Builder's Guide for AMD Athlon™ 64 Processor-Based Desktops and Workstations

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Trademarks

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Revision History

Date	Revision	Description
September 2004	3.00	Initial public release.

Chapter 1 AMD Athlon™ 64 Processor Key Architectural Features

The key architectural features of an AMD Athlon™ 64 processor-based system include AMD64 architecture, integrated DDR DRAM memory controller, HyperTransport™ technology, and many other features.

Figure 1 shows a block diagram of the AMD Athlon 64 processor architecture.

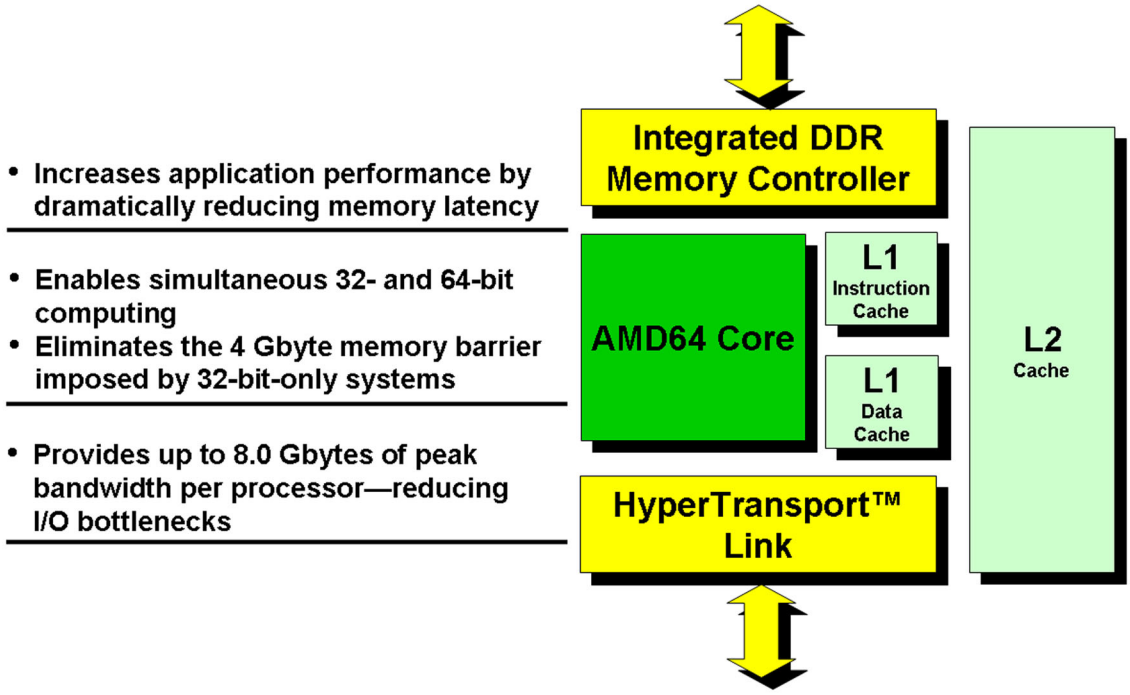


Figure 1. AMD Athlon™ 64 Processor Architecture

1.1 The AMD64 Architecture

AMD64 architecture allows end users to run existing, installed 32-bit applications and operating systems at peak performance, while providing a migration path that is 64-bit capable. It is designed to enable 64-bit computing while remaining compatible with the vast x86 software infrastructure. AMD64 architecture represents a new class of computing, enabling a single architecture across 32- and 64-bit environments.

1.2 Integrated DDR DRAM Memory Controller

The 64-/128-bit wide integrated DDR DRAM memory controller:

- changes the way the processor accesses main memory, resulting in increased bandwidth, reduced memory latencies, and increased processor performance.
- allows available memory bandwidth to scale with the number of processors and
  - can support up to eight registered DDR DIMMs with an AMD Athlon 64 FX processor.
  - can support up to four unbuffered DDR DIMMs with an AMD Athlon 64 939-pin processor.
- has available memory bandwidth of up to 6.4 Gbytes/s (with PC3200).

1.3 HyperTransport™ Technology

The HyperTransport technology of the AMD64 architecture offers the following features.

- A scalable bandwidth interconnection between I/O subsystems and other chipsets
- Up to 8.0 Gbytes/s bandwidth providing sufficient bandwidth for supporting new interconnects including PCI-X®, DDR, InfiniBand, and 10G Ethernet
- Low power consumption (1.2 W) to help reduce the system thermal budget

1.4 Other Features of the AMD Athlon™ 64 Processor

Other features of the AMD Athlon 64 processor include:

- 64-bit wide key data and address paths that incorporate a 48-bit virtual address space and a 40-bit physical address space.
- ECC (error correcting code) protection for L1 cache data, L2 cache data and tags, and DRAM with hardware scrubbing of all ECC-protected arrays.
- Support for all instructions necessary to be fully compatible with SSE2 technology.
- Two additional pipeline stages (compared to AMD's 32-bit architecture) for increased performance and frequency scalability.
- Higher IPC (instructions-per-clock) achieved through additional key features, such as larger TLBs (translation lookaside buffer), flush filters, and enhanced branch prediction algorithms.

Chapter 2 AMD Athlon™ 64 Processor-in-a-Box

The best solution for System Builders and Resellers manufacturing pedestal platforms is the processor-in-a-box (PIB) from AMD. The PIB is available now in a new retail box. The AMD PIB is covered by a three-year limited warranty.

Figure 2 shows the new AMD Athlon™ 64 processor PIB retail box.

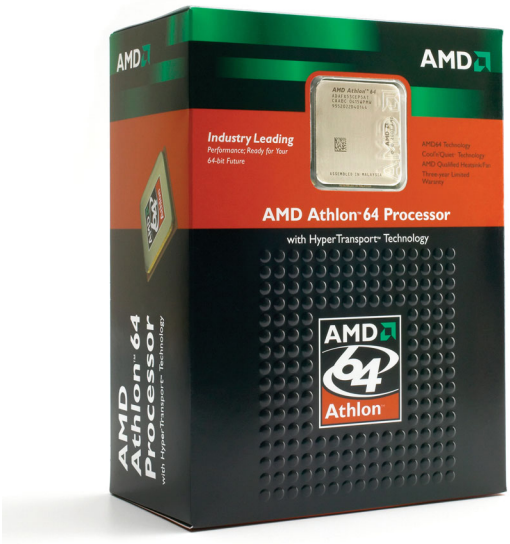


Figure 2. AMD Athlon™ 64 Processor-in-a-Box

Figure 3 shows the new AMD Athlon 64 FX processor PIB retail box.

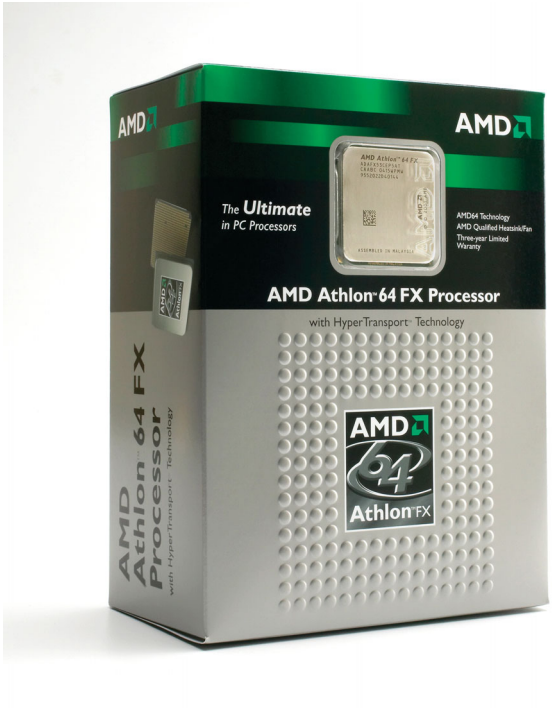


Figure 3. AMD Athlon™ 64 FX Processor-in-a-Box

The PIB includes the following items:

- The AMD64 processor of choice
- Heatsink and fan, properly sized for the thermal requirements of the processor
- Assembly and installation instructions
- AMD64 processor case sticker
- Double processor packaging allows higher impact resistance adding more protection
- A three-year limited warranty
- Certificate of Authenticity

Please check with your preferred distribution partner for AMD Athlon™ 64 processor-in-a-box.

Chapter 3 Heatsink Installation

This chapter contains instructions for the installation of the AMD Athlon™ 64 processor heatsink.

The AMD Athlon 64 processor heatsink requires the retention frame and the backplate to be attached to the motherboard. If the retention frame and backplate are already attached to the motherboard, proceed to step 10. Figure 4 shows the backplate and retention frame for the AMD Athlon 64 processor heatsink. The hardware shown in Figure 4 may not exactly match the one provided in a PIB.

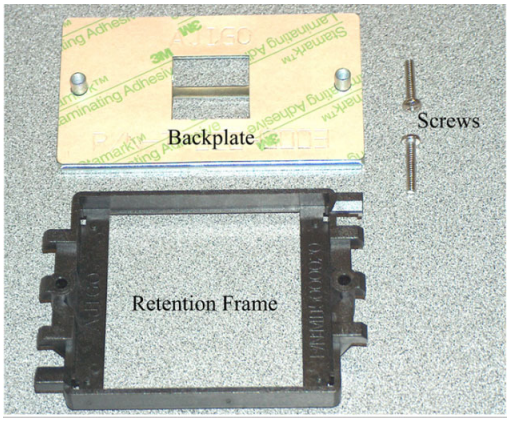


Figure 4. Retention Frame and Backplate for the AMD Athlon™ 64 Processor Heatsink

3.1 Heatsink Installation Procedure

Follow these instructions to install the AMD Athlon 64 processor heatsink.

CAUTION: *As with all computer equipment, the processor and motherboard components may be damaged by electrostatic discharge (ESD). Please take proper ESD precautions when handling any board or processor.*

Warning: *Do not apply voltage until the heatsink is fully installed. If voltage is applied before the heatsink is fully installed, the processor will overheat and failure will result. Read through the entire installation instructions completely to make sure you understand them before you begin.*

1. Place the backplate on a flat surface.

2. Peel the release liner off the backplate. (See Figure 5 on page 14.)

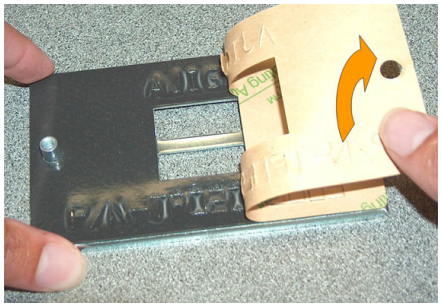


Figure 5. Backplate Release Liner

3. Gently lift the motherboard by the edges over the backplate.

4. Align the two threaded standoffs on the backplate with the two mounting holes near the socket on the motherboard. (See Figure 6.)

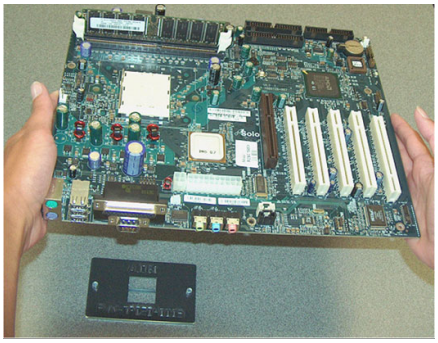


Figure 6. Motherboard Placed Over Backplate

5. Gently lower the motherboard until the standoffs fit through the holes near the socket and the backplate makes complete contact with the motherboard.

6. Press firmly on the processor socket to ensure proper contact between the backplate and motherboard. (See Figure 7 on page 15.)

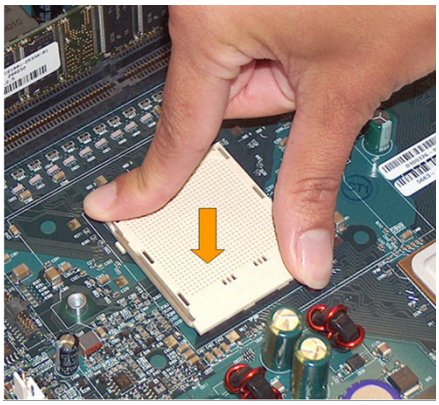


Figure 7. Ensure Proper Contact Between Backplate and Motherboard

Note: *The processor socket may be different from the socket pictured in Figure 7, depending on the version of the AMD Athlon 64 processor being used.*

7. Carefully place the retention frame on the motherboard.

8. The screw holes must align with the backplate standoffs. (See Figure 8.)

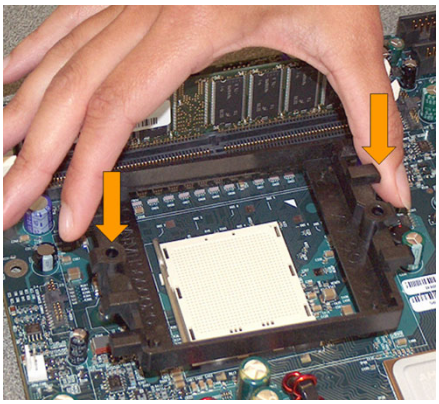


Figure 8. Retention Frame Screw Holes Aligned with Backplate Standoffs

9. Place the screws and tighten down the retention frame. (See Figure 9 on page 16.)
   - Ensure that the retention frame is flat with the motherboard.
   - Do not over-tighten the screws.

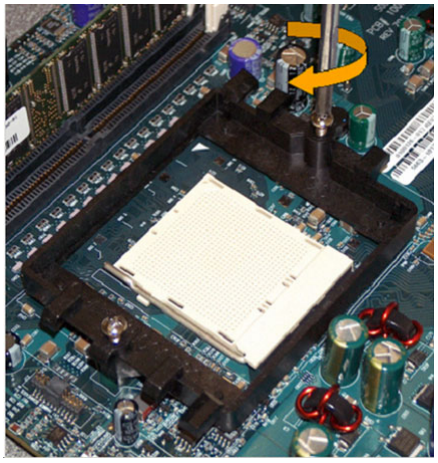


Figure 9. Tightening Down the Retention Frame

10. Lift the socket locking-lever. (Gently pull it away from the socket body, *and then* lift up.)

Warning: *Do not apply voltage until the heatsink is fully installed. If voltage is applied before the heatsink is fully installed, the processor will overheat and failure will result.*

11. Gently place the processor into the zero insertion force (ZIF) socket.

    The AMD Athlon 64 processor has a small triangle marking on one corner. (See Figure 10.) This triangle corresponds to the alignment marking on the motherboard. The corner with the triangle must be located at the corresponding corner marked on the motherboard.

    Be careful not to bend the processor pins.

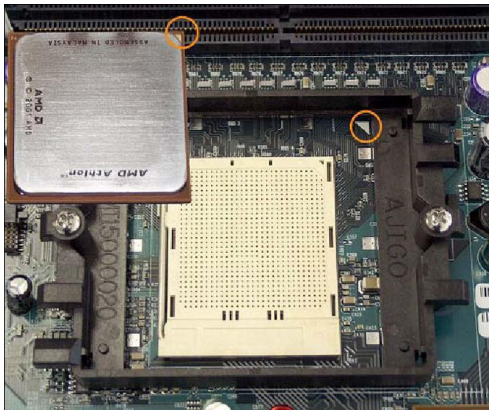


Figure 10. Alignment Markers on Processor and Motherboard

12. Push down gently on the processor while lowering the locking lever and latching it into the fully locked position. (See Figure 11 on page 17.)

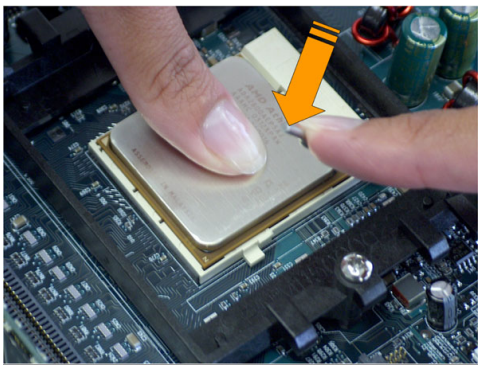


Figure 11. Pushing Gently Down on the Processor

13. Inspect the thermal interface material on the bottom of the heatsink for scratches or gaps.

    The heatsink has a thermal interface material pre-applied on the bottom. This material is protected by a plastic cover. (See Figure 12.)

    Do not use the thermal interface material if it has scratches or gaps. If replacement thermal interface material is needed, contact AMD technical support for assistance at *http://ask.amd.com* or (408) 749-3060. In EMEA, please contact AMD technical support for assistance at *http://www.amd.com/support*.

    If a heatsink is removed for any reason, clean the processor and heatsink surface and reapply an AMD-approved thermal interface material before reinstalling the processor.

14. Remove and discard the plastic cover.

    Be careful not to touch or scratch the thermal interface material.

Figure 12. Plastic Cover Over Thermal Interface Material

15. Center the heatsink over the processor. (See Figure 13 on page 18.)

    The mounting lug on the retention frame must match the heatsink clip.

    The heatsink must have full contact with the processor.

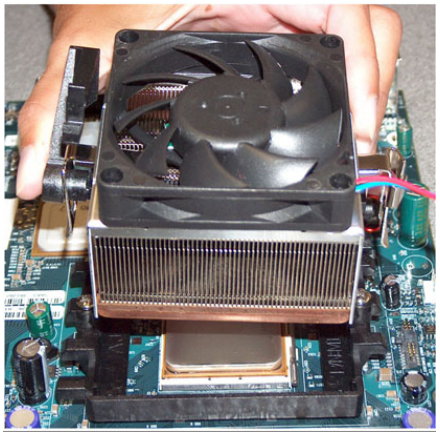


Figure 13. Heatsink Centered Over Processor

16. Hook the spring clip under the cam lever to the mounting lug on the retention frame.
    Some force may need to be applied.

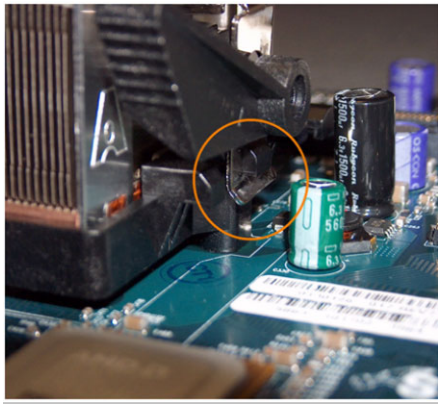


Figure 14. Heatsink Spring Clip

17. Ensure the spring clip is aligned with the plastic lug on the retention frame.

18. Carefully push straight down on the clip. (See Figure 15 on page 19.)
    This may take more force than the first side.

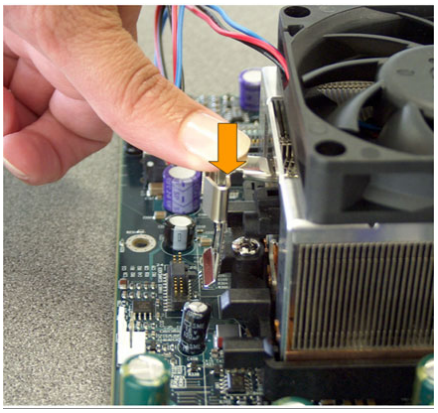


Figure 15. Pushing Straight Down on the Clip

The spring clip must be installed as shown in Figure 16.

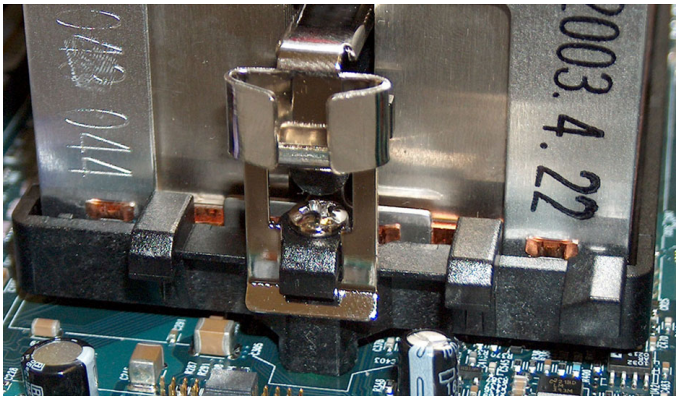


Figure 16. Correctly Installed Spring Clip

19. Carefully turn the cam lever to its installed position. (See Figure 17.)

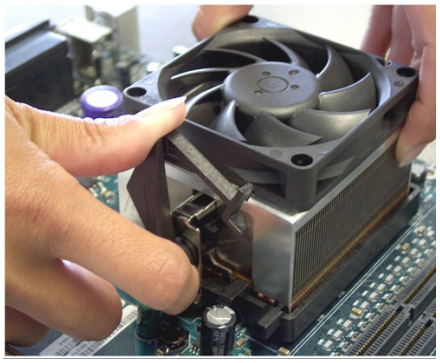


Figure 17. Turning the Cam Lever

20. Ensure the cam lever is fully rotated to the installed position. (See Figure 18.)

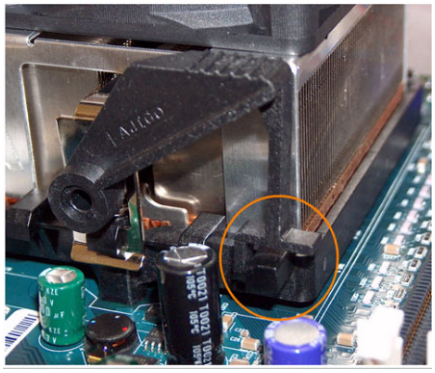


Figure 18. Cam Lever in Installed Position

21. Connect the fan power lead to the proper connector on the motherboard.
    Figure 19 shows an installed heatsink.

Figure 19. Installed Heatsink

22. Check the installation completely to make sure the heatsink is installed correctly before starting the system.

23. Power-on the system.

24. Verify immediately that the fan on the processor heatsink is turning at a rapid rate.
    If the fan is spinning at a slow rate or not spinning at all, power-down the system immediately to avoid any thermal damage.

Chapter 4 Hardware Considerations

AMD frequently updates its list of motherboard solutions. For the most up-to-date list of providers, please visit our Web site.

http://www2.amd.com/us-en/Processors/DevelopWithAMD/1,,30_2252_869_9460^9461,00.html?1081352043

In EMEA, for the most up-to-date list of providers, please visit our Web site.

http://www2.amd.com/gb-uk/Processors/ProductInformation/1,,30_118_3734_4348%5e7923,00.html?1083742689

Note: *If the links in this chapter produce an* Error 404 - Page Not Found *message, copy the link, paste it into the Address line of your browser, and connect to the Web site from your browser.*

4.1 System Enclosures and Chassis Selection

AMD Athlon™ 64 processor-based motherboards can leverage industry-standard tower or pedestal chassis. The selection of the proper system chassis is a critical element to the success of the finished system. For best results, a system builder should always contact the motherboard and chassis suppliers or vendors to verify that each of the chosen components supports the desired system configuration. The following data is a basic guideline that has been tested by the engineering staff at AMD.

Note: *This data is only a guideline and is not a substitute for a system builder verifying that a chassis meets industry and customer requirements, nor is it a substitute for the system builder conducting its own research, testing, and validation.*

4.1.1 Basic System Enclosure Selection Guidelines

The choice of the appropriate system enclosure depends on many factors as follows:

- It must be compatible with the chosen motherboard and power supply. Confirm the motherboard and power supply requirements with those suppliers.
- It must allow enough airflow through the system to adequately cool all the internal components, especially critical parts like the processor.
- It must have good fit and finish, e.g., no razor-sharp edges.

4.1.2 Basic Chassis Selection Guidelines

The following are some basic guidelines to aid in finding an enclosure with adequate cooling capability:

- Use 80 mm fans or larger.
- Choose a chassis with a fan in the back that is in addition to the processor fan.
- Cables inside the enclosure can cause airflow disruptions. Using cable ties, tie and route the cables out of the path of the cooling airflow.
- For tower chassis, choose a chassis with power supplies that have both ATX-style bottom air intake vents and front air intake vents.
- When the system is in a tower chassis, there must be clear space in front of the chassis to allow cool airflow in and space behind the chassis for the heated air to flow out.
- Rear fans should exhaust air in the same direction—out the back of the chassis.
- Front intake fans may not be of significant benefit to cooling a tower chassis, and should not be relied upon as the sole fan in a system.
- Testing done by the AMD thermal engineers has shown that the airflow pattern in Figure 20 is more desirable than the airflow pattern seen in Figure 21 on page 25.
- When the bottom inlet power supply is used, nearly all the air flows near or through the area of the processor. As a result, the processor remains cooler.

4.1.3 Power Supply Considerations

Because heatsinks are heat radiators, like the radiator in an automobile, they need airflow to function properly. Figure 20 on page 25 shows desirable airflow through a chassis. Desirable configurations use a bottom-inlet power supply.

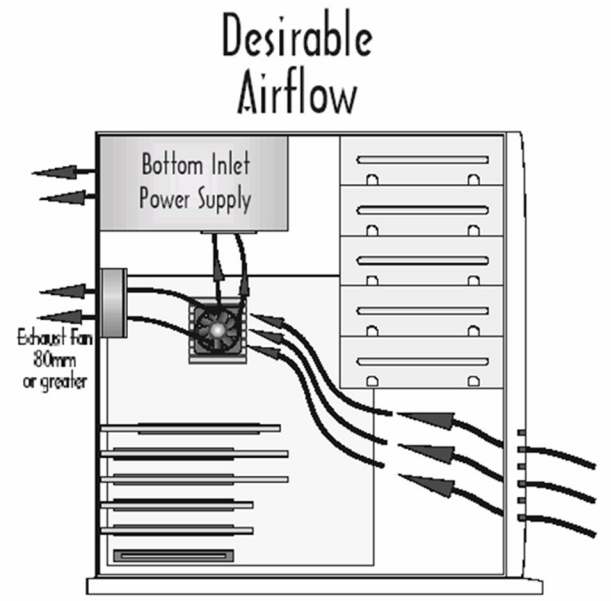


Figure 20. Desirable Airflow—Power Supply with Bottom Inlet

Figure 21 shows undesirable airflow through a chassis. Undesirable configurations use a front-inlet power supply.

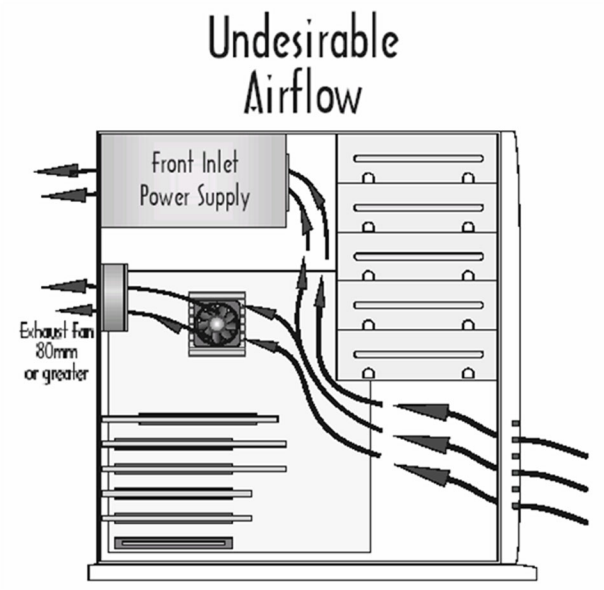


Figure 21. Undesirable Airflow—Power Supply with Front Inlet Only

4.2 Power Supply Guidelines

AMD Athlon 64 processor-based motherboards may be designed to leverage industry standard power supplies. The selection of the proper system-power supply is a critical element to the success of the finished system. For best results, a system builder should always contact the motherboard, power supply, and chassis suppliers or vendors to verify that each of the chosen components supports the desired system configuration, and a system builder should verify that support through internal testing and validation.

4.2.1 Desktop and Workstation Platform Power Supplies

Depending on the motherboard vendors' design requirements, a desktop or workstation platform can use either an ATX 12-V power supply, or an EPS12V. The motherboard design can use one or two power connectors. Usually a separate power connector is used to provide power for the I/O components. It is important that you confirm with the motherboard manufacturer the exact connector requirements.

Note: *It is imperative that system builders ensure that the power supply of choice and the selected chassis are mechanically compatible.*

In order to have a reliable and cost-effective system, system builders should calculate the power requirements for the intended configuration.

Note: *System builders should refer to the motherboard manual to check the type of power connector and type of power supply the motherboard uses. The motherboard, power supply, and case must be mechanically and electrically compatible.*

4.2.2 Calculating System Power Consumption

The total combined wattage for the system configuration must be less than the output of the power supply used. Overall current usage limitation on the power supply should not exceed a combined system power output for the +5-V and +3.3-V outputs.

Use the power worksheets given in Table 1 on page 27 and Table 2 on page 28 to calculate the system power consumption. For current and voltage requirements of add-in boards and peripherals, refer to your vendor's documents. The current draw on each voltage tap should be included with the documentation from the motherboard vendor.

In Power Worksheet 1—Component Power list the peak current for each board and device applicable in the appropriate voltage level column. Add the currents in each column, then go to Power Worksheet 2—Total Watts.

Table 1. Power Worksheet 1—Component Power

Device	Item Qty	Maximum Current at Each Voltage Level				
		+3.3 V	+5 V	+12 V	–12 V	5 VSB
Motherboard w/on-board devices						
System fan						
Processor fan						
Memory module						
AGP VGA card						
PCI modem card						
PCI sound card						
PCI NIC card						
PCI SCSI card						
Other PCI card/Bus card						
PCI RAID card						
IDE hard drive						
SCSI hard drive						
CD-ROM drive						
CD-RW drive						
DVD drive						
Floppy disk drive						
Tape drive						
ZIP drive						
USB devices						
IEEE 1394 devices						
Keyboard						
Mouse						
Other devices (if any)						
Processor						
Total current for all devices						

Use the following steps to determine the total combined power used by the system.

1. From Power Worksheet 1—Component Power, enter the total current for each column.
2. Multiply the voltage by the total current to get the total wattage for each voltage level.
3. Add the total wattage for each voltage level to arrive at a total combined power usage on the power supply.

Table 2. Power Worksheet 2—Total Watts

Voltage Level and Total Current (V x A = W)	Total Watts for Each Voltage Level
+3.3 V x (total amps)	Total Watts for +3.3 V
+5 V x (total amps)	Total Watts for +5 V
+12 V (I/O) x (total amps)	Total Watts for +12 V (I/O)
+12 V (processor) x (total amps)	Total Watts for +12 V (processor)
–12 V x (total amps)	Total Watts for –12 V
+5 VSB x (total amps)	Total Watts for 5 VSB
Total=	Total Combined Wattage=

Note: *To calculate the processor current at 12-V VRM source:*

$$I = \left(\frac{\text{processor core voltage} \times \text{processor core current}}{12} \right) \times 1.25$$

Where 12 = VRM source voltage and 1.25 is the reciprocal of the 80% voltage regulator efficiency.

4.3 AMD Athlon™ 64 Processor Thermal Solution Guidelines

This information is only a guideline for the systems being constructed and is not intended to be a substitute for system builder verification, validation, and testing on the reliability and effectiveness of a thermal solution.

For reliable operation of AMD Athlon 64 processor-based systems, the selection of the correct thermal solution is critical. For a list of heatsink suppliers that have developed products designed to support AMD Athlon 64 processors, please visit our Web site.

http://www2.amd.com/us-en/Processors/DevelopWithAMD/1,,30_2252_869_9460^10668,00.html?1081351292

In EMEA, for a list of heatsink suppliers that have developed products designed to support AMD Athlon 64 processors, please visit our Web site.

http://www2.amd.com/gb-uk/Processors/ProductInformation/1,,30_118_3734_4348%5e4356,00.html?1083742688

This selection of suppliers found at these Web sites is frequently updated and not intended to be a comprehensive listing of all heatsinks that support AMD Athlon 64 processors.

4.4 Memory Guidelines for AMD Athlon™ 64 Processor-Based Systems

AMD Athlon 64 processor-based platforms may be designed to leverage industry standard DDR registered DIMMs and unbuffered DIMMs, depending on processor type and motherboard design. An independent testing company, Computer Memory Test Labs (CMTL), has conducted memory compatibility testing. CMTL is an independent test facility and is able to test RAM modules from different module suppliers. System builders should access the CMTL web site at *http://www.cmtlabs.com* and view the recommended memory module list for the specific motherboard manufacturer and motherboard model.

Note: *The CMTL website is provided for informational purposes only, and AMD recommends that a system builder conduct its own testing and validation to confirm that the memory modules are suitable for its systems.*

Several AMD Athlon 64 processor-based motherboards currently support some of the following memory features:

- PC1600, PC2100, PC2700, and PC3200 registered and unbuffered memory modules
- 184-pin 2.5-V and 2.6-V DDR DIMMs
- 28-bit DDR memory bus
- 64-Mbyte, 128-Mbyte, 256-Mbyte, 512-Mbyte, 1-Gbyte, 2-Gbyte and 4-Gbyte memory technology
- Production DIMMs from industry standard DRAM memory manufacturers—The use of registered or unbuffered types of DIMMs should match the type for which the motherboard was designed.

Table 3 explains the differences between AMD Athlon 64 processor series and model numbers.

Table 3. AMD Athlon™ 64 Processor Series

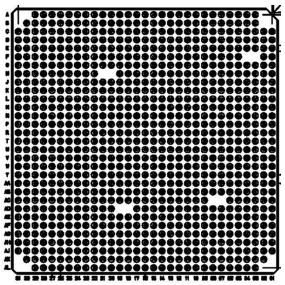
Series	AMD Athlon™ 64 FX (939-Pin or 940-Pin) Processor	AMD Athlon™ 64 (939-Pin) Processor	AMD Athlon™ 64 (754-Pin) Processor
	High-performance workstation and server applications	Performance desktop and workstation applications	Performance desktop and workstation applications
Performance	*http://www.amd.com/us-en/Processors/ProductInformation/0,,30_118_3734_3750,00.html*		
Frequency	A comprehensive list of available processors can be found on our Web site at *http://www.amd.com/us-en/Processors/ProductInformation/0,,30_118_9484,00.html*		
Integrated DDR memory controller	Yes	Yes	Yes

Table 3. AMD Athlon™ 64 Processor Series (Continued)

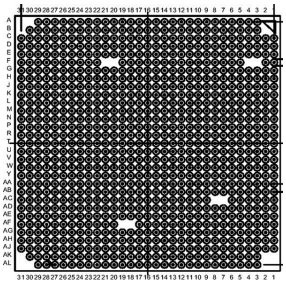
Series	AMD Athlon™ 64 FX (939-Pin or 940-Pin) Processor	AMD Athlon™ 64 (939-Pin) Processor	AMD Athlon™ 64 (754-Pin) Processor
Memory Type	Registered (940-pin) / Unbuffered (939-pin)	Unbuffered	Registered or unbuffered (not interchangeable, board designed for one or the other)
Memory Width	128-bit + ECC or 64-bit + ECC	128-bit + ECC or 64-bit + ECC	64-bit + ECC
DIMM Sizes	32 Mbytes – 4 Gbytes (940-pin) / 32 Mbytes – 1 Gbyte (939-pin)	32 Mbytes – 1 Gbyte	32 Mbytes – 1 Gbyte (unbuffered) 32 Mbytes – 4 Gbytes (registered)
DRAM Devices	4, 8, and 16 bits wide (940-pin) / 8 and 16 bits wide (939-pin)	8 and 16 bits wide	4, 8, and 16 bits wide
ECC DRAM protection	Yes	Yes	Yes
HyperTransport™ technology	Yes	Yes	Yes
HyperTransport™ link width	16 bits x 16 bits	16 bits x 16 bits	16 bits x 16 bits
HyperTransport™ bus frequency	800 MHz (940-pin) / 1.0 GHz (939-pin)	1.0 GHz	800 MHz
AMD64	Yes	Yes	Yes
HyperTransport™ bandwidth	6.4 Gbytes/s (940-pin) / 8 Gbytes/s (939-pin)	8 Gbytes/s	6.4 Gbytes/s
Simultaneous 32- and 64-bit computing	Yes	Yes	Yes
L1 Cache size (data/instruction)	64 Kbytes/64 Kbytes	64 Kbytes/64 Kbytes	64 Kbytes/64 Kbytes
L2 Cache size	1 Mbyte	512-Kbyte and 1-Mbyte options	256-Kbyte, 512-Kbyte, and 1-Mbyte options
Pipeline stages (integer/floating point)	12/17	12/17	12/17

Table 3. AMD Athlon™ 64 Processor Series (Continued)			
Series	**AMD Athlon™ 64 FX (939-Pin or 940-Pin) Processor**	**AMD Athlon™ 64 (939-Pin) Processor**	**AMD Athlon™ 64 (754-Pin) Processor**
L1/L2 data cache protection	ECC	ECC	ECC
L1/L2 instruction cache protection	Parity	Parity	Parity

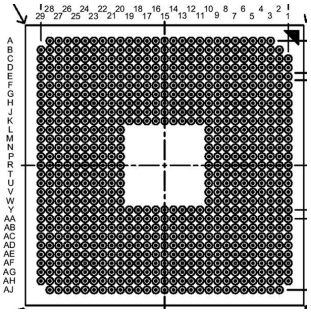
Note: *The different pin-count packages have different footprints.*



940-Pin Footprint



939-Pin Footprint



754-Pin Footprint

4.5 AMD Chipset Information

AMD offers an array of chipset products designed to unleash the full power of AMD Athlon 64 processors. From workstations to multiprocessor servers, AMD provides a world-class high-performance chipset solution to enable the most demanding designs.

4.5.1 AMD-8000™ Series Chipset

Ushering in the next generation of computing platforms, AMD introduces the AMD-8000™ series of core-logic components designed to support the AMD Athlon 64 processor. Implementing HyperTransport technology as the system backbone, these core-logic elements deliver outstanding performance and design flexibility. This chipset consists of several "building block" components that can be used together in a variety of system designs.

4.5.1.1 AMD-8151™ HyperTransport™ AGP3.0 Graphics Tunnel

The AMD-8151™ HyperTransport™ AGP3.0 graphics tunnel provides AGP3.0 capability to workstation platforms requiring high-end graphics performance. Included in the AMD-8151 graphics tunnel are the following high-level features:

- AGP3.0 interface
- HyperTransport tunnel

Refer to the AMD-8151 graphics tunnel product brief and to the *Preliminary AMD-8151™ HyperTransport™ AGP3.0 Graphics Tunnel Data Sheet*, order# 24888 for detailed specifications.

4.5.1.2 AMD-8131™ HyperTransport™ PCI-X® Tunnel

Targeting server and workstation applications, the AMD-8131™ HyperTransport™ PCI-X® tunnel provides high-speed PCI-X capability to platforms requiring high-performance I/O expansion. The AMD-8131 I/O bus tunnel high-level feature-set includes the following:

- Dual PCI-X interface (supporting 133-MHz, 100-Mhz, 66-MHz, and legacy-PCI speeds).
- HyperTransport tunnel
- APIC

Refer to the AMD-8131 I/O bus tunnel product brief and the *Preliminary AMD-8131™ HyperTransport™ PCI-X® Tunnel Data Sheet*, order# 24637 for detailed specifications.

4.5.1.3 AMD-8111™ HyperTransport™ I/O Hub

The AMD-8111™ HyperTransport I/O hub integrates the system I/O functions into a single component. The AMD-8111 I/O hub high-level feature-set includes the following:

- HyperTransport interface
- 10/100 Ethernet
- EIDE Controller, supporting up to ATA-133
- AC'97 Audio, USB
- I/O buses—PCI, LPC, SMbus, APIC

Refer to the AMD-8111 chipset component product brief and the *AMD-8111™ HyperTransport™ I/O Hub Data Sheet*, order# 24674 for detailed specifications.

4.5.2 Graphics and Storage

Workstations are typically more graphic-intensive than servers. A workstation is used by a single user running applications that are more processor-intensive than a desktop. Programs such as CAD systems, scientific analysis programs such as finite element analysis, etc., are very graphic intensive. These types of applications require higher graphics capability than desktop systems. Therefore, if you are building a workstation you would want to use a motherboard that supports an AGP-8X graphics interface, such as is provided with the AMD-8151 HyperTransport AGP3.0 tunnel.

4.6 AMD Athlon™ 64 Processor Drivers and Utilities

AMD CPUID—This application executes and displays the return data from the CPUID instruction set. No source code is provided.

AMD Processor Information Display Utility—This utility displays the processor signature, approximate speed, L1/L2 cache sizes, processor revision, and instruction extensions supported.

AMD Athlon™ 64 Processor Cool 'n' Quiet!™ Software for Windows® ME and Windows® 2000—Cool 'n' Quiet! technology allows the system to dynamically and automatically select the processor speed, voltage, and power combination to match instantaneous user performance need. These changes can happen as often as 30 times per second.

AMD Athlon™ 64 Processor Driver for Windows® XP, (exe)—AMD Athlon 64 Processor Driver for Windows® XP allows the system to automatically adjust the processor speed, voltage, and power combination to match instantaneous user performance need. Download this Setup Installation program (EXE) to automatically update all the files necessary for installation. This package is recommended for users who desire a graphical user interface for installation. This .EXE driver is a user-friendly localized software installation of the driver designed for end-users.

AMD Athlon™ 64 Processor Driver for Windows® XP, (zip)—AMD Athlon 64 Processor Driver for Windows XP allows the system to automatically adjust the processor speed, voltage, and power combination to match instantaneous user performance need. Download this Setup Installation program (ZIP) to automatically update all the files necessary for installation if you are using the Have Disk feature of the Install Driver button in Device Manager to install this driver.

The latest AMD Athlon™ 64 processor drivers and utilities can be found and downloaded from *http://www.amd.com/us-en/Processors/TechnicalResources/0,,30_182_871_9706,00.html*.

In EMEA, these utilities can be found and downloaded from *http://www.amd.com/drivers*.

4.7 AMD-8000™ Series Chipset Drivers

Table 4 on page 34 shows AMD-8000 series of chipset components drivers for Microsoft® operating systems.

Table 4. Microsoft® Drivers for the AMD-8000™ Series of Chipset Components

Drivers for Microsoft® Operating Systems	32-Bit Operating Systems				64-Bit Operating Systems
	Windows® 98	Windows 2000	Windows XP Pro	Windows Server 2003	Windows 64-Bit Editions for AMD64
AMD-8151™ HyperTransport™ AGP3.0 Graphics Tunnel Driver	√	√	√	√	enabled natively
AMD-8131™ HyperTransport™ PCI-X® Tunnel IOAPIC Controller Driver		√	√	√	enabled natively
AMD-8131 HyperTransport PCI-X Tunnel Driver		√		√	
AMD-8111™ I/O Hub EIDE Driver		√	√	√	
AMD-8111 I/O Hub System Management Controller Driver		√	√	enabled natively	enabled natively
AMD-8111 I/O Hub 10/100 Ethernet Controller Driver	√	√	√	√	enabled natively
AMD-8111 I/O Hub AC'97 Audio Controller Driver	√	√	√	√	enabled natively
AMD-8111 I/O Hub SMBus 2.0 Controller Driver		√	√	enabled natively	enabled natively
AMD-8111 I/O Hub High-Precision Event Timer		√		√	√
AMD Driver Pack	√	√	√	√	√
For the latest drivers visit *www.amd.com/drivers*					

Table 5 on page 35 shows AMD-8000 series core logic (chipset) drivers for Linux operating systems.

Table 5. Linux Drivers for the AMD-8000™ Series of Chipset Components

Drivers for Linux Operating Systems	Kernel 2.4.18	Kernel 2.4.20	Kernel 2.4.21	Kernel 2.5, 2.6
AMD-8151™ HyperTransport™ AGP3.0 Graphics Tunnel Driver for Linux 2P Platforms		√	√	√
AMD-8151 HyperTransport AGP3.0 Graphics Tunnel Driver for Linux 1P Platforms	√	√	√	√
AMD-8131™ PCI-X® Tunnel Standard Hot-Plug Controller (SHPC) Driver Version 1.03 for Linux				√
AMD-8111™ 10/100 Ethernet Driver for Linux	√	√	√	√
AMD-8111 AC'97 Audio Driver for Linux	√	√	√	√
AMD-8111 IDE for Linux	√	√	√	√
For the latest drivers visit *www.amd.com/drivers*				

Chapter 5 EMI Reduction Techniques

These electromagnetic interference (EMI) reduction techniques can be implemented with relatively short lead-times at the final system-assembly stage. Proper electromagnetic compliance (EMC) and motherboard design techniques are assumed.

The effectiveness of all the EMI-reduction techniques varies from system to system. This chapter is provided as a guideline only, to help identify and close the common EMI energy paths that allow radiated emissions to escape from the chassis enclosure.

5.1 EMI Emission Standards

EMI emissions from a computer system must be controlled and kept below regulatory limits. Radiated EMI emissions are measured with an antenna located at a specified distance from the computer system under test. There are different EMI standards for systems marketed in the United States and Europe, and all standards are continually updated. Typically, most computers must meet FCC Class "B" for the US and CE Class "B" EMI requirements to be sold in Europe.

5.2 AMD Athlon™ 64 Processor-Based System Builder EMI Reduction Techniques

This document describes system-level EMI reduction techniques based on past successful problem resolution of EMI radiated emissions. All the techniques described may be able to be implemented at the final system assembly stage with relatively short lead-time. This document does not contain long lead-time techniques involving motherboard re-layout or chassis sheet metal redesign. Proper up-front electromagnetic compatibility (EMC) motherboard design techniques are assumed. For more information on these techniques, please refer to the *AMD Athlon™ 64 FX and AMD Opteron™ Processors Motherboard Design Guide*, order# 25180.

The effectiveness of the following EMI reduction techniques varies among different computer systems. EMC engineering tests must be performed to determine how effective each of the following EMI reduction techniques is for a particular system.

The following list of EMI reduction techniques is numbered in the recommended order of evaluation and relative simplicity. Each item is described in detail for clarity.

1. Spread Spectrum Clocking

AMD processors are designed to run with spread spectrum clocking enabled. Ensure that the motherboard BIOS has enabled the spread spectrum feature of the system clock generator. Enabling the spread spectrum setting often lowers frequency amplitudes by more that 5 dB.

2. Disable Unused Clocks

Clock signals that have no load can have high levels of ringing that can lead to EMI problems. The motherboard BIOS firmware should be programmed to detect and disable unused memory DIMM and PCI clocks.

3. Processor Heatsink Fan Cable Routing

A problem sometimes encountered with the processor heatsink DC fan cable is the large loop formed in its routing to the motherboard connector. Shorten this cable length to reduce the loop area as much as possible.

4. Power Supply Cable Routing

Historically, the system power supply cable has been found to be very susceptible to picking up EMI energy from within the system and coupling into the power supply and then onto the AC power cord. Keep the power supply cable against the metal chassis and as far away from the processor, memory DIMMs, and VRM components as possible. Fix this cable routing in place with plastic cable ties.

5. Other Internal Cable Routing

Cable routing inside the system should generally be routed along the metal chassis and away from EMI sources such as the processor heatsink, clock modules, memory DIMMS, VRM components, and high speed VLSI modules. Internal cables that connect to front I/O ports such as USB and Audio are particularly sensitive. The use of a shielded cable or a ferrite core or both over these internal cables can be effective at reducing EMI.

6. Rear I/O Connector Shield

One common problem in many computer systems is poor electrical contact between the I/O connector metal housings, the metal I/O connector plate, and the cut out in the system chassis wall. This problem can be due to soft metal being used in the I/O connector plate or to an insufficient number of spring-finger contacts. A solution is to use a hardened stainless spring steel with a sufficient number of contact points to the I/O connectors and the wall of the system chassis. Each I/O connector housing should have at least two contacts and as a general rule, there should be a contact point at least every 1 cm between the I/O connector plate and the chassis. As a quick remedy if this condition exists, a die-cut, conductive, foam gasket matching the I/O connector pattern can be added to improve connector grounding to the chassis.

7. Chassis Shielding

All chassis designs have gaps and seams to enable assembly and option installation. From an EMI standpoint, however, some gaps are worse than others. The important dimension of a gap or seam is the longest dimension. If you can slide a piece of paper for several inches along a seam, that

seam could cause an EMI problem. Spring fingers or foam EMI gasket can be used to seal these gaps or seams.

8. Processor Heatsink Grounding

Although grounding of the processor heatsink has not yet been required on any AMD Athlon™ 64 processor-based systems, grounding of the processor heatsink can further lower the harmonic EMI levels of the processor. Many AMD Athlon 64 processor-based motherboards contain grounding pads around the footprint area of the processor. These grounding pads can be utilized to ground the heatsink to the motherboard ground.

If excessive system level EMI radiated emissions exist after attempting all the listed EMI reduction techniques, then more extensive remedies may be necessary. First, determine if the emissions emanate from the system I/O cables (including the AC power cord) or from aperture leaks in the system chassis. If EMI emissions emanate from a particular I/O cable, then improved filtering or cable shielding may be required on that cable. If EMI emissions emanate from slots or seams in the chassis enclosure, use copper tape across the apertures to improve shielding effectiveness. If copper tape reduces emission levels to a satisfactory level, then chassis sheet metal changes or conductive EMI gasketing can be added at that location.

Appendix A AMD Athlon™ 64 Processor-Based System Build Procedure

Always verify that the system you are building only uses components from the list recommended by AMD, or follow the recommendations outlined in this document to select a suitable component, and then follow this procedure to build your system

For additional configuration information, go to:
http://www.amd.com/us-en/Processors/TechnicalResources/0,,30_182_869_9460,00.html

In EMEA, please go to:
http://www.amd.com/gb-uk/Processors/ProductInformation/0,,30_118_9485_9487,00.html

Note: *If the links in this appendix produce an* Error 404 - Page Not Found *message, copy the link, paste it into the Address line of your browser, and connect to the Web site from your browser.*

1. Ensure the selected motherboard is appropriate for the chosen processor model and frequency.

2. Verify that your case follows the system case (chassis) airflow guidelines on the AMD website.

3. Calculate the power requirements for the intended configuration prior to selecting and installing a power supply.

   Note: *Ensure that the power supply wattage selected meets the intended configuration requirement and the motherboard and chassis are electrically and mechanically compatible.*

4. Ensure that you are properly grounded at all times during the system construction to protect the delicate electronic components from static electricity damage.

5. Install the selected hard drives, floppy disk drives, DVD or CD-ROM player, and other devices into the chassis.

   Note: *Check the hard drive installation guide. For full performance, you* must *also install the appropriate data cable (see drive installation instructions).*

6. Remove the motherboard from its protective packaging and place it on a firm (but not hard) surface—ideally the surface will be a grounded anti-static pad.

7. Remove the AMD Athlon™ 64 processor from its protective packaging (always make sure you are electrically grounded), install the processor into the motherboard socket, then install only an AMD recommended heatsink and fan assembly. For more specific information, follow the instructions found in Chapter 3 of this document.

8. Check the motherboard for any jumper settings. (Most motherboards do not require jumpers.)

9. Install the assembled motherboard and processor with heatsink into the chassis. Always install any standoffs needed to support the motherboard, especially in the areas where cards will be placed.

10. Ensure the selected memory (256 Mbytes or more are recommended for workstations) is shown on the motherboard maker's recommended memory list. If the motherboard manufacturer does not have a verified/recommended memory listing, check with the memory supplier to verify that they have tested your chosen motherboard and deemed it to be compatible with the DIMM memory modules you plan to use.

11. Install the recommended memory into the motherboard. Be sure to install the RAM in the sequence required for the chosen motherboard. Verify each memory DIMM is inserted all the way into the socket and locked in place.

12. Install a high-performance video graphics card. Have the latest drivers available (see the Web site of the card maker). You will need the drivers shortly.

13. Connect the power cables to the drives and motherboard.

14. Connect the hard drive, floppy disk drive, and DVD (CD-ROM) data cables in the normal manner. Verify that the cables are installed securely and with the proper edge near Pin 1.

15. Connect the monitor data cable, keyboard cable, and mouse cable to the rear of the system.

16. Install the AC-line power cord on the power supply and connect to the power outlet.

17. Go to the Web sites of the motherboard vendor or the chipset maker for the latest drivers and utilities.

18. Check your motherboard vendor's Web site for the latest version of the BIOS, AGP miniport driver and bus mastering IDE driver. (AMD has drivers available for its chipsets at *www.amd.com*. In EMEA, please go to *http://www.amd.com/drivers*.)

19. Check the peripheral manufacturer's Web site for the latest drivers for the sound card, network interface card, the video graphics card, and any other added devices.

20. Power the system on and begin loading software and drivers, following the installation instructions.

21. Make sure the system starts and runs reliably with just the graphics card installed. Restart and run the system multiple times.

22. Use the following steps to install additional cards at this time, if additional cards are to be installed.

    a. Turn off the system and unplug it before installing each card.

    b. Install additional cards one at a time.

    c. Restart the system after every card installation.

Note: *If you have difficulties with the installation of any of the cards or drivers, contact your hardware vendor.*

23. As you install each card, verify the card is properly seated (connector fully inserted into the slot, front and back) and that the retention screws are in place.

24. Test the complete system for proper operation. If system functions properly, load any other software.

Appendix B AMD Athlon™ 64 Processor FAQs

Appendix B contains frequently asked questions concerning AMD Athlon™ 64 processors and the validated server program.

Q: *What software supports these processors?*

A: AMD Athlon 64 processors are based on the industry-standard x86 instruction set and are thus supported by the thousands of applications based on this instruction set. All 32-bit Microsoft® Windows® operating systems, including Microsoft Windows Server 2003, include support for the AMD Athlon 64 processor, as do the major 32-bit Linux distributions SuSE, Red Hat, TurboLinux, MandrakeSoft, SCO, among others. Commercial 64-bit versions of SuSE Linux, United Linux, and MandrakeSoft are available today and several other 64-bit operating systems are in development, including the 64-bit version of Microsoft Windows Server 2003 and Microsoft Windows XP. Sixty-four-bit applications for the AMD Athlon 64 processor include Apache Server, Mental Ray, Zeus, Cluster Strike Server, SendMail, MY SQL, IBM DB2, and CA Ingres. Sixty-four-bit versions of Microsoft IIS, Red Hat Stronghold, Oracle 9i, MS SQL Server 2000, MS Terminal server, Synopsys VCS, and CA Unicenter are under development.

Q: *What is the value proposition of the AMD Athlon 64 processor?*

A: The AMD Athlon 64 processor is an x86-based processor that can simultaneously run 32-bit and 64-bit applications, with leading performance for both. This gives businesses a competitive advantage with world-leading 32-bit performance, while allowing them to easily take advantage of 64-bit applications when conditions are right for their business to do so. By choosing open-standard, non-proprietary computer architecture, a business can maintain its current investment in IT and lower its total cost of ownership—there is no need to retrain IT professionals in a new proprietary architecture, no forced migration to 64-bit applications, and no need to overhaul hardware or change existing software.

Q: *What operating systems does the AMD Athlon 64 processor support?*

A: As a fully backward-compatible x86 microprocessor, the AMD Athlon 64 processor is designed to support all existing 32-bit server, desktop, and workstation operating systems from Microsoft (Windows Server 2003, Windows XP, etc.), major Linux distributors (Red Hat, SuSE, TurboLinux, SCO, MandrakeSoft), and Sun Microsystems Solaris. In addition, several 64-bit operating systems exist in production versions (SuSE Linux Enterprise Server 8, UnitedLinux V1, MandrakeLinux Corporate Version 2.1 and NetBSD) and several, including Windows for AMD64, Red Hat Advanced Server 3.0, and TurboLinux, are in development.

Q: *What are the benefits of the AMD Athlon 64 processor?*

A: The AMD Athlon 64 processor architecture is designed to provide unparalleled performance and supports the x86 instruction set, delivering outstanding performance for both 32-bit code and 64-bit code. As the need for memory-intensive 64-bit applications becomes greater, our

plan is for IT managers to seamlessly move to 64-bit applications that benefit their business while continuing to leverage their investment in 32-bit software and personnel. Additionally, the HyperTransport™ technology interface addresses the high memory and I/O bandwidth needs we believe will be required for future personal computers, workstations, and servers.

Q: *What specific applications can benefit from the performance of the AMD Athlon 64 processor?*

A: Many applications will run faster on the AMD Athlon 64 processor due to its doubled-data paths. Current 32-bit processors have a 4-GByte memory addressing cap. The 40-bit physical and 48-bit virtual addressing of the AMD Athlon 64 processor remove that limitation, permitting up to 1 Terabyte (Tbyte) of physical memory space and 256 Tbytes of virtual memory addressing space. E-commerce applications, ERP, CRM, and other highly transactional database applications can benefit from the AMD Athlon 64 processor's larger cache, and big workload features that make manipulating larger data sets faster. Other large data set applications that can benefit from the AMD Athlon 64 processor include CAD and DCC type applications, as well as financial and scientific modeling applications.