

AMD Geode™ GX and LX Processors Typical CPU Core Power Consumption Determination



1.0 Scope

This document describes how the AMD Geode™ GX 533@1.1W processor* and the Geode™ LX 800@0.9W processor** typical CPU core power consumption was determined.

Note: This is revision C of this document. The changes from revision B (dated May 2005) are: added last paragraph in Section 2.2, edited the last paragraph of method 4 in Section 2.4 on page 2, and edited the typical power calculations in Section 2.6 on page 4.

2.0 Discussion

Addressing the need for processors in embedded x86 applications to be rated with something more than just clock frequency, AMD created the Performance-Power Rating (PPR) system. A critical component of the PPR system is the typical power consumption of the CPU core. Since the AMD Geode GX processor family features integrated functionality in addition to the CPU core itself, the task of determining typical CPU core power consumption requires some explanation.

The process used to determine the typical CPU core power consumption in the Geode GX 533@1.1W and Geode LX 800@0.9W processors is described in the following sub-sections.

2.1 What is the AMD Geode™ GX 533@1.1W Processor

The Geode GX 533@1.1W processor is an x86-based embedded system-on-chip with the following functional units:

- 400 MHz x86 CPU core
- 266 MHz DDR SDRAM controller
- 66 MHz PCI bus/arbitrator
- Graphics controller

These functional units communicate with each other as peripherals on an internal crossbar switch known as the GeodeLink™ Interface Unit (GLIU).

2.2 What is the AMD Geode™ LX 800@0.9W Processor

The Geode LX 800@0.9W processor is an x86-based embedded system-on-chip with the following functional units:

- 500 MHz x86 CPU core
- 400 MHz DDR SDRAM controller
- 66 MHz PCI bus/arbitrator
- Graphics controller
- Other:
 - VIP (Video Input Port)
 - AES (Advanced Encryption Standard)
 - GLCP debug
 - JTAG and boundary scan
 - Top-level clock distribution

These functional units communicate with each other as peripherals on an internal crossbar switch known as the GeodeLink™ Interface Unit (GLIU).

The Geode LX 800@0.9W processor comes in two versions, one with an EEPROM that operates at a 1.2V V_{CORE} and one without an EEPROM that operates at a 1.25V V_{CORE} .

2.3 Defining CPU Core Power

Since Geode processors typically compete with x86 processors that consist of an x86 CPU only, power comparisons with these other processors should be done using the Geode processor's CPU core power only. Power consumed by the additional integrated features must be eliminated. To do this, the power being supplied to the Geode processor's core voltage input must be measured. Then, the power consumed by the integrated features must be subtracted from this measurement, leaving only the power consumed by the x86 CPU core.

*The AMD Geode GX 533@1.1W processor operates at 400 MHz. Model numbers reflect performance as described here: <http://www.amd.com/connectivitysolutions/geodegxbenchmark>.

**The AMD Geode LX 800@0.9W processor operates at 500 MHz. Model number reflect performance as described here: <http://www.amd.com/connectivitysolutions/geodelxbenchmark>.

2.4 Method for Measuring Device Core Power

The Geode processor's device core power consumption is measured using the following method:

- 1) The power supplied by the system's processor core regulator to the Geode processor's core voltage input is configured for measurement by placing a 0.01 ohm resistor in series with this regulator's output, and connecting a precision voltmeter channel across this resistor (V1). An additional voltmeter channel is used to measure the voltage from the load side of this measurement resistor to ground (V2).
- 2) A specific task is then executed on the Geode processor-based system while V1 and V2 are measured once per second over the duration of the task. For the purpose of rating the Geode processor's power consumption, the task was defined to be a complete run of WinBench99 Business Graphics while in Microsoft® Windows® XP Pro Service Pack 1. This benchmark was used as it is an important part of the Synchro-mesh Embedded Performance Rating System.

- 3) Power for each set of n measurements is calculated using the following equation:

$$P(n) = (V1(n) / 0.01) * V2(n)$$

- 4) Average device core power for the given task is then calculated by adding all P values and dividing by n.

For the Geode GX 533@1.1W processor, average core power consumption, while running WinBench99 Business Graphics, is 1.957W.

For the Geode LX 800@0.9W processor, average core power consumption, while running WinBench99 Business Graphics, is 1.431W for the 1.2V V_{CORE} EEPROM version, and 1.487W for the 1.25V V_{CORE} non-EEPROM version.

2.5 Breaking Down Device Core Power

Now the power figure must be broken down to include only the power consumed by the functional units that are found in a typical x86 processor. Figure 2-1 is a simplified block diagram of the Geode processor indicating which functional units are normally found in a discrete x86 microprocessor.

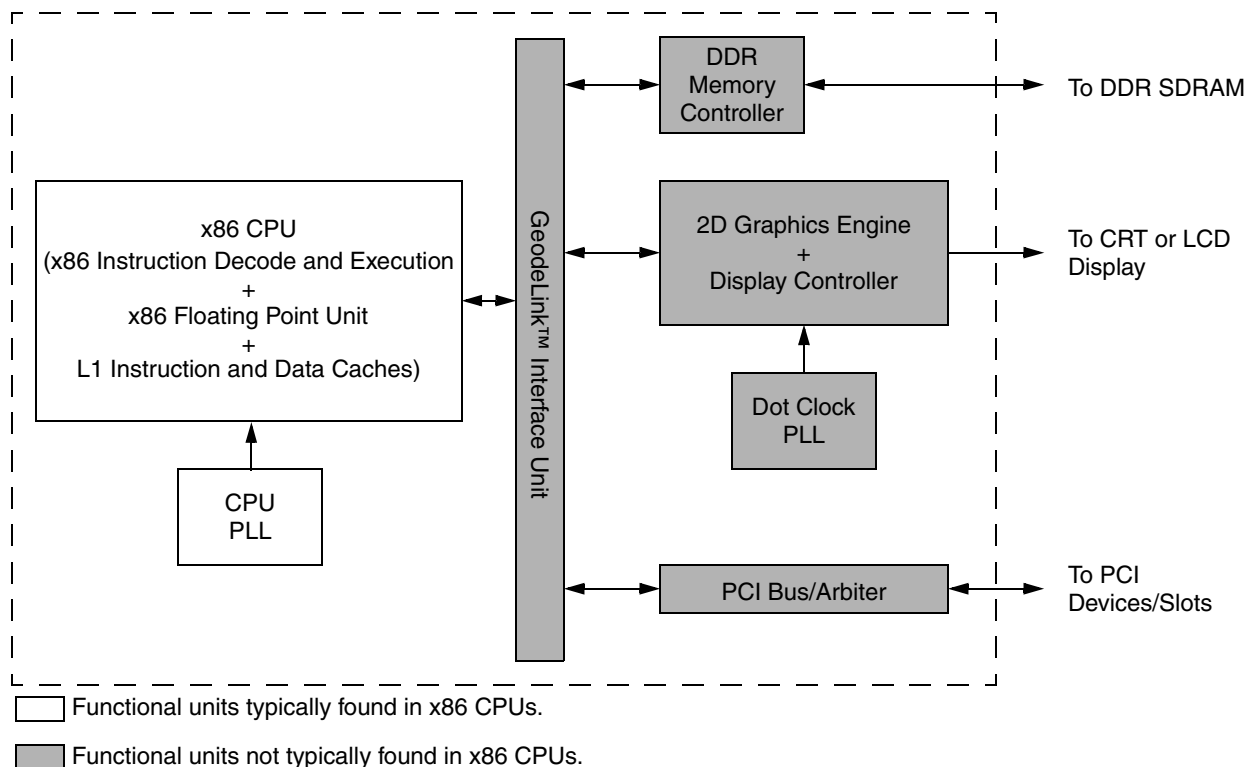


Figure 2-1. AMD Geode™ Processor Basic Block Diagram

Figure 2-2 shows the percentage of total Geode GX 533@1.1W processor core power that each of these internal functional units consumes. This data was obtained through simulations and measurements by the Geode GX 533@1.1W processor design team.

Figure 2-3 on page 4 shows the percentage of total Geode LX 800@0.9W processor core power that each of these internal functional units consumes. This data was obtained through simulations and measurements by the Geode LX 800@0.9W processor design team.

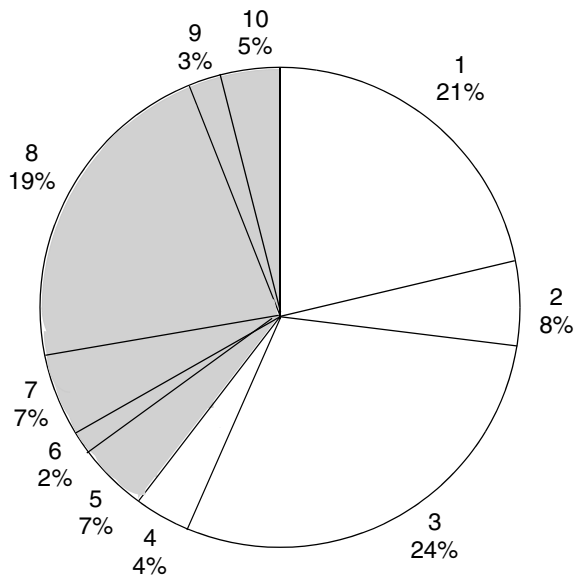
Many of these features were added to the Geode processor to remove the need for an external north bridge and graphics controller. These extra features include the display logic, the PCI bus controller/arbiter, the memory controller, the GLIU, and the Dot Clock PLL. The power consumed by these units is ignored since they are not found in a typical x86 processor.

Features in Figure 2-1 on page 2 that are found in a typical discrete x86 processor and the percent of total device core power they consume are listed below:

- x86 Instruction Decode and Execution
- x86 Floating Point Unit
- L1 Instruction and Data Caches
- Other (CPU PLL, etc.)

For the Geode GX processor the sum of the above percentages is equal to 57%. Therefore, 57% of the total device core power consumed by the Geode GX processor can be fairly compared to the device core power of typical discrete x86 processors.

For the Geode LX processor, the CPU core block power usage is 61%. Therefore, 61% of the total device core power consumed by the Geode LX processor can be fairly compared to the device core power of typical discrete x86 processors. Since new power reductions schemes were implemented for the Geode LX processor, different measurement techniques were required to get the appropriate data, which also means that the granularity achieved on the Geode GX processor was not possible.



1	x86 Instruction Decode and Execution	21%
2	x86 FPU	8%
3	L1 Instruction and Data Caches	24%
4	CPU PLL	4%
5	Dot Clock PLL	7%
6	2D Graphics Engine	2%
7	GeodeLink™ Interface Unit	7%
8	Display Controller	19%
9	PCI Bus/Arbiter	3%
10	DDR Memory Controller	5%

Figure 2-2. Percent of Total AMD Geode™ 533@1.1W Processor Core Power

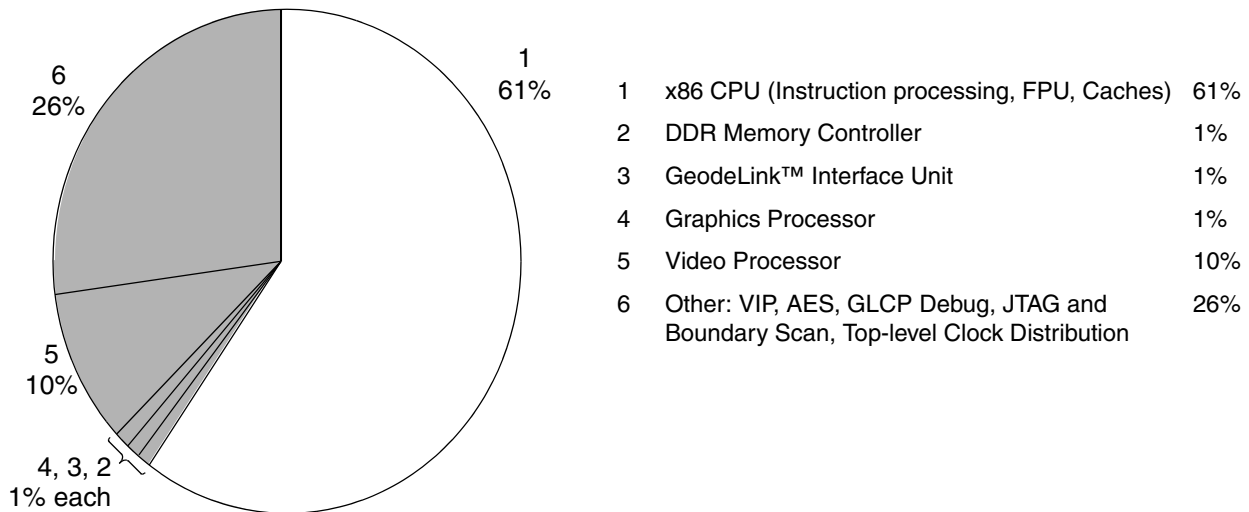


Figure 2-3. Percent of Total AMD Geode™ LX 800@0.9W Processor Core Power

2.6 Defining Typical CPU Core Power

The results from Sections 2.4 and 2.5 on page 2 were used to define typical power for the Geode GX 533@1.1W and Geode LX 800@0.9W processors.

Using 1.957W from Section 2.4 on page 2 and 57% of the Geode GX processor's device core power from Section 2.5 on page 2, typical power for the Geode GX 533@1.1W processor can be calculated:

$$1.957W * 57\% = 1.115W$$

Rounding this result yields 1.1W.

Using 1.431W from Section 2.4 on page 2 and 61% of Geode LX processor's device core power from Section 2.5 on page 2, typical power for the Geode LX 800@0.9W processor can be calculated:

@ 1.2V V_{CORE} :

$$1.431W * 61\% = 878 \text{ mW}$$

Rounding this result yields 0.9W.

@ 1.25V V_{CORE} :

$$1.487W * 61\% = 907 \text{ mW}$$

Rounding this result yields 0.9W.

3.0 Summary

This document clearly describes how the Geode GX 533@1.1W and Geode LX 800@0.9W processors' typical power ratings were obtained. It shows that this measure is conservative and that many applications could yield even lower typical CPU core power consumption with this device.

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