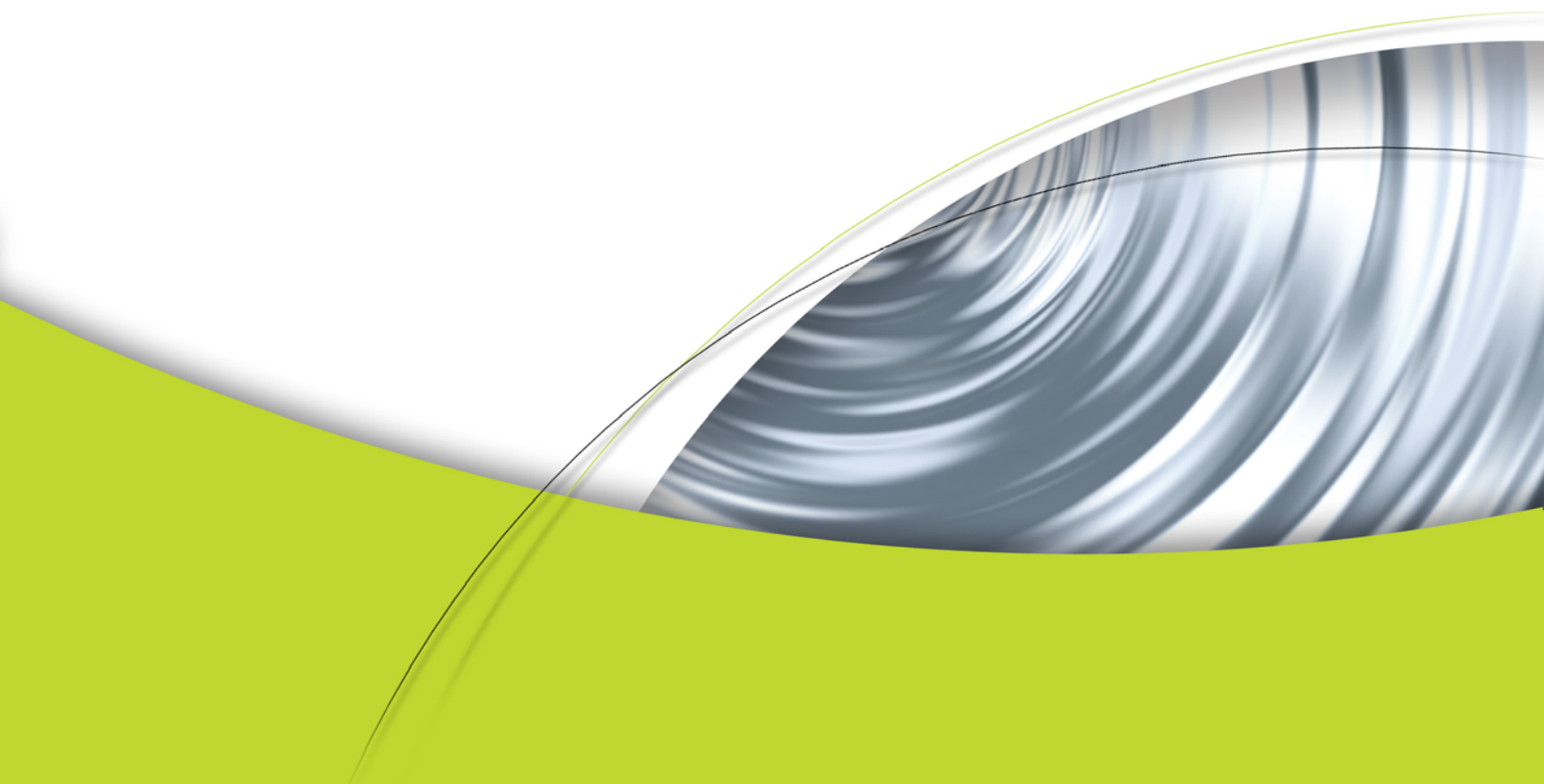




# Technical Brief

**NVIDIA GeForce FX GPUs**  
Cinematic Computing for Every User



# Cinematic Computing for Every User

The NVIDIA® GeForce™ FX GPUs are a top-to-bottom family of cinematic computing solutions for desktop PCs. Delivering insane speeds, ultra-high resolutions, and unmatched visual quality, the GeForce FX GPUs enable a new generation of cinematic gaming effects and are the development platform of choice for developers trying to achieve stunning visualizations and immersive user experiences through their applications. Leveraging the rock-solid, feature-rich NVIDIA® ForceWare™ unified software environment (USE), the GeForce FX GPUs deliver the compatibility and reliability users expect from NVIDIA. In addition, GeForce FX allows developers to create spectacular content quickly and efficiently using only one driver designed for all NVIDIA GPUs. All GeForce FX GPUs offer innovations that affect the entire desktop experience, including:

- ❑ ***Uncompromising 3D graphics power:*** a wide path to memory for increased throughput, and NVIDIA antialiasing technology for industry-leading performance.
- ❑ ***Engineering excellence:*** quality and stability of design from the best available process and design techniques.
- ❑ ***A graphics engine that enables the art and science of visual effects:*** the most stunning gaming effects, rendered in real-time by the NVIDIA CineFX™ engine with full compatibility for the OpenGL® API, and Microsoft® DirectX® 9.0 pixel shader 2.0+ and vertex shader 2.0+ programmable shading specifications.
- ❑ ***The gold standard for compatibility and software excellence:*** software drivers so good that gaming enthusiasts refer to them as “the gold standard,” and hardware that runs all applications with rock-solid compatibility, reliability, and blazing performance.

This technical brief reviews the main innovations that contribute to the elegant power of the GeForce FX family of GPUs. The innovations introduced with the newest members of the family—the GeForce FX 5900 models (5950 Ultra, 5900 Ultra, and 5900), and the GeForce FX 5700 models (5700 Ultra and 5700)—are summarized, and a table compares this latest platform to the other GeForce FX solutions. For detailed overviews of the technical aspects of the new architecture, visit and review the technical briefs at [www.nvidia.com](http://www.nvidia.com)



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Figure 1. The NVIDIA GeForce FX GPUs push visual effects to new levels, as illustrated in the NVIDIA technology demo, *Time Machine*.

## Raw Power

The GeForce FX GPUs power today's games at lightning-fast speeds and high resolutions, while providing a graphics platform primed for the games of tomorrow. Key features that contribute to this performance include:

- ❑ ***Up to 8 pixels per clock cycle.*** The high graphics bandwidth facilitates the application of complex textures, lighting, and other effects to an entire scene, without limiting cinematic realism to a portion of the screen or to just the main characters. Games and other desktop applications take on a film-like appearance, in real time.
- ❑ ***Unmatched visual quality.*** The GeForce FX 5900 and GeForce FX 5700 models include both z and color compression, which pay huge performance dividends and allow users to run applications at higher resolutions with antialiasing

turned on. These GPUs also include advances in NVIDIA® Intellisample™ technology's compression and antialiasing techniques that ensure realistic color and smooth edges at resolutions up to 1600 × 1200, with a minimal loss in performance. Users will experience the most fluid frame rates possible for a truly realistic experience.

- ❑ **AGP 8X bus implementation.** The newest specification of the AGP bus doubles the theoretical bandwidth between the graphics engine and the rest of the system, accelerating transfers to main memory and minimizing the overhead associated with storing and retrieving textures using main memory.
- ❑ **The power of 256 bits.** The GeForce FX 5900 GPUs include next-generation NVIDIA memory controller technology for increased efficiency and throughput. Supported graphics memory up to 256 MB allows more complex textures and data to be loaded on-board for faster access.

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## A Passion for Excellence

Quality and stability of design—hallmarks of NVIDIA solutions—can only be achieved by incorporating the best available process and design techniques. The GeForce FX GPUs:

- ❑ Apply the latest and most sophisticated 0.13 micron semiconductor fabrication process to deliver the industry's fastest clock rates. High clock rates mean higher frame rates.
- ❑ Implement true 128-bit studio-precision computations throughout the entire graphics pipeline for uncompromised precision levels without visual artifacts.
- ❑ Incorporate a seamless design and the most complete support of high-level shader languages (HLSLs), including Cg and Microsoft® HLSL. HLSLs make it easier for artists and developers to create stunning content and exploit the potential of the GeForce FX GPUs' capabilities.

This commitment to engineering excellence has made the GeForce FX GPUs the best development platform and the best playback platform for next-generation cinematic-quality games.



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Figure 2. A graphics card with the new NVIDIA GeForce FX 5950 Ultra GPU.

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## Cinematic Effects Beyond Imagination

The CineFX engine allows artists and designers to easily convert their artistic visions into digital content by using specialized graphics programs called shaders. By simplifying the creation of shaders and building in support for shader execution at the hardware level, the GeForce FX GPUs inspire a new generation of special effects programming (see Figure 3). The NVIDIA GPUs also offer programmers the power of the Cg high-level graphics programming language, and the choice of programming environments. These new GPUs offer the most complete hardware implementation for both the OpenGL and Microsoft DirectX APIs. For more information on the Cg language and the DirectX API, refer to [developer.nvidia.com](http://developer.nvidia.com).

All of the programming advancements are complemented with significantly raised levels of precision. The innovative graphics pipeline of the CineFX engine has the ability to deliver true 128-bit color, or 32-bit components for red, green, blue, and alpha values. With 128-bit color, literally millions of choices exist for each color component, compared to only a couple of hundred with 32-bit color. Major motion picture studios apply 128-bit precision to create rich, realistic computer-generated scenes. By matching these film industry levels of precision, the GeForce FX GPUs



enable high-quality images with spectacular cinematic effects—without any artifacts or compromises in quality—and the real-time application of those effects throughout the entire scene.



Figure 3. NVIDIA GeForce FX GPUs enable cinematic-quality real-time rendering, as illustrated in the NVIDIA technology demo, *Vulcan*.

## Vertex and Pixel Shaders

Powered by the CineFX engine, the GeForce FX GPUs shift the focus from simple pixel fill rate to sophisticated pixel shading. Shader programming has been advanced with several new capabilities, and the hardware builds in many features to accelerate both pixel and vertex shader execution, and complex lighting and shadow calculations. Many programming barriers previously associated with shaders have been eliminated; the GeForce FX GPUs support long programs for even the most elaborate effects, and advanced programming techniques such as conditional branching and looping for better program flow. The second-generation CineFX 2.0 engine further advances pixel shaders with double the performance compared to the previous generation.

CineFX 2.0 also supports the new NVIDIA® UltraShadow™ technology for hardware accelerated shadow calculations. UltraShadow uses rectangular volume approximations, allowing programmers to limit intensive light source and object

interaction computations to the portion of the scene that will be most effected by each source. This hardware-assisted technique eliminates unnecessary programming passes, speeding up execution and making it practical to implement advanced effects such as soft shadows.

## Advanced Shader Support

The CineFX engine implements complete versions of both OpenGL 1.5 and DirectX 9.0 specifications. These APIs give programmers access to many new programming tools that speed development.

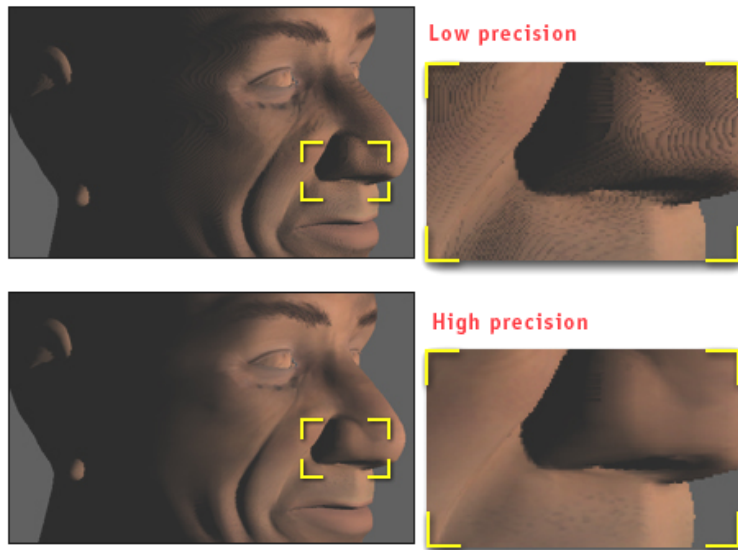
The DirectX 9.0 specification includes three major new features:

- ❑ ***Pixel shader 2.0+.*** DirectX 9.0 exposes true programmability of the pixel-shading engine. This makes procedural shading on a GPU possible for the first time.
- ❑ ***Vertex shader 2.0+.*** DirectX 9.0 dramatically enhances the power of the previous DirectX vertex shader by increasing the length and flexibility of vertex programs.
- ❑ ***High-precision, floating-point color.*** DirectX 9.0 breaks the mathematical precision barrier that has limited PC graphics in the past. Precision, and therefore visual quality, is increased with 128-bit floating-point color per pixel.
- ❑ ***Advanced shader operations in OpenGL through extensions:*** OpenGL uses extensions to enable the use of vertex and pixel shaders in its API. Those extensions are seamlessly integrated into NVIDIA ForceWare graphics drivers.

With Cg and the GeForce FX GPUs, developers have the ability to take full advantage of the API to develop stunning visual effects.

## Studio-Quality Precision Color

The inherent 16-bit and 32-bit floating-point formats of the CineFX engine give developers the flexibility to create the highest-quality graphics. The 32-bit format offers the ultimate image quality, bringing full 128-bit precision processing to the entire graphics pipeline and delivering true 128-bit color in pixel shaders. The 16-bit format provides an optimal balance of image quality and performance. In fact, this format exactly matches the format and precision level used by the leading studios to produce today's feature films and special effects. Developers are free to move back and forth between these formats within a single shader program, using the format that is best suited to each particular computation. (See Figure 4.)



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Figure 4. These images contrast high-precision graphics and the low-resolution results with low precision. The insets zoom in on the quality difference.

## New Generation of Gaming Effects

The GeForce FX 5900 and GeForce FX 5700 GPUs continue the NVIDIA tradition of pushing gaming experiences to the limit. These GPUs introduce innovations that deliver blistering performance and ultimate visual quality to emerging games such as *Doom III* (id Software). Table 1 compares the new GPUs with other NVIDIA GeForce FX solutions. The key features of the GeForce FX 5900 and GeForce FX 5700 GPUs include:

- ❑ **Power of 256 bits:** The GeForce FX 5900 GPUs include the CineFX 2.0 engine with a 256-bit path to memory and support for up to 256 MB of on-board memory for more efficiency and higher throughput.
- ❑ **Advanced pixel shaders:** These innovations—features of the GeForce FX 5900 and GeForce FX 5700 GPUs—double the pixel processing power compared to the previous generation, and result in twice the performance for DirectX 9.0 applications.



- ❑ **Enhanced antialiasing:** With the new Intellisample HCT technology, the GeForce FX 5900 and GeForce FX 5700 GPUs deliver z and color compression, and accelerated texture compression capabilities. The new compression technology improves antialiasing performance and advances image quality even for extreme resolutions such as  $1600 \times 1200$ . New anisotropic filtering techniques offer accurate texture filtering even for surfaces viewed from a sharp angle or from a distance.
- ❑ **UltraShadow technology:** Hardware-assisted depths bound checks allow programmers to greatly simplify the calculations required for accurate shadow generation, making it possible to generate complex, realistic scenes in real time.

Table 1. GeForce FX Family Comparison

	5900 Models	5700 Models	5200 Models
Process	0.13	0.13	0.15 Enhanced
AGP	8X	8X	8X
DirectX Version	9+	9+	9+
Memory Width	256-bits	128-bits	128-bits
Max Memory	256MB	256MB	256MB
Vertex Shader Version	2.0+	2.0+	2.0+
Pixel Shader Version	2.0+	2.0+	2.0+
Pixels per Clock	8 (peak)	4	4
RAMDAC Speed	400 MHz	400 MHz	350 MHz
Graphics Engine	CineFX 2.0	CineFX 2.0	CineFX
Antialiasing Technology	Intellisample HCT	Intellisample HCT	Accuvision
Textures per Rendering Pass	16	16	16
Crossbar Memory Architecture	Yes	Yes	Yes
Z-Compression	Yes	Yes	No
Color Compression	Yes	Yes	No
Texture Compression	Yes	Yes	No
Z Culling	Yes	Yes	Yes
Fast Z Clears	Yes	Yes	Yes
UltraShadow Technology	Yes	Yes	No

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## ForceWare: Unleash the Experience

The GeForce FX GPUs leverage the NVIDIA ForceWare software solution to unleash the full potential of your PC graphics experience. Built on the foundation of the NVIDIA Unified Driver Architecture (UDA), ForceWare's simple software installations and upgrades consistently deliver compatibility with future software applications and APIs for long-term reliability and stability. An industry-leading software feature set, ForceWare delivers advanced technologies, including:

- **NVIDIA® nView™ multi-display technology.** A versatile solution for multi-monitor support, increasing screen real estate for more efficient viewing and switching between multiple active windows.
- **NVIDIA® Digital Vibrance Control™ (DVC) technology.** Increased levels of adjustment for conveniently achieving richer colors and brighter, cleaner, more ergonomically pleasing images and text under any lighting conditions.


Delivering the most complete software feature set, a rock-solid driver architecture, and continual performance and feature updates over the life of the product, ForceWare unleashes the full graphics potential of your GPU.

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## Conclusion

The top-to-bottom family of GeForce FX GPUs raises the bar by uniquely delivering blazing performance, applying elegant engineering, and enabling unmatched cinematic effects on the desktop. From the business user to the casual home PC user to the extreme gamer, the GeForce FX GPUs raise the quality of the digital experience for all users on all applications.

The GeForce FX GPUs represent the dawn of cinematic computing that will ignite the gaming industry. These new GPUs take their place as the development platform of choice for game developers, and also deliver a seamless gaming experience from start to finish. The GeForce FX GPUs will inspire new levels of creativity from developers, and give users exactly what they want—games and other interactive applications that look more like the images, special effects, and animation they see in the film world.



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