



Family 16h Models 00h - 0Fh AMD Opteron™ Processor Product Data Sheet

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Revision History

Date	Revision	Description
February 2014	3.02	Third Public Release.
October 2013	3.01	Second Public Release. Updated Table 2 on page 12.
June 2013	3.00	First Public Release

1 Family 16h Models 00h-0Fh AMD Opteron™ Features

1.1 Family 16h Models 00h-0Fh AMD Opteron™ Features

This section lists the features and design capabilities of the Family 16h Models 00h - 0Fh AMD Opteron™ 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**
 - Quad-core
 - 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 -Kbyte Maximum 16-Way Associative ECC-Protected L2 Cache Shared between Four Cores**
- **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 AllDay™ 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
- Supports adaptive S4
- PCIe® power gating
- PCIe speed power policy

• 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
- FT3 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 DRAM down or single SODIMM plus DRAM down
 - 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
- FT3 package
 - Refer to the *AMD FT3 Functional Processor Data Sheet*, order# 51489, for functional and mechanical details of the FT3 package processor.
 - 769-ball, lidless micro BGA
 - Multi-pitch package with 0.65-mm minimum pitch
 - 24.5 mm x 24.5 mm
 - Organic C4 die attach

1.2 Family 16h Models 00h-0Fh AMD Opteron™ Graphics Features

This section lists the graphics features available for the Family 16h Models 00h-0Fh AMD Opteron™ 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
- Vari-Bright™ technology
- Dynamic refresh rate
- Frame Buffer Compression
- Panel Self-Refresh
- PowerTune

- **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:¹
 - ¹ 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:²
 - ² 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
 - MPEG³ implementation based on the ISO/IEC 14496-2 specification
 - ³ 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 Interfaces⁴**
 - ⁴ Refer to Table 2 on page 12 for maximum resolution, color depth, and audio support per display interface.
 - Two independent display controllers⁵ enabling dual displays in extended or clone modes
 - ⁵ See the "Display Interface Design Guidelines" chapter in the *FT3 Processor Motherboard Design Guide*, order# 51387 for simultaneous display combinations and display restrictions.
 - HDCP⁶ (High-bandwidth Digital Content Protection) supported on HDMI™ (High-Definition Multimedia Interface), DVI (Digital Visual Interface), Miracast, and DisplayPort
 - ⁶ HDCP content protection support is available only to HDCP licensees and can be enabled only when connected to an HDCP-capable receiver.
 - DVI/HDMI Features⁷
 - ⁷ 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 HDMI⁸
 - ⁸ 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 1080⁹
 - ⁹ 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 subsystems¹⁰
 - ¹⁰ 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)¹¹

- ¹¹ 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 v1r1
 - Fully integrated with built-in bandgap reference circuitry
 - Integrated monitor detection circuit

Table 1. HDMI™ Features

HDMI™ Feature	Compatibility
Link Capabilities	
Maximum Signal Bandwidth (MHz)	297
Maximum HDMI Data Bandwidth (Gbit/s)	8.91
Video Capabilities	
Maximum 2D Resolution ³	1920 x 1080p at 60 Hz, 36 bpp ¹ 1920 x 1200p at 60 Hz, 24 bpp 3840 x 2160 at 30 Hz, 24 bpp 4096 x 2160 @ 24 Hz, 24 bpp
RGB	Yes
YCbCr 4:4:4	Yes
YCbCr 4:2:2	Yes
HDMI™ 1.3 xvYCC	Yes
HDMI 1.3 Deep Color	Yes
Underscan	Yes
Maximum 4:4:4 Color Depth (bits per component)	12 ²
Maximum 4:2:2 Color Depth (bits per component)	12 ²
PCM (Pulse-Code Modulation) Audio Capabilities	
PCM Audio Rates Supported	192, 176.4, 96, 88.2, 48, 44.1, 32 KHz
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® 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 ³	1080p at 60 Hz, 1080p at 30 Hz, 1080p at 24 Hz, 720p at 60 Hz, 720p at 50 Hz ⁴

Notes:

- 36-bpp mode uses 30 bpp of meaningfully derived data.
- 12-bit mode uses 10 bits of meaningfully derived data.
- Some models do not support the highest resolutions.
- Stereo 3D refresh rates are specified per eye.

Table 2 shows the maximum resolution for each output configuration.

Table 2. Display Interface Support

Output Configuration	Maximum Resolution ³	Bit Depth	Audio
eDP ¹	2560 x 1600 at 60 Hz	18, 24, 30 bpp	Not Supported
DisplayPort	4096 x 2160 at 30 Hz ⁴ 2560 x 1600 at 60 Hz	18, 24, 30 bpp	Supported ²
Single-link DVI	1920 × 1200 at 60 Hz	24 bpp	Not Supported
Native HDMI™	4096 x 2160 at 24 Hz ⁴	24 bpp	Supported
	3840 x 2160 at 30 Hz ⁴	24 bpp	Supported
	1920 × 1080 at 60 Hz	24, 30, 36 bpp	Supported
	1920 × 1200 at 60 Hz	24 bpp	Supported
Single link LVDS (DP0 only)	1600 x 900 at 60 Hz	18 bpp	Not Supported
LVDS via eDP translator	1920 × 1200 at 60 Hz	18, 24 bpp	Not Supported
VGA	2048 x 1536 at 60 Hz	30 bpp	Not Supported

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.

For display interface mapping, see the "Display Interface Design Guidelines" chapter in the *FT3 Processor Motherboard Design Guide*, order# 51387.