### Revision History

<table>
<thead>
<tr>
<th>Date</th>
<th>Revision</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>February 2014</td>
<td>3.01</td>
<td>Second Public Release</td>
</tr>
<tr>
<td>November 2013</td>
<td>3.00</td>
<td>First Public Release</td>
</tr>
</tbody>
</table>
1 Family 16h Models 00h-0Fh AMD Sempron™ Desktop Processor Features

1.1 Family 16h Models 00h-0Fh AMD Sempron™ Desktop Processor Features

This section lists the features and design capabilities of the Family 16h Models 00h-0Fh AMD Sempron™ Desktop Processor accelerated processor.

- **Compatible with Existing 32-Bit x86 and 64-bit AMD64 Code Base**
  - Including support for SSE, SSE2, SSE3, SSE4a, SSE4.1, SSE4.2, SSSE3, ABM, AVX, AES, BMI, XSAVE/XRSTOR, XGETBV/XSETBV, PCLMULQDQ, MOVBE, POPCNT, F16C, MMX™, and legacy x86 instructions
  - Runs existing operating systems and drivers
  - Local APIC on the chip
  - Light Weight Profiling (LWP) support

- **AMD64 Technology**
  - AMD64 technology instruction-set extensions
  - 64-bit integer registers, 48-bit virtual addresses, and 40-bit physical addresses
  - Sixteen 64-bit integer registers
  - Sixteen 128-bit SSE/SSE2/SSE3/SSE4a registers

- **Family 16h Architecture**
  - Dual-core and quad-core options
  - Shared L2 cache architecture storage in addition to exclusive L1 cache

- **Cache Structures**
  - **32-Kbyte 8-Way Associative, Write-back ECC-Protected L1 Data Cache per Core**
    - Two 64-bit operations per cycle, 3-cycle latency
  - **32-Kbyte 2-Way Associative Parity-Protected L1 Instruction Cache per Core**
    - With advanced branch prediction
  - **2048^1^ -Kbyte Maximum 16-Way Associative ECC-Protected L2 Cache Shared between Four Cores**
    - 2048 Kbytes of L2 cache are available on quad-core options, and 1024 Kbytes of L2 cache are available on dual-core options.

- **Floating-Point Unit**
  - Dedicated 128-bit floating-point unit (FPU)

- **Management and Virtualization Features**
  - AMD Virtualization™ technology
    - SVM pause count capability
    - SVM disable and lock
    - Rapid virtualization indexing (nested paging)
    - Improved world-switch speed
• **Power Management**
  - Multiple low-power states
  - AMD PowerNow™ power technology
  - System Management Mode (SMM)
  - ACPI-compliant, including support for processor performance states (P-states)
  - Supports processor power states C0, C1, CC6, and PC6
  - Supports sleep states including S0, S3, S4, and S5
  - PCIe® power gating
  - PCIe speed power policy
  - System Clock Deep Sleep

• **Electrical Interfaces**
  - DDR3 SDRAM: Compliant with JEDEC DDR3 1.5V, DDR3L 1.35V, and DDR3U 1.25V SDRAM specifications
  - Refer to the *Electrical Data Sheet (EDS) for AMD Family 16h Models 00h-0Fh Processors*, order# 51492, for electrical details of AMD Family 16h (Models 00h-0Fh) processors.

• **Thermal Controls**
  - Sideband temperature control (SB-TSI)
  - Hardware thermal control (HTC)
  - Local hardware thermal control (LHTC)
  - DRAM thermal protection
  - Fan Control

• **PCIe® Technology**
  - PCIe Gen 1.0 and PCIe Gen 2.0 technology supported:
    - Four configurable x1 General Purpose Ports (GPP)
    - One configurable x4 GFX port

• **Integrated Memory Controller**
  - AMD Memory Controller PowerCap
  - Low-latency, high-bandwidth
  - DRAM Prefetcher:
    - Adaptive prefetching support
    - 32-entry DRAM prefetch table
    - Differentiation between core prefetch requests and core demand requests

• **FS1b package**
  - 64-bit DDR3 SDRAM controller operating at frequencies up to 1600 MT/s (800 MHz)
  - DDR3 1.5V up to 1600 MT/s, DDR3L 1.35V up to 1600 MT/s, DDR3U 1.25V up to 1333 MT/s
  - Supports up to two dual-rank SODIMMs or unbuffered DIMMs
  - Supports ECC
• Integrated Controller Hub
  • Supports
    • Universal Serial Bus (USB) versions 1.1, 2.0, and 3.0
    • Serial ATA revision 3.0
    • Secure Digital (SD)
    • System Management Bus (SMBus)
    • Low Pin Count (LPC) bus
    • High Definition (HD) audio
    • Serial IRQ
    • Serial Peripheral Interface (SPI)
    • Advanced Configuration and Power Interface (ACPI)
  • Functions
    • Real-Time Clock (RTC)
    • Programmable Interrupt Controller (PIC)
    • System Management Interrupt (SMI)
    • General-Purpose I/O (GPIO)
    • Power Management
    • Watchdog Timer (WDT)
    • Integrated Clock Generator

• Available Packages
  • Compliant with RoHS (EU Directive 2002/95/EC), with lead used only in small amounts in specifically
    exempted applications
  • FS1b package
    • Refer to the Socket FS1b Functional Processor Data Sheet, order# 52170, for functional and mechanical
      details of the FS1b package processor
    • 721 pins uPGA Lidded
    • Pin Pitch : 1.2192 mm
    • 35 mm x 35 mm
1.2 Family 16h Models 00h-0Fh AMD Sempron™ Desktop Processor Graphics Features

This section lists the graphics features available for the Family 16h Models 00h-0Fh AMD Sempron™ Desktop Processor accelerated processor when the internal GPU is enabled.

• **Graphics**
  - Discrete-level graphics processor embedded alongside the x86 CPU complex
  - Dedicated graphics memory controller
  - Refer to AMD Family 16h Models 00h - 0Fh Processor Power and Thermal Data Sheet, order# 51522, for graphics engine clock speeds.

• **Power Management**
  - GPU power gating
  - UVD power gating
  - VCE power gating
  - GFX power gating
  - DCE power gating
  - SCLK, LCLK, DCLK and VCLK scaling
  - Graphics Memory Controller (GMC) power gating
  - AMD PowerPlay™ power management technology
  - Dynamic refresh rate
  - Frame Buffer Compression

• **2D Acceleration Features**
  - Highly-optimized 128-bit engine, capable of processing multiple pixels per clock
  - Game acceleration including support for Microsoft® DirectDraw: Double Buffering, Virtual Sprites, Transparent Blit, and Masked Blit
  - Acceleration in 1/8/15/16/32-bpp modes:
    • Pseudocolor mode for 8 bpp
    • ARGB1555 and RGB565 modes for 16 bpp
    • ARGB8888 mode for 32 bpp
  - Support for GDI extensions:
    • In Windows® 7 and Windows 8: Alpha BLT, Transparent BLT, Color Fill BLT, and Stretch BLT
  - Hardware cursor (up to 128 pixels x 128 lines x 32 bpp), with alpha channel for direct support of Windows 7 and Windows 8 alpha cursor

• **3D Acceleration Features**
  - DirectX® 11.2 compliant, including full speed 32-bit floating point per component operations:
    • Shader Model 5 geometry and pixel support in a unified shader architecture
      - Graphics Core Next (GCN) architecture
      - Advanced shader instructions, including flexible flow control with CPU-level flexibility on branching
      - Read/Write caching system, replacing texture cache with a unified read-write two-level cache
      - Vertex, pixel, geometry, compute, domain, and hull shaders
      - 32-bit and 64-bit floating point processing per component
      - High performance dynamic branching and flow control
      - Shader instruction store, using an advanced caching system
      - Advanced shader design, with ultra-threading sequencer for high efficiency operations
      - Advanced, high performance branching support, including static and dynamic branching
      - High dynamic range rendering with floating point blending, texture filtering, and anti-aliasing support
      - 16-bit and 32-bit floating point components for high dynamic range computations
      - Full anti-aliasing on render surfaces up to and including 128-bit floating point formats
  - Support for OpenCL™ 1.2, DirectCompute 11 and Microsoft C++ AMP
• Support for OpenGL 4.1/4.1+
• Partially Resident Texture (PRT) support
• Anti-Aliasing Filtering:\(^2\)
  \(^2\) Support for anti-aliasing filtering is dependent on application.
  • 2x/4x/8x MSAA (multi-sample anti-aliasing) modes are supported
  • Multi-sample algorithm with gamma correction, programmable sample patterns, and centroid sampling
  • Custom filter anti-aliasing with up to 12-samples per pixel
  • Adaptive anti-aliasing mode
  • Lossless color compression (up to 16:1)
• Anisotropic Filtering:\(^3\)
  \(^3\) Support for anisotropic filtering is dependent on application.
  • Up to 128-tap texture filtering
  • Anisotropic biasing to allow trading quality for performance
  • Improved anisotropic filtering with unified non-power of two-tap distribution and higher precision filter computations
  • Advanced texture compression (3Dc+)
  • High quality 4:1 compression for normal maps and luminance maps
  • Angle-invariant algorithm for improved quality
  • Single-channel or two-channel data format
• 3D resources virtualized to a 40-bit addressing space, for support of large numbers of render targets and textures
• Support for up to 16k x 16k textures, including 128-bit/pixel textures
• Software-upgradeable, programmable arbitration logic maximizing memory efficiency
• Fully associative texture, color, and Z cache design
• Hierarchical Z and stencil buffers with early Z Test
• Lossless Z-buffer compression for both Z and stencil
• Fast Z-buffer clear
• Fast color-buffer clear
• Z cache optimized for real-time shadow rendering
• Z and color compression resources virtualized to a 32-bit addressing space, for simultaneous support of multiple render targets and textures

**Motion Video Acceleration Features**

• Supports DVD, Blu-ray, and SDTV/HDTV content playback with low CPU usage
• Supports stereoscopic 3D Blu-ray
• Video compression engine:
  • Dedicated hardware (VCE 2.0) assisted encoding of HD video streams to H.264 (main profile)
  • Support H.264 SVC temporal scalability
  • Real-time transcoding by encoding the output from UVD with reduction of CPU utilization and power consumption
• Motion video decode acceleration technology:
  • Dedicated hardware (UVD) for H.264, MPEG4, VC-1, MVC, and MPEG2 decode:
    • H.264 implementation based on the ISO/IEC 14496-10 specification
    • MPEG\(^4\) implementation based on the ISO/IEC 14496-2 specification
      \(^4\) Sprite, global motion compensation, and reversible variable length coding are not supported.
    • VC-1 implementation based on the SMPTE 421M specification
    • MPEG2 implementation based on the ISO 13818-2 specification
    • Multi View Coding (MVC) for Blu-ray 3D content
    • WMV-9 implementation
  • Real time high-definition and standard definition stream decode
  • Real time dual high-definition stream decode
• Microsoft DirectX video acceleration (DXVA) API (application programming interface) for Windows operating system

• **Motion Video Process Acceleration:**
  • Video scaling and YCrCb to RGB color space conversion for video playback and fully adjustable color controls
  • Motion adaptive and vector based de-interlacing filter eliminates video artifacts caused by displaying interlaced video on non-interlaced displays, and by analyzing image and using optimal de-interlacing functions on a per-pixel basis
  • HD HQV and SD HQV support: noise removal, detail enhancement, color enhancement, cadence detection, dynamic contrast, flesh tone correction, dynamic range, gamma, and advanced de-interlacing
  • Advanced up-conversion for SD to HD resolutions

• **Display Interfaces**
  5 Refer to Table 2 on page 12 for maximum resolution, color depth, and audio support per display interface.
  6 Two independent display controllers enabling dual displays in extended or clone modes
  7 HDCP (High-bandwidth Digital Content Protection) supported on HDMI™ (High-Definition Multimedia Interface), DVI (Digital Visual Interface), Miracast, and DisplayPort
  8 Refer to Table 1 on page 11 for HDMI feature table.
  • Supports DVI or HDMI, using TMDS data encoding
  • Supports industry-standard CEA-861-D/E video modes including 480p, 720p, 1080i, and 1080p
  • Supports single-link DVI with resolutions of up to 1920 x 1200 @ 60 Hz, 24 bpp, RB
  • Maximum pixel clock rate of 162 MHz for single-link DVI, and 297 MHz for HDMI
  • HDMI modes up to 1920 x 1080 @ 60 Hz and Deep Color as well as all HDMI 4k x 2K modes at 8 bpc
  • Dolby® Digital, Dolby Digital Plus, DTS Digital, DTS-HD High Res, Dolby TrueHD and DTS-HD Master Audio
  • Supports stereoscopic 3D frame transport, and stereoscopic 3D gaming, Blu-ray 3D, and stereoscopic 3D video decoding via HDMI
  9 Support is available through software, in full-screen and windowed mode.

• Integrated LVDS Interface
  • Integrated single-link 18-bit LVDS interface
  • 115 MHz pixel clock rate
  • FPDI-2 compliant
  • Programmable internal spread spectrum controller for the signals

• Miracast Wireless Display Features
  • One wireless display low latency wireless display output at up to 1920 x 1080
  10 1080 is available on selected models
  • Total display head limit remains two total with up to one being Miracast
  • Supports HDCP 2 protection for the wireless display output
  • Miracast compliant under Windows 8 when paired with specific Wi-Fi WLAN subsystems
  11 Contact AMD for current list of compatible Wi-Fi subsystems

• DisplayPort Features
  • Supports all mandatory features of the VESA DisplayPort Standard, Version 1.2, plus the following optional features:
    • Supports DP++
    • Supports Panel Self Refresh (PSR)

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**Family 16h Models 00h-0Fh AMD Sempron™ Desktop Processor Features**
Contact AMD for a current list of qualified PSR panels

- DisplayPort audio
  - Linear PCM, Dolby Digital (AC-3), Dolby TrueHD, DTS, and DTS-HD Master Audio
  - LPCM at sample rates: 32 kHz, 44.1 kHz, 48 kHz, 88.2 kHz, 96 kHz, 176.4 kHz, and 192 kHz, Bits per sample: 16, 20, and 24
  - Supports up to 8 channels
  - Supports 4, 2, or 1-lane transmission
  - Supports 5.4 Gbps, 2.7 Gbps, and 1.62 Gbps link bit rates
  - Supports 1 Mbps Auxiliary Channel (AUX CH)
  - Supports DisplayPort multi-streaming for up to two independent video and audio streams on one connector
  - Maximum link bit rate of 5.4 Gbps
  - Maximum resolution of 4096 x 2160 at 30 Hz and 24 bpp
  - Supports Embedded DisplayPort (eDP) features as described in the VESA eDP Standard, Version 1.3
  - Supports stereoscopic 3D frame transport, and stereoscopic 3D gaming, Blu-ray 3D, and stereoscopic 3D video decoding via eDP for 120-Hz sequential frame internal LCD panels

- VGA/DAC Interface
  - Integrated triple DACs with built-in reference circuit
  - RGB CRT output
  - Maximum pixel frequency of 210 MHz
  - Individual power-down feature for each of the three guns
  - Fully compliant with electrical specification of VSIS
  - Fully integrated with built-in bandgap reference circuitry
  - Integrated monitor detection circuit
### Table 1. HDMI™ Features

<table>
<thead>
<tr>
<th>HDMI™ Feature</th>
<th>Compatibility</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Link Capabilities</strong></td>
<td></td>
</tr>
<tr>
<td>Maximum Signal Bandwidth (MHz)</td>
<td>297</td>
</tr>
<tr>
<td>Maximum HDMI Data Bandwidth (Gbit/s)</td>
<td>8.91</td>
</tr>
<tr>
<td><strong>Video Capabilities</strong></td>
<td></td>
</tr>
<tr>
<td>Maximum 2D Resolution</td>
<td>1920 x 1080p at 60 Hz, 36 bpp&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>1920 x 1200p at 60 Hz, 24 bpp</td>
</tr>
<tr>
<td></td>
<td>3840 x 2160 at 30 Hz, 24 bpp</td>
</tr>
<tr>
<td></td>
<td>4096 x 2160 @ 24 Hz, 24 bpp</td>
</tr>
<tr>
<td>RGB</td>
<td>Yes</td>
</tr>
<tr>
<td>YCbCr 4:4:4</td>
<td>Yes</td>
</tr>
<tr>
<td>YCbCr 4:2:2</td>
<td>Yes</td>
</tr>
<tr>
<td>HDMI™ 1.3 xvYCC</td>
<td>Yes</td>
</tr>
<tr>
<td>HDMI 1.3 Deep Color</td>
<td>Yes</td>
</tr>
<tr>
<td>Underscan</td>
<td>Yes</td>
</tr>
<tr>
<td>Maximum 4:4:4 Color Depth (bits per component)</td>
<td>12&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Maximum 4:2:2 Color Depth (bits per component)</td>
<td>12&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

**PCM (Pulse-Code Modulation) Audio Capabilities**

| PCM Audio Bits per Sample                          | 24, 20, 16                                                                   |
| PCM Audio Maximum Channels                         | 8                                                                            |
| PCM Audio Maximum Bandwidth (Rate × Bits × Channels)| 36.864 Mbps                                                                 |

**Compressed-Audio Capabilities**

| Compressed-Audio Maximum Bandwidth                 | 24.576 Mbps                                                                 |

**Specific non-PCM Audio-Format Support**

| IEC 61937 Compressed-Format support. For example, 5.1-channel Dolby<sup>®</sup> DTS and 5.1-channel AC-3. | Yes                                                                           |
| Dolby-TrueHD Bitstream Capable                     | Yes                                                                           |
| DTS-HD Master-Audio Bitstream Capable              | Yes                                                                           |
| DVD-A (DST) Support                                | No                                                                           |
| SACD (DSD) Support                                 | No                                                                           |

**CEC (consumer electronic control) Capabilities**

| CEC                                                | No                                                                           |

**HDMI™ 3D Display Capabilities**

| Packed Frame Stereo 3D Video Formats<sup>3</sup>     | 1080p at 60 Hz, 1080p at 30 Hz, 1080p at 24 Hz, 720p at 60 Hz<sup>4</sup> |

**Notes:**
1. 36-bpp mode uses 30 bpp of meaningfully derived data.
2. 12-bit mode uses 10 bits of meaningfully derived data.
3. Some models do not support the highest resolutions.
4. Stereo 3D refresh rates are specified per eye.
Table 2 shows the maximum resolution for each output configuration.

Table 2. Display Interface Support

<table>
<thead>
<tr>
<th>Output Configuration</th>
<th>Maximum Resolution</th>
<th>Bit Depth</th>
<th>Audio</th>
</tr>
</thead>
<tbody>
<tr>
<td>eDP¹</td>
<td>2560 x 1600 at 60 Hz</td>
<td>18, 24, 30 bpp</td>
<td>Not Supported</td>
</tr>
<tr>
<td>DisplayPort</td>
<td>2560 x 1600 at 60 Hz 4096 x 2160 at 30 Hz</td>
<td>18, 24, 30 bpp</td>
<td>Supported²</td>
</tr>
<tr>
<td>Single-link DVI</td>
<td>1920 x 1200 at 60 Hz</td>
<td>24 bpp</td>
<td>Not Supported</td>
</tr>
<tr>
<td>Native HDMI™</td>
<td>1920 x 1080 at 60 Hz</td>
<td>24, 30, 36 bpp</td>
<td>Supported</td>
</tr>
<tr>
<td></td>
<td>1920 x 1200 at 60 Hz</td>
<td>24 bpp</td>
<td>Supported</td>
</tr>
<tr>
<td></td>
<td>3840 x 2160 at 30 Hz⁴</td>
<td>24 bpp</td>
<td>Supported</td>
</tr>
<tr>
<td></td>
<td>4096 x 2160 at 24 Hz⁴</td>
<td>24 bpp</td>
<td>Supported</td>
</tr>
<tr>
<td>Single link LVDS (DP0 only)</td>
<td>1600 x 900 at 60 Hz</td>
<td>18 bpp</td>
<td>Not Supported</td>
</tr>
<tr>
<td>LVDS via eDP translator</td>
<td>1920 x 1200 at 60 Hz</td>
<td>18, 24 bpp</td>
<td>Not Supported</td>
</tr>
<tr>
<td>VGA</td>
<td>2048 x 1536 at 60 Hz</td>
<td>30 bpp</td>
<td>Not Supported</td>
</tr>
</tbody>
</table>

**Notes:**
1. Internal LCD panel.
2. Audio support is available for DisplayPort.
3. Some models do not support the highest resolutions.
4. Video playback is not guaranteed in this mode.