock:
When using the HP Ultraslim Dock, the HP ZBook 14u and 15u G4 support up to three independent displays. These three displays can include a combination of the internal panel, VGA and ports from the Shared Bandwidth Hub on the HP Ultraslim Dock, including the VGA, DisplayPort™ 1 and DisplayPort™ 2.

Figure 5. Multiple Displays Configuration for HP ZBook 14u and 15u G4 with Integrated Graphics
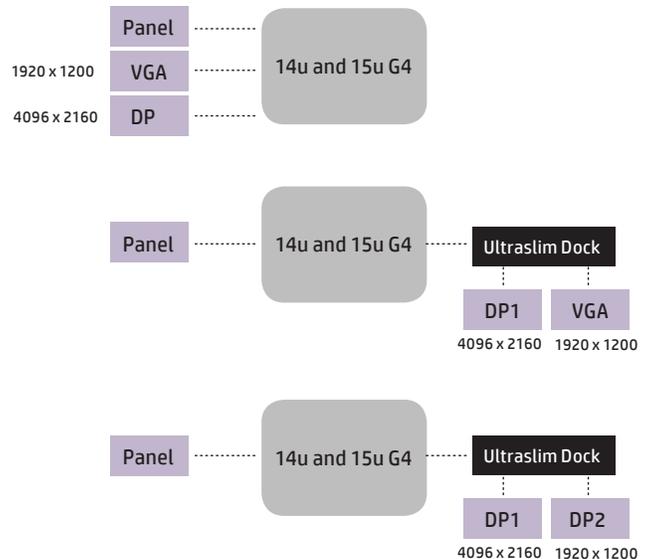
Recommended Configurations

No Dock

Configuration	HP ZBook 14u and 15u G4
Max displays no dock	3

With Dock

Configuration	HP ZBook 14u and 15u G4
Max displays with dock #1	3

Configuration	HP ZBook 14u and 15u G4
Max displays with dock #2	3

IGPU

Reference Diagram

*DisplayPort™ connector supports a DisplayPort™ display, an HDMI display with a DP-to-HDMI dongle, a VGA display with a DP-to-VGA dongle, or a DVI display with a DP-to-DVI dongle.

DisplayPort™ 1.2 "daisy-chain" feature

DisplayPort™ v1.2 supports "Multi-Stream Transport" which allows multiple video streams across a single DisplayPort™ connection. This is commonly referred to as DP 1.2 "daisy-chain" feature where multiple displays may be driven by a single DisplayPort™ connector.

The HP ZBooks, UltraSlim Docking Station, and the HP ZBook Dock with Thunderbolt 3 support the DisplayPort™ v1.2 "daisy-chain" feature. With the use of a DisplayPort™ 1.2 hub or a DisplayPort™ 1.2 display that supports Multi-Stream Transport or "daisy- chaining," a user may connect multiple external displays to a single DP connector on a supporting docking station. A dongle is needed to connect Thunderbolt™ 3 port to a DisplayPort™ 1.2 hub or a DisplayPort™ 1.2 display for this feature. On all HP ZBooks, this capability provides for more flexibility on the type of displays and an expansion of the number of displays that may be used. For example, three DP displays may be connected with the use of a DP 1.2 hub with all three DP monitors connected to the hub, and the hub connected to a supporting docking station.

Multiple displays management

On the HP ZBook 14u and 15u G4, users may use Windows Display Manager to set up and manage multiple displays. To launch Windows Display Manager, right-click any empty area of your desktop, and then select **Display Settings** on Windows 10. (Figure 6 shows the screen shot for Windows Display Manager).

Tip: A quick way to enable all displays connected (up to the maximum supported) in extended desktop mode is to use Windows presentation key and choose "Extend" mode.1- Connect displays.2- Press Windows logo key + P.3- Select Extend.

Figure 6. Screenshot for Windows Display Manager
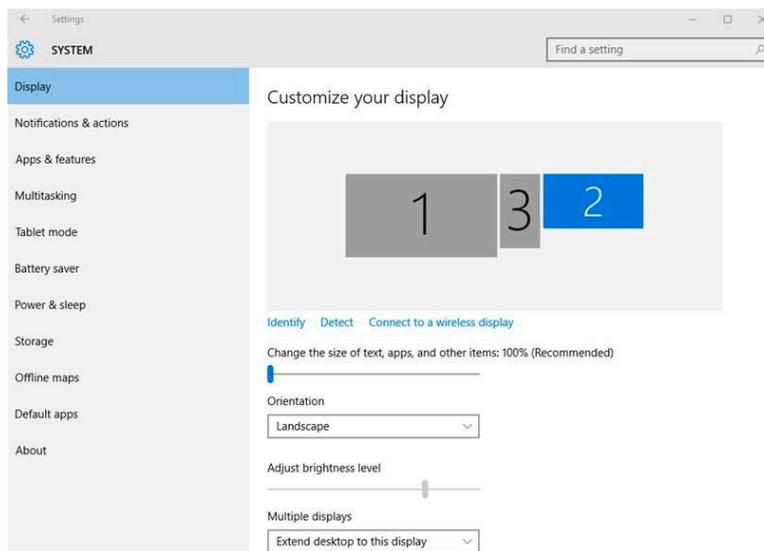
SATA to PCIe technology transition for SSDs

This section highlights the transition from SATA protocol to PCIe protocol as it relates to solid-state storage (SSD) devices.

Why the transition from SATA to PCIe?

HP ZBooks are transitioning from the use of SATA SSDs onto the PCI Express (PCIe) SSDs. M.2 is the new and smaller industry standard for factor that enables thinner and lighter HP ZBooks and provides support for various devices, focusing on SSDs that support either the legacy SATA interface or the PCIe interface. This transition fosters performance improvements of SSDs on the HP ZBook 15u G4. The HP Z Turbo Drive, built on the industry standard M.2 form factor, is a PCIe based NVMe SSD storage device that takes advantage of this advancement.

Today's SATA HDDs and SATA SSDs have reached a performance ceiling. HDDs are limited by the mechanical nature of the devices, while SATA SSDs are limited by the 6 Gb/s ceiling of the SATA bus. In order to maximize the performance HP has shifted focus from storage devices connected to the SATA bus to the multi-lane capabilities of PCIe.

Introduction to M.2 PCIe SSDs

M.2 form factor has a specification for internally mounted computer expansion cards and associated connectors. Through different keying the M.2 specification supports multiple functions for add-in cards including WLAN11 (Wi-Fi), 3G/LTE (WWAN), and SSDs. Exposed buses through M.2 are SATA, PCIe 3.0, and USB 3.0 buses. M.2 storage devices replace mSATA with a denser, more flexible physical specification that is most suitable for SSDs, especially when utilized in small devices.
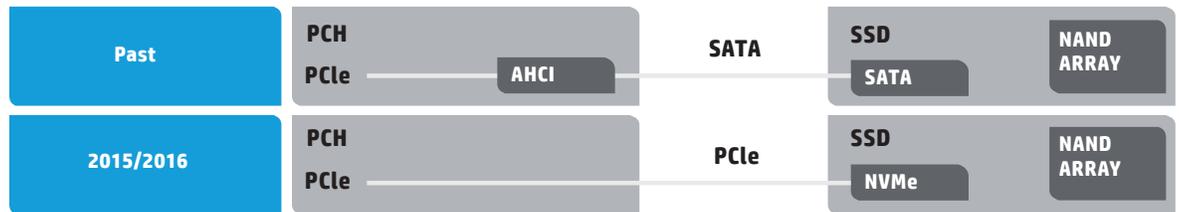
Figure 7. M.2 PCIe SSD

Table 5. Physical dimension specification of M.2 available for ZBook G4

	M.2
Board area (mm)	22 x 80

M.2 PCIe SSD benefits and features

• Support for PCIe devices and SATA devices
  –Compatibility to legacy storage interface (SATA)
  –Same form-factor and interface provides path to the PCIe storage devices of the future

• Reduces bottlenecks by connecting directly to the PCIe bus thus providing an excellent performance for those with large files and big data workflows
  –Bandwidth to the SSDs increases due to lane aggregation
  –Simpler storage hierarchy reduces latency

• NVMe Controller: designed specifically for non-volatile memory storage devices
  –Lowers latency that results in significantly better Random Read performance
  –Lowers command overhead
  –Exploits the parallelism available in modern host HW and SW

Figure 8. ACHI to NVMe Transition

Past	PCH PCIe	AHCI	SATA	SSD SATA	NAND ARRAY
2015/2016	PCH PCIe		PCIe	SSD NVMe	NAND ARRAY

Performance advantage with HP Z Turbo Drive

Table 6. HP ZBook and HP Z Turbo Drive Generations

HP ZBook Generations	PCIe Bandwidth	HP Z Turbo Drive Generation
G4	PCIe 3x4 (4 lanes)	G2 (NVMe Controller)
G3	PCIe 3x4 (4 lanes)	G2 (NVMe Controller)
G2	PCIe 2x2 (2 lanes)	G1 (AHCI Controller)

Table 7. HP Z Turbo Drive specifications on HP ZBook Mobile Workstations G4

	HP Z Turbo Drive G2 256 GB MLC	HP Z Turbo Drive G2 512 GB MLC	HP Z Turbo Drive G2 1 TB MLC
Connection	PCIe 3x4 (4 lanes)	PCIe 3x4 (4 lanes)	PCIe 3x4 (4 lanes)
Sequential read	2800 MB/s	2800 MB/s	3200 MB/s
Sequential write	1400 MB/s	1600 MB/s	1700 MB/s

	ZTD 256 GB TLC	ZTD 512 GB TLC	ZTD 1 TB TLC
Connection	PCIe 3x4 (4 lanes)	PCIe 3x4 (4 lanes)	PCIe 3x4 (4 lanes)
Seq Read (MB/s)	2800 MB/s	2800 MB/s	3000 MB/s
Seq Write (MB/s) (max)*	1100 MB/s	1600 MB/s	1700 MB/s

*Lower performance is possible with TLC SSDs due to cache architecture

The chart below shows a comparison of storage device performance measured in MB/s. By directly connecting to the PCIe Bus, the HP Z Turbo Drive is able to considerably exceed previous performance capabilities.

Figure 9. Comparison of storage device performance
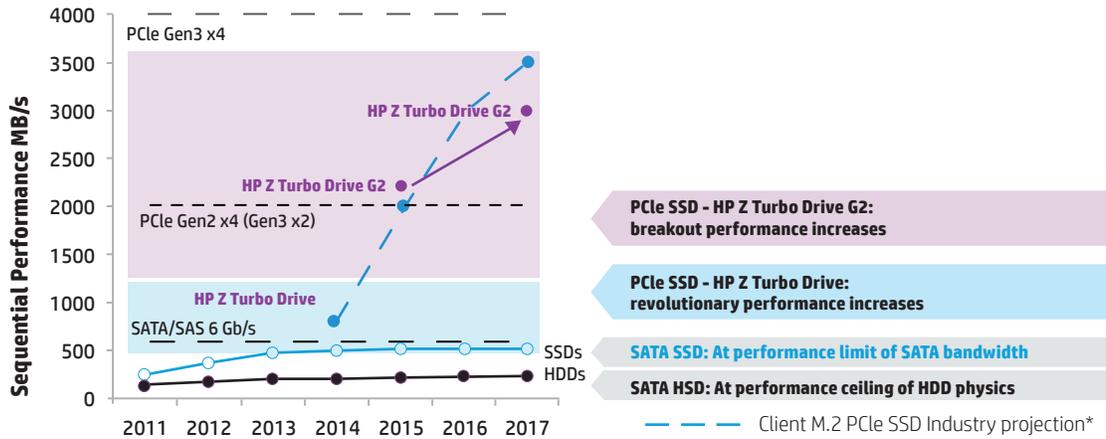
Detailed performance and benchmarking results

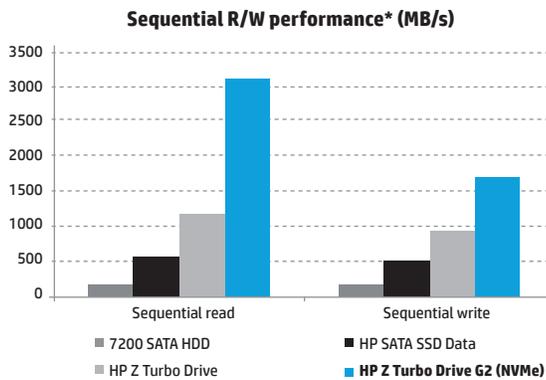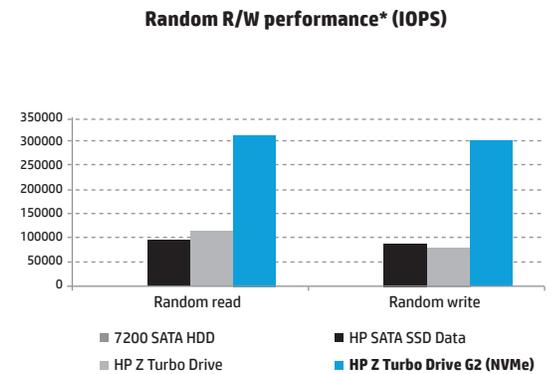**Figure 10.** Sequential R/W performance (MB/s)

Figure 11. Random R/W performance (IOPS)

*Performance measured using IOMeter 2006 with queue depth 32

Customer advantages

The HP Z Turbo Drive benefits all workstation customer segments by allowing customers to realize performance gains due to improvements in storage performance. While workflows with large data files will see the most noticeable improvement, all users will appreciate the improved transfer rates and quicker performance.

These specific segments are:
• Product Development/AEC
• Media & Entertainment
• Finance
• Oil & Gas
• Geospatial

Summary

The transition from SATA to PCIe protocols for solid-state devices enables customers to utilize the M.2 form factor to benefit from faster data transfer speeds and improved storage performance. The HP Z Turbo Drive offering on the HP ZBook 14u and 15u G4 provides a huge performance gain over HDDs, enables large file/big data workflows, and offers impressive price/performance for NAND components. Integrating the HP Z Turbo Drive technology into HP platforms increases the flexibility of the storage subsystems and provides the user options for performance and capacity that stand out in the industry.

Power supply

Save size and weight

The HP ZBook 14u and 15u G4 Mobile Workstations take the reliability and performance advantages of a workstation on the go. With Intel® processor technology and AMD mobile graphics cards, professionals can take their work with them wherever they travel. Our system requires an efficient power supply, which is why the HP ZBook 14u and 15u G4 ship standard with the HP 65W Slim Smart AC Adapter.

Function of the power supply
External power supplies convert the 120 V or 240 V AC power, depending on the country, from a wall outlet into DC current. The HP ZBook 14u and 15u G4 will only pull as much power as required to operate all operating components and open applications. The HP ZBook 14u and 15u G4 ship with the power supply option to best meet the demands of a fully loaded machines running an intense workload. Power supply units have an efficiency rating, measured as a percentage of power the machine uses out of total power pulled from the source.

What happens if the power supply is too low in wattage?
The HP ZBook 14u and 15u G4 can be configured in the settings to run in full use, balanced, or power saving modes. When the HP ZBook is connected to a landline, it will attempt to pull all of the current it needs from the wall. If the energy demand exceeds the power supply rating, the management system within the BIOS will automatically draw the additional power needed from the battery. In this case, it is possible to drain the battery while connected to a landline. When run at maximum capacity, low wattage power supplies may produce noticeable but not harmful heat.

The HP ZBook 14u and 15u G4 are compatible with power adapters 65W and above.

What makes the power adapter smart?
The smart feature displays a pop-up message:

"For full performance, connect a higher capacity AC adapter"

This message informs the user that as power demands increase, the HP ZBook may not perform at full capacity, which may result in longer battery charging time. In cases of extreme power demands, the system may also throttle back the processor or, with systems that have discrete video subsystems, a video balance mode may occur to further balance the power needs of the system.

Note: System CPU functions always have priority over battery charging, so charging delays will occur first.

Table 8. HP ZBook 14u and 15u G4 AC power adapter configure to order options

Adapter	External 65 Watt Slim Smart AC Adapter
Size	153 x 66 x 22 mm
Weight	0.70 lb (320 g)
Total cord length	6 feet (1.8 meters)
Barrel Size	4.5 mm

Switch it up
When workloads change or the user finds that they require a different power supply, all of the power supply sizes are offered as after-market options that customers can purchase at a later time. In the case of a professional using a docking station to connect at work, it is highly recommended to use the higher wattage power supply option. For many of these users, the purpose of a docking station is to connect to a larger and/or multiple displays, often to use more applications that require greater resources. For this reason, it is best to choose the higher wattage power supply. HP recommends the External HP 65 W Smart AC Adapter for optimal performance on the HP ZBook 14u and 15u G4.

MIL-STD-810G testing[13]

The HP ZBook 14u and 15u G4 Mobile Workstations are designed with reliability in mind, which is why it undergoes a series of tests. This testing consists of a variety of conditions that are intended to evaluate the reliability of the HP ZBook 14u and 15u G4 under a specific set of environmental conditions.

HP Total Test Process

The HP ZBook 14u and 15u G4 are intended to provide users with a reliable product wherever they go, under many conditions. In the design phase, we start with the HP Total Test Process. This is a multi-tiered product validation process with comprehensive, end-to-end diagnostics and a minimum of 120,000 hours of testing per platform. After this phase, we send our products to a third party to see how well they can match up against the MIL-STD-810G testing process[13].

MIL-STD-810G testing[13]

MIL-STD-810G testing[13] is from the Department of Defense (DoD) Test Method Standard for Environmental Engineering Considerations and Laboratory Tests. This standard, though created specifically for DoD, is widely used for a variety of technological devices, including the HP ZBook 14u and 15u G4. It outlines a broad range of tests that can be tailored to measure the reliability of specific pieces of equipment and is intended to help organizations design their equipment for enhanced durability. The MIL-STD-810G is a set of testing standards set by the U.S. military and it is now the most widely used international standard for testing a computer's durability. It uses a range of test methods to determine the reliability of the equipment. The series of tests performed are approved and used by all departments and agencies of the DoD. This set of standards is used to:

• Define the environmental stresses, durations, and equipment lifecycle
• Develop analysis and test criteria tailored to the equipment and its environmental life cycle
• Evaluate equipment lifecycles when exposed to environmental stresses
• Identify deficiencies and defects in the design, materials, manufacturing processes, packaging techniques, and maintenance methods

How do the HP ZBook 14u and 15u G4 measure up?

Below is the ZBook 14u and 15u G4 MIL-STD-810G testing report. The HP ZBook 14u and 15u G4 passed all 14 tests listed below and all tests were performed from a third party to ensure accurate testing results and no bias in the reports.

Table 9. MIL-STD-810G tests passed by the HP ZBook 14u and 15u G4 in 2017

	MIL-STD-810G reference
Altitude	Method 500.5 Procedure I Method 500.5 Procedure II
Bench Handling	Method 516.6 Procedure IV
Crash Hazard Shock	Method 516.5 Procedure V
Drop	Method 516.6 Procedure IV
Dust	Method 510.5 Procedure I
Explosive Atmosphere	Method 511.5 Procedure I
Freeze/Thaw	Method 524.5 Procedure III

Functional Shock	Method 516.6 Procedure I
High temperature	Method 501.5 Procedure I Method 501.5 Procedure II
Humidity	Method 507.5 Procedure II
Low temperature	Method 502.5 Procedure I Method 502.5 Procedure II
Sand	Method 510.5 Procedure II
Temperature Shock	Method 503.5 Procedure I
Vibration	Method 514.6 Procedure I category 4 Method 514.6 Procedure I category 24

Testing scenarios

A third party performs the various MIL-STD-810G testing at its own facility. This eliminates any bias in the testing, and ensures that the durability of our products is accurately measured for customers. The variety of tests that the HP ZBook 14u and 15u G4 undergo is listed below with explanations to the specific testing purpose.

Altitude test[13]
The Altitude test was performed in accordance with MIL-STD-810G, Method 500.5, Procedure I (Storage) and II (Operation). The altitude level simulated for both procedures was 15,000 feet (the highest equivalent altitude given within MIL-STD-810G for cargo pressures within military aircraft).

Bench Handling test[13]
The Bench Handling test was performed in accordance to the MIL-STD-810G, Method 516.6 Procedure IV. This test was designed to test whether the unit can withstand levels of shock resulting from bench handling, bench maintenance, and/ or packaging.

Crash Hazard test[13]
The Crash Hazard test was performed in accordance to the MIL-STD-810G, Method 516.5 Procedure V. The purpose of this test was to ensure that the HP ZBook does not eject sub-elements and that it's restraining devices will not fail during crash situations.

Drop test[13]
The Drop test was performed in accordance with MIL-STD-810G, Method 516.6 Procedure IV. The objective of this test was to determine whether the unit could be safely operated after being dropped from desk height. For this test, 26 drops were performed from 30 in. onto every side, angle, and edge onto 2 in. of plywood over steel over concrete. Unit is powered down and checked for operation.

Dust Resistance test[13]
The Dust Resistance test was performed in accordance with MIL-STD-810G, Method 510.5, Procedure I (Dust). Test parameters were set so that the unit was dusted with Arizona Road Dust for six hours while being operated.

Explosive Atmosphere test[13]
The Explosive Atmosphere test was performed in accordance with MIL-STD-810G, Method 511.5, Procedure I. The objective of the test was to determine whether the unit can operate in fuel-air explosive atmospheres without igniting the surrounding atmosphere.

Freeze/Thaw test[13]
The Freeze/Thaw test was performed in accordance with MIL-STD-810G, Method 524.5 Procedure III. The objective of this test was to determine whether the unit could be safely operated after being exposed to a temperature drop of -10°C (14°F) for two hours. Unit was removed and checked for operation.

Functional Shock test[13]
The Functional Shock test was performed in accordance to the MIL-STD-810G, Method 516.6 Procedure I. The purpose of the functional shock test is to determine if the HP ZBook can operate after sudden exposure to physical shock. During this test, three shocks are performed across each axis and direction for a total of 18 shocks. Shock testing of products and materials determines to what degree the items can physically and functionally withstand a relatively infrequent, short time, moderately high-level force impulse that would be encountered in handling, transportation, and service environments. This test is done with the same machine as the one used for the Vibration test.

High Temperature test[13]
The High Temperature test was performed in accordance with MIL-STD-810G, Method 501.5, Procedure I (Storage) and II (Operation). This test evaluated the units' performance while it was being exposed to high temperature conditions: 60°C (140°F) operational and 71°C (160°F) non-operational.

Humidity test[13]
The Humidity test was performed in accordance with MIL-STD-810G, Method 507.5, Procedure II with the aggravated temperature-humidity cycle. Each cycle was one day (24 hours); ten cycles with the temperature being cycled between 30°C (86°F) and 60°C (140°F); and relative humidity was a constant 95%.

Low Temperature test[13]
The Low Temperature test was performed in accordance with MIL-STD-810G, Method 502.5, Procedure I (Storage) and II (Operation). This test evaluated the unit's performance while it was being exposed to low temperature conditions: -29°C (-20°F) operational and -51°C (-60°F) non-operational.

Sand test[13]
The Sand test was performed in accordance with MIL-STD-810G, Method 510.4 Procedure II. The objective of this test was to determine whether the unit could be safely operated after being exposed to blowing sand of up to 20 M/S at a temperature of 60°C (140°F) for 4.5 hours (every 90 minutes, the unit is rotated 90°).

Temperature Shock test[13]
The Temperature Shock test was performed in accordance with MIL-STD-810G, Method 503.5 Procedure I. The objective of this test was to determine whether the unit could be safely operated after being exposed to sudden changes in ambient temperature while non-operational. The high temperature was set to be 96°C (205°F) and the low temperature to be -51°C (-60°F); three high-to-low cycles were performed.

Vibration Resistance test[13]
The Vibration Resistance test was performed in accordance with MIL-STD-810G Test Method 514.6, Procedure I (Non-operational) and Procedure II (Operational). Test parameters were set to simulate the following:

• Operate the unit during a 1000-mile simulation of vibrations created by a truck driving on a U.S. highway
• Operate the unit after it has been subjected to higher levels of vibration while in storage

Terrain, road and surface discontinuities, vehicle speed, loading, structural characteristics, and suspension system are all reflected in this simulation.

Resources, contacts, or additional links

HP ZBook 14u and 15u G4 Mobile Workstations
hp.com/go/zbook15u

Learn more at
hp.com/go/whitepapers

[1] Not all configurations qualify as an Ultrabook™.

[2] Sold separately or as an optional feature.

[3] 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 microsoft.com

[4] HP Performance Advisor requires Windows and an internet connection.

[5] EPEAT® registered where applicable. EPEAT registration varies by country. See epeat.net for registration status by country.

[6] Multi-core is designed to improve performance of certain software products. Not all 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 is not a measurement of higher performance.

[7] Windows 10 MM14 battery life will vary depending on various factors including product model, configuration, loaded applications, features, use, wireless functionality, and power management settings. The maximum capacity of the battery will naturally decrease with time and usage. See bapco.com for additional details.

[8] This system is preinstalled with Windows 7 Pro software and also comes with a license and media for Windows 10 Pro software. You may only use one version of the Windows. software at a time. Switching between versions will require you to uninstall one version and install the other version. You must back up all data (files, photos, etc.) before uninstalling and installing operating systems to avoid loss of your data.

[9] For hard drives, GB = 1 billion bytes. TB = 1 trillion bytes. Actual formatted capacity is less. Up to 16 GB (for Windows 7) and up to 30 GB (for Windows 8.1/10) of system disk is reserved for system recovery software.

[10] HD content required to view HD images.

[11] Wireless cards are optional or add-on features and requires separately purchased wireless access point and internet service. Availability of public wireless access points limited.The specifications for the 802.11ac WLAN are draft specifications and are not final. If the final specifications differ from the draft specifications, it may affect the ability of the notebook to communicate with other 802.11ac WLAN devices.

[12] Multiple displays may be connected to DP 1.2 Hub. DP 1.2 Hub is connected to a DisplayPort connector on the HP ZBook or Docking Station.

[13] Testing was not intended to demonstrate fitness for Department of Defense contracts requirements or for military use. Test results are not a guarantee of future performance under these test conditions. Accidental damage or damage under the MIL STD test conditions requires an optional HP Accidental Damage Protection Care Pack.

[14] Maximum memory capacities assume Windows 64-bit operating systems or Linux. With Windows 32-bit operating systems, memory above 3 GB may not all be available due to system resource requirements.

[15] 4K content required to view 4K resolution.

[16] Recharges your battery up to 50% within 30 minutes when the system is off or in standby mode. Power adapter with a minimum capacity of 65 watts is required. After charging has reached 50% capacity, charging will return to normal. Charging time may vary +/-10% due to System tolerance.

[17] Performance measurements tested with Iometer 1.1.0 with 12 workers, queue depth of 128, file size of 128KB used for sequential measurements, file size of 4KB used for random measurements.

[18] NOTE: This product does not support Windows 8 or Windows 7. 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.

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