Technical white paper

Optimizing hardware systems for Adobe® Creative Cloud™

The artist's guide to configuring or upgrading a computer to get the most out of these cornerstone video software applications

Today's digital content creators demand more performance from their systems—especially as they take on an ever-widening array of jobs at ever-larger media sizes. However, not all editors, colorists, and motion graphic artists are also computer hardware specialists.

This document will discuss how you—a user of Adobe Premiere® Pro CC, After Effect®s CC, SpeedGrade™ CC, and Photoshop® CC software—can analyze your needs based on the type of work you do. With this information, you can then either choose a new computer system or enhance an existing one with simple add-in components that will deliver optimal performance for your unique set of requirements. The goal is to balance the components of your system to deliver the performance your specific tasks require. This allows you to focus on your own creativity while efficiently delivering what your client needs.

First we will present the hardware configuration options available from HP and Apple. Then we will discuss the hardware demands of Adobe Premiere Pro, After Effects, SpeedGrade, and Photoshop, highlighting which functions will benefit the most from specific hardware improvements. We'll then pull that information together to make suggestions about what areas you should focus on to execute common tasks with Adobe video software. We will assume you have basic familiarity with the major components of a computer system—CPU (central processing unit), GPU (graphics processing unit), RAM (working memory), and storage (including hard drives and solid state drives)—but we don't expect you to be a computer technician; we assume you're a computer-savvy artist looking to get work done as efficiently as possible.

Table of contents

Hardware solutions

There are three basic types of computer systems: desktop workstations where the hardware is separate from the monitor, all-in-one systems where the hardware and monitor are integrated, and mobile solutions such as laptop computers. Generally, desktop workstations are the most powerful, most expandable, and most expensive—but that's not always the case. The charts below will give you an overview of the configuration options available for HP and Apple computers in these three classes, including external connections and internal expandability. (For more information on HP Z Workstations, visit the HP Workstations web page.

Table 1. Desktop Workstations

	Maximum CPU cores	Maximum RAM	Expansion slots	Drive bays	Thunderbolt™ 2[1]	USB 3.0 ports
HP Z420	8	64 GB	6	6	e*	4
HP Z620	24	192 GB	6	5	e*	4
HP Z820	24	512 GB	7	7	e*	4
Apple Mac Pro	12	64 GB	0	0	6	4

* Up to the number of available expansion slots by adding HP Thunderbolt™ 2 PCIe cards

Table 2. All-in-One Workstations

	Maximum CPU cores	Maximum RAM	Expansion slots	Drive bays	Thunderbolt™ 2[1]	USB 3.0 ports	Maximum display resolution
HP Z1 27"	4	32 GB	3	3	2 (optional)	2	2560 x 1440
Apple iMac 21.5"	4	16 GB	0	1	0*	4	1920 x 1080
Apple iMac 27"	4	32 GB	0	1	0*	4	2560 x 1440

* Apple iMacs have two Thunderbolt™ 1 ports, but no Thunderbolt™ 2 support

Table 3. Mobile Workstations

	Maximum CPU cores	Maximum RAM	Drive bays	Thunderbolt™ 2[1]	USB 3.0 ports	Maximum display resolution
HP ZBook 14	2	16 GB	1	0	3	1920 x 1080
HP ZBook 15	4	32 GB	2	1	2	1920 x 1080
HP ZBook 17	4	32 GB	3	1	2	1920 x 1080
MacBook Pro 13"	2	16 GB	1	2	2	2560 x 1600
MacBook Pro 15"	4	16 GB	1	2	2	2880 x 1800

Identifying Performance Bottlenecks

Adobe Premiere® Pro, After Effects®, SpeedGrade™, and Photoshop® each place unique demands on the major hardware components discussed above. Even different tasks performed inside the same software may vary these requirements drastically. In this section, we will state the basic system requirements for each software package, and then discuss specific demands and potential performance bottlenecks that may lead you to go beyond those basic requirements to optimize your own experience.

Adobe Premiere® Pro CC

Let's start with the basic system requirements. You don't want to go below these when configuring an HP system for Adobe Premiere Pro CC. After that, we'll discuss which hardware components you may want to upgrade to get the most performance out of Premiere Pro:

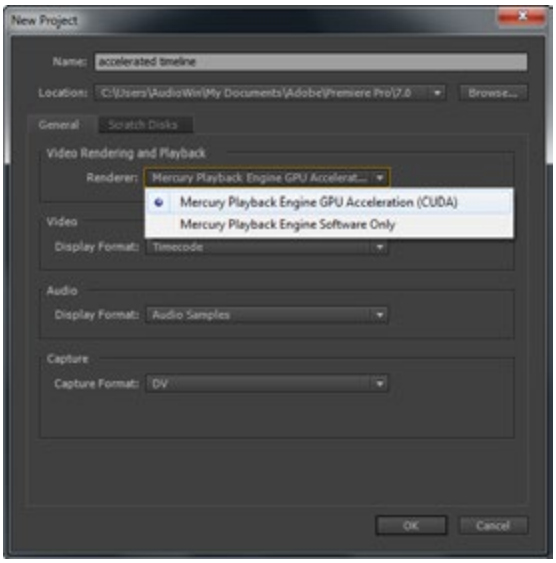
Basic System Requirements:

- Intel® Core™ Duo or AMD Phenom® II processor with 64-bit support[3]
- 4 GB of RAM (8 GB recommended)
- 4 GB of available hard-disk space for installation; additional free space required during installation (cannot install on removable flash storage devices)
- Additional disk space required for preview files and other working files (10 GB recommended)
- 1280 x 800 display
- 7200 RPM hard drive (multiple fast disk drives configured for RAID 0 recommended)
- Sound card compatible with ASIO protocol or Microsoft Windows Driver Model
- QuickTime 7.6.6 software required for QuickTime features
- Optional: Adobe-certified GPU card with at least 1 GB of VRAM for GPU accelerated-performance
- Internet connection and registration are necessary for required software activation, membership validation, and access to online services.[4]

Check the Adobe Premiere Pro CC system requirements web page for details and updates.

OpenCL and CUDA Accelerated Effects and Transitions in Adobe Premiere Pro CC:

Additive Dissolve
Alpha Adjust
Basic 3D
Black & White
Brightness & Contrast
Color Balance (RGB)
Color Pass
Color Replace
Crop
Cross Dissolve
Dip to Black
Dip to White
Directional Blur
Drop Shadow
Extract
Fast Blur
Fast Color Corrector
Feather Edges
Film Dissolve
Gamma Correction
Garbage Matte (4, 8, 16)
Gaussian Blur
Horizontal Flip
Invert
Levels
Luma Corrector
Luma Curve
Lumetri
Noise
Proc Amp
RGB Curves
RGB Color Corrector
Sharpen
Three-way Color Corrector
Timecode
Tint
Track Matte
Ultra Keyer
Video Limiter
Vertical Flip
Warp Stabilizer



A core performance feature in Adobe Premiere Pro is the Mercury Playback Engine (MPE), which optimizes video processing calculations during previewing, exporting, scrubbing, and other functions in addition to playback. MPE employs multithreading to take advantage of multiple CPU cores (both real and virtual) to accelerate these functions. The speed of encoding and decoding the wide range of media types Adobe Premiere Pro can handle is also generally dependent on your CPU.

Additionally, if your computer has an OpenCL-compatible AMD or CUDA-enabled NVIDIA® graphics card or chip installed, it can also take advantage of a qualified GPU to greatly accelerate a number of functions by a factor of up to eight times that of high-end multicore CPUs. Adobe Premiere Pro can also take advantage of multiple GPUs installed inside the same computer for even greater performance. Check the Adobe Premiere Pro CC system requirements web page for the lastest information on which cards are supported.

Functions that are accelerated include a growing list of effects and transitions (see the sidebar on this page), scaling including different pixel aspect ratios, deinterlacing, frame rate differences, blending modes, color space conversions, and alpha channel interpretation. Additionally, LUT (color lookup table) processing is accelerated by OpenGL, OpenCL, and/or CUDA.

HP recommends Windows.

Your choice of graphics card—together with the speed of your storage devices (discussed below)—has a direct impact on the number and size of streams of video that may be played back in real time. It also affects rendering time of your final output. For example, NVIDIA® performed a test using a timeline consisting of six layers of video with Tint effects, 3-way color correction, Gaussian blurs, the Ultra keyer, text layers, and layer blend effects. This was rendered for H.264 BluRay output with MRQ (Maximum Render Quality) enabled. The times required for this job were (times are stated as minutes:seconds):

Render times for example timeline in Adobe Premiere Pro:

4:50.4	CPU only (dual 8-core 3.1 GHz Xeon® E5 2687W PC)
0:59.8	NVIDIA® Quadro® K2000
0:31.8	NVIDIA® Quadro® K4000
0:25.8	NVIDIA® Quadro® K5000
0:17.7	NVIDIA® Quadro® K6000
0:13.8	Dual NVIDIA® Quadro® K6000

Another series of tests were run using different combinations of host computer, CPU, and GPU, which further illustrates the importance of treating your hardware as an overall system:

Render times for Mercury Playback Engine test in Adobe Premiere Pro (times in seconds):

32.514	Apple MacPro 2013 4-core CPU; two AMD FirePro™ D300 GPUs
31.761	HP Z420 4-core CPU; NVIDIA® Quadro® K5000 GPU
31.127	HP Z420 6-core CPU; NVIDIA® Quadro® K5000 GPU
28.007	Apple MacPro 2013 6-core CPU; two AMD FirePro™ D500 GPUs
26.845	Apple MacPro 2013 12-core CPU; two AMD FirePro™ D700 GPUs
22.565	HP Z420 4-core CPU; NVIDIA® Quadro® K6000 GPU
20.314	HP Z420 6-core CPU; NVIDIA® Quadro® K6000 GPU
22.703	HP Z620 4-core CPU; two NVIDIA® Quadro® K5000 GPUs
19.833	HP Z620 6-core CPU; two NVIDIA® Quadro® K5000 GPUs
21.318	HP Z820 dual 8-core CPUs; NVIDIA® Quadro® K6000 GPU
18.980	HP Z820 dual 8-core CPUs; two NVIDIA® Quadro® K6000 GPUs
17.663	HP Z820 dual 8-core CPUs; two NVIDIA® Quadro® K6000 GPUs; PCIe SSD

As a natural consequence of the impact the GPU has on overall performance, Adobe Premiere Pro is as sensitive to the amount of GPU memory available as normal CPU memory. Whether the OpenCL or CUDA hardware acceleration portion of the Mercury Playback Engine can process a frame depends on the size of the frame compared to the amount of GPU memory. To be processed with OpenCL or CUDA, a single frame of video requires 64 bytes per pixel (16 bytes each for the three color components and the alpha channe l). The number of megabytes for a frame can be calculated using (width x height) ÷ 16,384. If that value exceeds the available memory, Adobe Premiere Pro will use the CPU for rendering of that current segment. This becomes a consideration for larger digital cinema formats: For example, a 5120x2700 pixel "5k" frame from a RED camera requires 843MB of free GPU memory. This is on the edge of what can be supported by a card with 1 GB of total GPU memory (as some memory needs to be reserved for other display functions), but would work comfortably on a card with 1.5 or 2 GB of GPU memory. Bottom line: If you plan to be working with large image sizes, get a GPU with more than 1 GB of VRAM.

Adobe Premiere Pro is highly dependent on the speed of your storage media. You will enjoy better performance and fewer dropped frames if you use multiple drives to spread the work load. At a minimum, you should consider a two-drive system, with one drive containing your operating system, software, and media cache, while the other is used for your source files, previews, and final exported renders. Preferred is a four-drive system, with one dedicated to the operating system and software, the second for source media and project files, the third for the media cache, and the fourth for previews and exports. An excellent solution is if you can use a Solid State Drive (SSD)—or better yet, a PCIe interface SSD such as the HP Z Turbo Drive—for one or more of these tasks, as they yield much higher performance that traditional spinning hard drives.

To play back digital cinema files or multiple streams of HD (High Definition) video files without dropped frames or other interruptions, you should consider a RAID. A RAID can be used in lieu of additional drives for everything except your operating system and software. To give an example of performance, a RAID system such as a G-Technology G-SPEED eS PRO with four 7200 RPM drives can play back:

- 4 streams of 1080i AVCIntra footage
- 6 streams of 1080p H.264 Canon 5D footage
- 8 streams of RED 4k R3D files
- 14 streams of 1080i XDCAM EX, 1080p DVCPROHD, or 1080i HDV
- 40 streams of DV NTSC

(In addition to file size demands, different codecs require differing amounts of processing power to decode and play back in real time. That's why so many more streams of DVCPROHD can be played back than Canon 5D H.264 footage.)

Some hardware cards may also be used to accelerate media encoding and decoding. For example, RED Digital Cinema makes the RED ROCKET that enhances transcode and playback abilities of R3D files in various resolutions in real time speeds. Multiple RED ROCKET cards may be used in one system to boost system performance when working with R3D files. Adobe's Mercury Transmit technology gives Adobe I/O hardware partners, such as AJA, Black Magic Design, Bluefish444, Matrox, and MOTU, direct access to the Mercury Playback Engine, so you experience better playback performance. When using external broadcast monitors, you'll get full-screen playback while maintaining all the real-time performance benefits of the Mercury Playback Engine. Note that some NVIDIA® and AMD video cards allow for 4K hardware monitoring via HDMI and Display Port. By adding a 4K monitor with one of these ports to your work flow, you now monitor in full 4K resolution.

As stated in the introduction, Adobe has created numerous documents and videos that go into more detail on how to improve performance when using Adobe Premiere Pro.

After Effects® CC

Below are basic system requirements for After Effects CC. You don't want to go below these when configuring an HP system for After Effects CC. After this, we'll discuss which hardware components you may want to upgrade to get the most out of After Effects, depending on your chosen tasks:

Basic System Requirements:

- Intel® Core™ Duo or AMD Phenom® II processor; 64-bit support required[3]
- 4 GB of RAM (8 GB recommended)
- 5 GB of available hard-disk space; additional free space required during installation (cannot install on removable flash storage devices)
- Additional disk space for disk cache (10 GB recommended)
- 1280 x 900 display
- OpenGL 2.0–capable system
- QuickTime 7.6.6 software required for QuickTime features
- Optional: Adobe-certified GPU card for GPU-accelerated ray-traced 3D renderer
- Internet connection and registration are necessary for required software activation, membership validation, and access to online services.[4]

Check the After Effects CC system requirements web page for details and updates.

After Effects CC takes advantage of all the CPU power available to it. Many After Effects features are accelerated on a multiprocessor system through the use of multithreading, where it employs all of the cores—both real and virtual—available to it in order to process imagery.

In addition, After Effects may also be set in Preferences > Memory & Multiprocessing to Render Multiple Frames Simultaneously. When this multiprocessing option is enabled, After Effects will launch additional copies of itself in the background, each processing individual frames for RAM Previews and final renders. Note that multiprocessing can only use physical processor cores, not virtual cores created by hyperthreading; you should also reserve at least two physical cores for the operating system and other software running at the same time. To translate this theory to a typical application, a computer with 12 physical cores may appear to the operating system as having 24 cores with hyper-threading[2] turned enabled, but in reality you can safely assign a maximum of 10 CPUs (processor cores).

Certain functions in After Effects CC are accelerated by the GPU in your computer using OpenGL, including some Fast Previews settings for 3D compositions and the drawing of images to the Composition, Footage, and Layer panels. Additionally, the Ray-traced 3D rendering engine is massively accelerated by the presence of a compatible CUDA-enabled NVIDIA® graphics card or chip set. Check the After Effects CC system requirements web page for the latest list of supported cards; this list often changes with each new software update.

Note: A small subset of functions in After Effects—including the Ray-traced 3D rendering engine and some third-party effects that need to access multiple frames across time to render the current frame—disable multiprocessing, but in these instances After Effects still takes advantage of multithreading to use all available processor cores to render a single frame.

If a supported CUDA card is not installed, the ray-traced renderer will fall back to using the available processor cores. However, if a CUDA-enabled card is present, After Effects® CC uses NVIDIA's CUDA to significantly speed up ray-tracing calculations:

Render times for a suite of five compositions with ray-traced 3D layers in After Effects:

- 65:42.3 CPU-only (8-core 3.47 GHz Intel® Xeon® 5690 PC)
- 12:21.1 NVIDIA® Quadro® K2000
- 06:18.8 NVIDIA® Quadro® K4000
- 04:39.7 NVIDIA® Quadro® K5000
- 02:20.3 NVIDIA® Quadro® K6000
- 01:40.7 Dual NVIDIA® Quadro® K6000

After Effects users have also been quite active in performing their own benchmark tests for a variety of configurations; you can download these results from the loopOut("continue") web site.

Note that ray-traced 3D in After Effects can take advantage of multiple GPUs running the same version of CUDA in the same system, as is the case with the Maximus configurations or dual Quadro® GPUs. (Check the NVIDIA® website for the CUDA version supported by various cards: For example, a Quadro® FX 4800 supports CUDA 1.3, while a Quadro® 4000 supports CUDA 2.0—so you cannot combine these two different-generation cards and expect a performance gain over the fastest single card.)

Another consideration is how much VRAM the video card supports: Among other things, more VRAM means larger images can be used for Environment Layers in After Effects, which allows higher-quality renderings of these panoramic wrap-around worlds.

Global Performance Cache

After Effects also benefits from having more RAM installed. Available memory is used to store the RAM Preview cache for real-time playback, including the Global RAM Cache feature that remembers previously-previewed frames and compositions even from other projects. More RAM increases the amount of time and frame size that can be cached for playback or later recall. Enabling multiprocessing also uses additional RAM. At least 2 GB (preferably 3 GB) should be assigned to each background process. In the scenario mentioned earlier, if you want to use 10 cores for multiprocessor previews and rendering, you will need 30 GB of RAM installed in addition to RAM reserved for the normal foreground copy of After Effects, the operating system, and any other software currently running.

Since After Effects uses RAM instead of drives for real-time playback, it is not as sensitive to storage speed as Adobe Premiere Pro or SpeedGrade. Nonetheless, storage speed still affects how fast sources can be read into memory to be composited, as well as how fast rendered frames can be rendered back to disk. Drive speed becomes more of an issue when considering the Global Performance Cache: The speed of your cache drive directly affects how fast frames can be swapped between the RAM and disk caches, plus a faster cache drive means more frames are retained as opposed to re-rendered if needed.

At a minimum, place your media and cache on a separate drive than used by the system, so that normal system memory swapping does not compete with After Effects for disk access. Ideally, you would also dedicate a separate very fast drive such as an SSD—or better yet a PCIe SSD such as the HP Z Turbo Drive—for the Persistent Disk Cache in After Effects, as it uses this to save already-previewed frames to reuse later. If you do not plan on enabling multiprocessing, you can use the same drive for both source media and your render destination, as After Effects does not read and write at the same time; if you do plan on enabling multiprocessing, then it is best if the sources were on their own drive separate from your render destination as the different background rendering processes may be trying to read and write at the same time.

As noted in the introduction, don't overlook software settings and work habits as another source of increased performance and productivity. The After Effects online Help file contains an extensive list of suggestions and links to related resources.

SpeedGrade™ CC

Again, we'll start with the basic system requirments for SpeedGrade CC before talking about enhancements:

Basic System Requirements:

- Intel® Core™ i7 processor with 64-bit support[3]
- 4 GB of RAM (8 GB recommended)
- 1 GB of available hard-disk space for installation
- 1680 x 1050 display required; 1920 x 1080 display and second professionally calibrated viewing display recommended
- OpenGL 2.0–capable system
- Dedicated GPU card with at least 1 GB VRAM is required: (NVIDIA® Quadro® 4000, 5000, or 6000 recommended)
- QuickTime 7.6.6 software required for QuickTime features
- Optional: Tangent Element control surface recommended. Tangent CP200 family and Tangent Wave control surface are also supported.
- Internet connection and registration are necessary for required software activation, membership validation, and access to online services.[4]

Check the SpeedGrade CC system requirements web page for details and updates.

The Lumetri Deep Color Engine in SpeedGrade CC uses massive parallel processing in a single GPU running OpenGL for optimum graphics performance. This makes SpeedGrade unique among the software discussed here in that virtually the entire program runs on the GPU in your computer, rather than the CPU. The power of your single GPU will affect how many layers of color grading—including masking, filters, and effects—you can apply to a clip and still be able to preview the results in real time; other computationally intensive processes such as de-Bayering ARRIRAW footage are also performed on the GPU. A card such as the NVIDIA® Quadro® 4000 provides a good baseline for most color grading tasks. Similarly, SpeedGrade is more sensitive to the amount of VRAM on your GPU than RAM available to your CPU; 1 GB of VRAM and at least 4 GB of system RAM will suffice.

In addition to processing images, for proper evaluation of your footage during grading you need a storage system capable of playing back at least a single stream of your chosen media format in real time; it is best to plan on playing back two streams so you can use two timeline playheads for shot matching. Using Direct Link, Speedgrade CC utilizes Adobe Premiere Pro's Mercury Playback engine; indeed, it can even load its .prproj files. Therefore, all of the advice stated earlier about configuring a system for Adobe Premiere Pro CC applies to Speedgrade CC when running in Direct Link mode. If you are working in typical compressed High Definition (HD) formats such as HDV, AVCHD, or H.264, a single 7200 RPM or faster drive with a FireWire 800 or faster connection will work well. For digital cinema applications, consider a RAID with a fast interface and data rates high enough to sustain full-speed playback.

Photoshop® CC

Below are basic system requirements for Photoshop CC. You don't want to go below these when configuring an HP system for Photoshop CC. After this, we'll discuss which hardware components you may want to upgrade to get the most out of Photoshop:

Basic System Requirements:

- Intel® Pentium® 4 or AMD Athlon® 64 processor (2 GHz or faster)[3]
- 2 GB of RAM (8 GB recommended)
- 2.5 GB of available hard-disk space for installation; additional free space required during installation (cannot install on removable flash storage devices)
- 1024 x 768 display (1280 x 800 recommended) with OpenGL 2.0, 16-bit color, and 512 MB of VRAM (1 GB recommended)
- Internet connection and registration are necessary for required software activation, membership validation, and access to online services.[4]

Check the Photoshop CC system requirements web page for updates.

As is the case with After Effects, Photoshop CC makes significant use of the CPU. Most Photoshop CC features are faster on a multiprocessor system, with some features taking particular advantage of additional cores including Adobe Camera Raw (ACR) processing, Lens Blur, Radial Blur, Field Blur, Iris Blur, and Tilt/Shift. Only a few functions—such as reading PSD files, or the healing brush—are limited to single core due to the algorithms they use.

Beyond the CPU, the Mercury Graphics Engine in Photoshop CC includes features that use your single GPU for acceleration. In Photoshop CC this engine delivers near-instant results when editing with key tools such as Smart Sharpen, Liquify, Blur Gallery, Warp, Lighting Effects and the Oil Paint filter, plus delivers a more responsive, fluid feel as you work. The Mercury Graphics Engine uses both the OpenGL and OpenCL frameworks.

OpenGL GPU-accelerated display and image processing functions in Photoshop CC include the Adobe Color Engine (ACE), Pixel Grid, Smooth Pan/Zoom/Scrubby Zoom, Bird's Eye View, Flick Pan, Rotate Canvas, the Heads-Up Display (HUD) Color Picker, on-canvas brush resizing and rich cursor info, Bristle Tip Preview, 3D (including Extrude, formerly known as Repoussé), Liquify, Adaptive Wide Angle, Lighting Effects Gallery, Oil Paint Filter, new 3D enhancements such as Draggable Shadows, Ground Plane and ground plane reflections, Roughness, On-canvas UI controls, Light widgets, and the image-based light controller, plus GPU previews for Warp and Transform including Puppet Warp and Content Aware Scale. Additionally, Photoshop CC can take advantage of OpenCL acceleration for Iris Blur, Field Blur, Tilt-Shift, and Smart Sharpen. OpenCL acceleration is also used for mouse-down interactive previewing in the Blur Gallery features (1 GB of VRAM required).

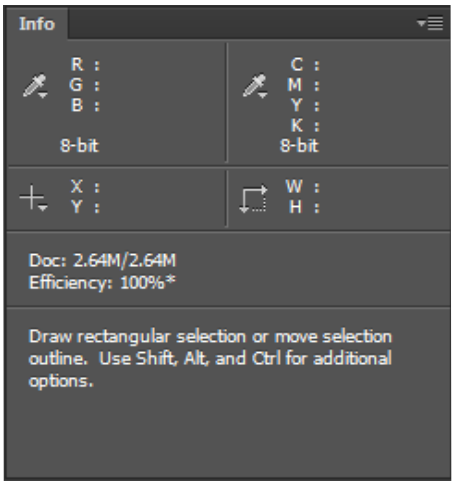
In order to take advantage of the Mercury Graphics Engine in Photoshop CC, you must have a supported video card and updated driver. If you do not have a supported card, performance may be degraded. In most cases the acceleration is lost and the feature runs in the normal CPU mode. However, there are some features that will not work without a supported video card. Also, mixing multiple video cards of different models in the same computer may cause problems in Photoshop.Make sure you check the Photoshop system requirements web page for the latest list of approved cards.

The benefit of using the GPU for image processing can be significant for some functions. For example, AMD has found that enabling OpenCL can increase Smart Sharpen tasks by over twentyfold, with choice of video card making a large difference:

Render times for Smart Sharpen in Photoshop CC *(Intel® Xeon® 2.13 GHz E5506 PC)*

8:49.5	CPU-only (OpenCL off)	0:23.5	OpenCL with AMD FirePro™ W5000
8:43.8	CPU-only (OpenCL off)	0:16.8	OpenCL with AMD FirePro™ W7000
8:46.7	CPU-only (OpenCL off)	0:12.3	OpenCL with AMD FirePro™ W8000
8:42.0	CPU-only (OpenCL off)	0:11.2	OpenCL with AMD FirePro™ W9000

Another factor to keep in mind is that Photoshop® utilizes RAM to process images. If Photoshop has insufficient memory, it uses the connected storage device designated in its Preferences as a "scratch" disk to process information. Therefore, increasing the amount of RAM in your computer will enable you to work on more and larger images inside Photoshop.



How much RAM is enough? Watch the Efficiency indicator (available at the bottom of each image's window) while you work in Photoshop to determine when Photoshop maxes out on RAM and starts using the scratch disk, which slows performance. Click the pop-up menu at the bottom of the image window and choose Efficiency. (You can also view the Efficiency status in the Info panel.) If the Efficiency value is below 100%, Photoshop is using the scratch disk and, therefore, is operating more slowly. If the efficiency is less than 90% to 95%, allocate more RAM to Photoshop in Performance Preferences or add additional RAM to your system. 4 GB will cover most digital photography uses; 8 GB leaves room for other apps and fits huge documents in RAM.

If you are unable to add more RAM to your computer, then install or connect a fast drive and designate it as your scratch disk. An SSD (Solid State Drive) or PCIe flash storage system such as the HP Z Turbo Drive are the fastest solutions; an external RAID 0 system connected by Thunderbolt™ 2,[1] USB3, or FireWire 800 is a workable alternative if you are unable to add internal storage.

Photoshop performance is discussed in greater detail in this Adobe Knowledge Base article. For more on video card usage in Photoshop CC, visit the relevant Help page.

HP DreamColor 10-bit displays

Another important component of your hardware system is your monitor. HP DreamColor Z24x and Z27x displays feature expanded color resolution: 10 bits or 1,024 gray levels per channel, which is twice that of standard displays. As a result, they can show up to 1.07 billion colors with digital cinema-class gamuts—including 100% coverage of sRGB and BT.709 and 99% of Adobe® RGB, with a 1000:1 contrast ratio. Connect your display to a PC, workstation, and range of digital video devices with DVI, DisplayPort, and HDMI inputs.

Given all that, it's no surprise that HP DreamColor displays are used by many of the world's leading animation studios and visual effects artists.

For more on using HP DreamColor displays in a digital video production workflow, see HP's White Paper on the advantages of this increased color resolution.

Summary: Choosing the right tools for the job

Now that you have an understanding of how Adobe® Premiere® Pro, After Effects®, SpeedGrade™, and Photoshop® interact with the major hardware components in your computer, you can make informed decisions on what options to order for your next computer system, or how to upgrade your existing computer to work more efficiently.

CPU: After Effects CC and Photoshop CC benefit the most from faster CPUs and more CPU cores. Indeed, given sufficient RAM (discussed earlier), After Effects CC is capable of running multiple copies of itself on individual physical cores to speed previews and rendering. Although Adobe Premiere Pro CC's Mercury Playback Engine (MPE) also benefits from faster CPU configurations, as noted earlier using an approved AMD OpenCL or NVIDIA® CUDA-enabled GPU accelerates MPE by an even larger amount and is preferred. On the other hand, if you are relying on the relatively few functions in Adobe Premiere Pro that are not accelerated by the MPE—for example, if you are primarily converting media from one codec to another, rather than combining multiple streams of different-sized media—then CPU power is more important to you. SpeedGrade CC runs almost entirely on the GPU rather than the CPU, so if that is the only software you intend to use, then the CPU is far less important.

Note that Adobe Premiere Pro CC, After Effects CC, Speedgrade CC, and Photoshop CC run locally on your computer—not over the internet—so the speed of your internet connection will not affect the performance of these applications.

GPU: A faster compatible OpenGL video card will allow you to perform more real-time processing with the Lumetri Deep Color Engine in SpeedGrade CC, and will also accelerate numerous functions (outlined earlier) with the Mercury Graphics Engine in Photoshop CC. It will also give incremental performance boosts to Adobe Premiere Pro and After Effects.

As detailed earlier in this document, to really get performance improvements with the Mercury Playback Engine (MPE) in Adobe Premiere Pro CC you need to use an approved CUDA-compatible GPU from NVIDIA® or an OpenCL-compatible AMD GPU. Note that Adobe Premiere Pro can also take advantage of multiple GPUs installed inside the same system. As a bonus, both Adobe Premiere Pro and SpeedGrade can utilize an NVIDIA® Quadro® SDI Output card. If an approved OpenCL or CUDA-enabled card or chipset is simply not an option for you, then choose a computer with the maximum number of CPU cores available to help make up the difference.

Note that if you rely heavily on ray-traced 3D in After Effects CC, it requires an approved CUDA-compatible GPU from NVIDIA® for true acceleration. After Effects can also take advantage of multiple cards running the same version of CUDA.

In short, it is worth upgrading to newer generation cards, and installing multiple cards if possible. In that vein, note that an HP Z820 has three 16-lane PCIe slots that can accept GPUs. Again, for maximum performance make sure any add-in video card is installed in a x16 PCI slot inside the host computer. For more on choosing the right GPU, refer to this blog by Adobe Pro Video & Audio Field Team manager David Helmly. Both AMD and NVIDIA® also have web pages dedicated to helping you choose the right GPU for your Adobe Creative Cloud video application.

RAM: If you plan to primarily run After Effects CC, then you will directly benefit from installing more RAM. Although the stated minimum is 4 GB of memory, if you plan on taking advantage of multiprocessing, you should consider installing as much as 48 GB for a 12-core system and 64 GB for a 16-core system. You can install even more RAM for longer previews and Global RAM Cache memory, and to run other programs at the same time as After Effects. Make sure you install RAM in a way that is optimal for your particular system; HP has a very useful PDF on the subject.

If you plan to use Adobe Premiere Pro, 4 or 6 GB of RAM is minimum, while 8 or 12 GB is suggested for most users. While SpeedGrade is the least RAM-dependent of the applications discussed here; 4 GB is still the minimum recommended amount, with 8 GB preferred. Although Photoshop's Minimum System Requirements states only 2 GB is needed, you should consider allocating 4 GB, with 8 GB allowing you to work on very large documents.

Remember that each of these numbers are for the software running alone (along with the operating system); add at least their minimum requirements together if you plan on having them open at the same time.

Storage: A recurring theme you may have noticed in this document is that the secret to optimizing performance is to employ multiple drives in a RAID (Redundant Array of Inexpensive Drives) configuration, or solid-state drives. As stated earlier, you should consider a two-drive system as a minimum configuration, with one drive containing your operating system, software, and media cache or scratch disk, while the other is used for your source files, previews, and final exported renders. Preferred is a four-drive system, with one dedicated to the operating system and software, the second for source media and project files, the third for the media cache or scratch disk, and the fourth for exports and final renders. You can use a RAID in lieu of multiple non-system individual drives. An SSD (Solid State Drive) is an excellent choice for your media cache/scratch disk; PCIe-based storage devices such as the HP Z Turbo Drive provide even higher performance. The HP Z Turbo Drive may also be used as a boot drive for faster application and system performance

Although Adobe® Premiere® Pro, After Effects®, Speedgrade™, and Photoshop® all benefit from faster drive configurations, Adobe Premiere Pro (and by extension, Speedgrade CC as it uses Premiere Pro's playback system and can load its project files) is the most sensitive as you will inevitably want to play multiple media streams in real time. A drive system that isn't fast enough doesn't just mean a longer wait, it means dropped frames and jumpy playback. Although you can do a remarkable amount with a single source drive (7200 RPM or faster) with a speedy connection, if you plan to work with larger digital cinema formats, you need to consider moving up to a RAID. In addition to transfer speed, look at the specification for disk seek times as well: For example, for a single stream of 2k-pixel 10 bit DPX frames, your drive system will need to transfer frames of data at 270 MB per second while also performing a head seek potentially on every frame—every 42 msec for 24 FPS (frames per second) source.

Keep in mind that your computer system is an interconnected unit; not just a collection of individual components. The goal is a balanced system with sufficient performance in every area required, rather than a system that's really fast in one area but deficient in others. For example, there is little point in having a large number of processor cores if you don't have enough RAM installed to use multiprocessing in After Effects—if you are on a budget, you may be better off spending it on more RAM rather than a hotter CPU. Similarly, the GPU can be even more important than the CPU if you plan to edit multiple streams of media in Adobe Premiere Pro, use ray-traced 3D rendering in After Effects, or are a colorist interested in SpeedGrade.

And as we mentioned in the introduction, there are many things you can do as a user to optimize your software, operating system, and—perhaps most importantly—how you use them. A good starting point is the Adobe video team's blog, as well as the online Help files for each Adobe program.

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1. Thunderbolt cable and Thunderbolt device (sold separately) must be compatible with Windows. To determine whether your device is Thunderbolt certified for Windows, see thunderbolttechnology.net/products.
2. The hyper-threading feature is designed to improve performance of multi-threaded software products; please contact your software provider to determine software compatibility. Not all customers or software applications will benefit from the use of hyper-threading. Go to intel.com/info/hyperthreading/ for more information including which processors support HT Technology.
3. 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. 64-bit computing or Intel® architecture requires a computer system with a processor, chipset, BIOS, operating system, device drivers, and applications enabled for Intel® 64 architecture. Processors will not operate (including 32-bit operation) without an Intel® 64 architecture-enabled BIOS. Performance will vary depending on your hardware and software configurations. Intel's numbering is not a measurement of higher performance.
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