



# CPU & GPU Overclocking Guide

*By Sami Maekinen*



# Introduction

## Sami Maekinen's Overclocking Notes

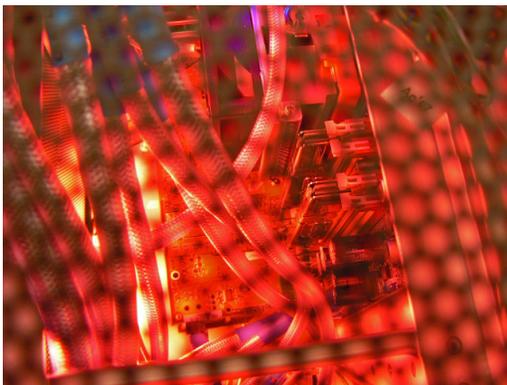
These notes cover the topic of overclocking and will present several techniques to increase overall system performance by overclocking the CPU, system memory and graphics processor.

Although the basic procedure isn't exactly rocket science, there are a few tips and tricks that will help you bring your PC to its full potential.

This guide focuses on how to successfully overclock the CrossFire Xpress 3200 chipset, ATI's newest enthusiast northbridge for the AMD Athlon platform, as well as optimizing and overclocking AMD's Athlon 64 processor and DDR system memory using levers found inside the CrossFire Xpress 3200.

In the past, many companies making motherboards, graphics cards or processors were not especially fond of the word *overclocking* and the practice it described, and with good reason. Many components suffered a premature demise as a result of the overclocking experiments performed on them by their owners. There have always been price-conscious buyers who buy low-end hardware and then operate it at high-end settings. As far as the consumer is concerned, this is undoubtedly an attractive concept – after all, who would say no to extra performance at a bargain price?

The manufacturers, on the other hand, do not benefit from this situation at all – instead, the users hold those companies responsible when their overclocked computers become unstable or when a component is damaged as a result of careless overclocking.



Today, the number of users that overclock their systems or individual components is higher than ever, and ATI has been among the first companies to actively support this community. Often, manufacturers whose motherboards, graphics cards or processors offer the best overclocking capabilities will find their products at the top of the bestseller lists of enthusiast products. Additionally, many "normal buyers" base their purchasing decision on recommendations or reviews originating in the enthusiast community. The result is that nowadays there are many products that are already geared towards overclocking, making overclocking experiments much easier and, above all, safer. The most progressive overclocking platform available today, ATI's

CrossFire Xpress 3200 CrossFire motherboard, the focus of this guide – delivers virtually every conceivable overclocking feature and unmatched overclockability.

Overclocking refers to operating a component such as the GPU, CPU, chipset or memory at a higher frequency than originally intended by the manufacturer. Overclocking makes use of a certain safety margin (often called 'headroom') present in practically every chip. Because the chips are designed to operate smoothly in a wide variety of surroundings and conditions, this often allows overclockers to squeeze a little extra performance out of a chip using its safety margin.

Read on to find out how to unlock this hidden potential.

## Glossary of Terms

**FSB / HTT:** Front Side Bus, Hyper Transport Technology. These two terms describe the speed (in MHz) of the underlying bus that connects the CPU to the northbridge chipset (the CrossFire Xpress 3200). The CPU's frequency is always a multiple of the FSB/HTT.

**CAS:** Column Access Strobe. This is the term most often used by overclockers when talking about the latency (waiting time) of a stick of memory. Here, lower values denote higher performance. Trcd, Tras and Trp are also commonly used terms when discussing memory.

**Vcore / Vdimm / Vdd / Vwhatever:** These are various voltages used for certain system components. Normally, a higher voltage is used to enable higher frequencies

**TIM:** Thermal Interface Material. This material usually takes the shape of white silicon paste and is applied to the CPU or GPU, ensuring proper contact with the heatsink. Its purpose is to fill small uneven areas on the CPU or GPU's surface, optimizing heat dissipation and thereby facilitating lower temperatures and higher performance.

**PSU:** Power Supply Unit. This is the unit from which the PC and its components draw their power. A high-quality PSU is an essential element in any overclocking endeavor.

**BH5:** Winbond's BH5 memory is an especially popular type of RAM among overclockers. Samsung TTCd and Winbond UTT are other favorites.

**3DMark:** A synthetic benchmark, Futuremark's 3DMark is often used to compare the gaming performance of computers. The benchmark determines a 3DMark score, for example 8349 3DMarks, which rates the computer's 3D performance. Higher scores mean better performance. Currently, there are five different versions of this benchmark (3DMark 2000, 2001, 2003, 2005, 2006). The 3DMark scores are only comparable within the same benchmark version.

**SuperPI:** This is a very popular benchmark for determining the overall performance of a PC (CPU, memory, motherboard) without taking the 3D capabilities into consideration. The benchmark calculates several different decimal places of the number Pi, measuring the time it takes to get the result. The lower this value is, the better the performance.

**BIOS:** Basic input/output system. The BIOS carries the basic programming that governs the hardware and is where most overclocking attempts start. When used in the context of a PC, the term "BIOS" usually refers to the motherboard's BIOS, which offers a wide variety of options that influence the clock speed and overall performance of a computer. Nowadays, some settings can also be changed from within Windows XP during normal operation with the help of special overclocking utilities.

**CPU-Z:** This is an application for Windows that displays various performance parameters of the CPU, motherboard, memory, and other components. It can also be used to document a successful overclocking attempt and verify it online, making it official.

**A64 Tweaker:** Another utility for Windows XP which allows the user to change the memory timings of an Athlon 64 system as well as several other settings.

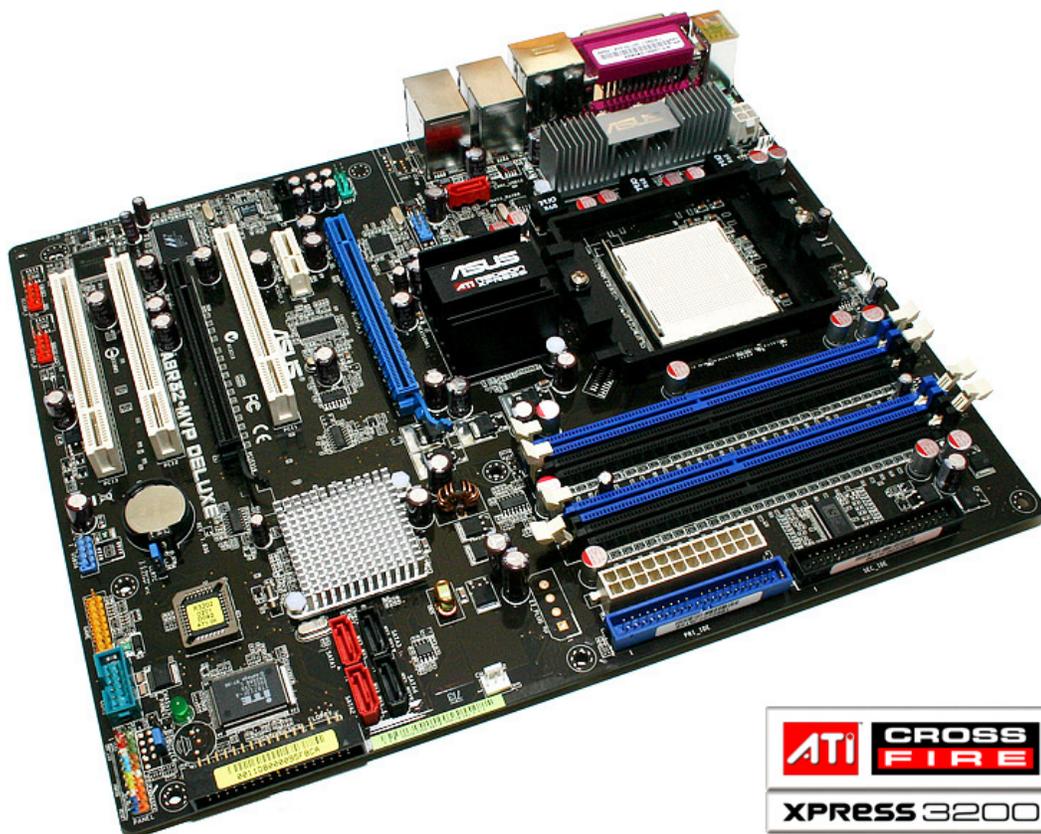
**Prime95:** This Windows XP application can be used to stress test a PC to verify its stability. If a system is deemed "prime stable", that means it can run Prime95 around the clock without crashing or encountering an error.

**Memtest86:** This is a bootable application that tests the computer's RAM. There is also a Windows XP version that checks system memory.

## A Systematic Approach

While some overclockers have advocated a wide range of unusual and spirited techniques, a disciplined systematic approach is still the way to ensure the best results. In order to find the ideal tuning balance for a system, prepare to be patient. In the end, it will be worth it.

The first step is to determine the performance ratings of all components in the PC. These include the CPU's MHz, the RAM's MHz (in some cases, RAM MHz with different timings), the graphics card's clock speed, FSB / HTT Bus speed, PCI Express (PCIe) bus, the power supply, and the cooling solution. A successful and optimal overclock is the result of a combination of these components. For example, it makes no sense to pair high-end hardware with a weak power supply – this will bring any overclocking ambitions to a swift end.



*ASUS A8R32-MVP Deluxe, based on ATI CrossFire Xpress 3200 Chipset*

Let's begin by looking at the motherboard's BIOS. It is important to familiarize yourself with the individual settings of your motherboard. An incorrect setting can lead to disastrous effects, including data loss – and that usually means re-installing the operating system. For this example, we'll use an ATI CrossFire Xpress 3200 motherboard, although most of the settings described here can be found on many other mainboards as well or apply to the majority of AMD Athlon 64 mainboards.

## BIOS Settings (AMD Platform):

**ONLY CHANGE THE SETTINGS DESCRIBED IN THIS SECTION. IF YOU FIND ANY SETTINGS THAT ARE NOT DESCRIBED HERE IN YOUR BIOS, DO NOT CHANGE IT. KEEP THE DEFAULT SETTING INSTEAD.**

**MAIN Menu:** No important settings in this section. Set the correct time and date here.

### **ADVANCED Menu:**

Overclocking Configuration

**FID/VID Change** – Set to **AUTO** for default values. Select **Manual** if you want to change the CPU multiplier or the voltage.

**Processor Frequency Multiplier** – selects the multiplier for the CPU, which determines the CPU's frequency. CPU Frequency is determined by multiplying the Processor Frequency Multiplier with the CPU/HT frequency. For example, the AMD Athlon FX-57 uses a default multiplier of **x14** and a HT of 200MHz, resulting in  $200\text{MHz} \times 14 = 2800\text{ MHz}$  as a CPU frequency.

**Processor Voltage** – This first voltage setting chooses determines the CPU VID values that comprise a very narrow selection of voltages that are definitely safe to use. In the case of an FX-57, **1.45V** is the maximum setting. The older 130 nanometer CPUs allow a VID of **1.55V**.

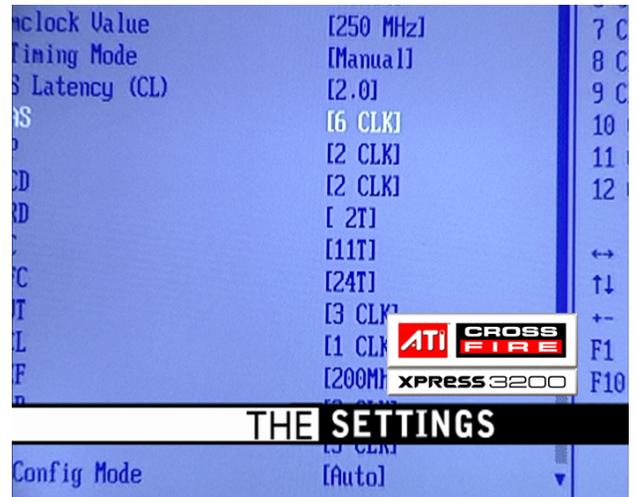
**Processor Voltage** – The second voltage setting allows a more refined adjustment to the CPU's voltage. The default setting is **+0.00V**, which corresponds to a setting of 1.45V if the CPU VID value is set to 1.45V (see above). The highest setting is **+0.60V**, which would result in a voltage of 2.05V, if CPU VID is set to 1.45V. The optimal setting for a system using air-cooling lies somewhere between 1.50-1.55V (VID 1.45 + 0.05 or +0.10V) for 90 nanometer CPUs. "Sub-zero" cooling enables values between 1.65-1.75V (in some cases even as much as 1.85V), allowing users to squeeze some extra MHz out of the CPU. On the first boot, the default settings should be used. (For the FX-57, these would be x14, 2800 MHz, 1.45V, +0.00V).

**CPU/HT Clock, MHz** – This setting determines the HT (FSB) frequency. The default value is **200**. Changing this setting overlocks the CPU MHz, HT AND the memory simultaneously. The CPU frequency is the result of multiplying the Processor Frequency Multiplier with the CPU/HT frequency (The default value of an AMD Athlon FX-57 is x14, which makes  $200\text{MHz} \times 14 = 2800\text{ MHz}$  CPU frequency). For the initial boot-up tests, it is not necessary to change the original setting of 200 MHz.

**PCIe Clock, MHz** – The PCIe frequency can be adjusted here. The default value is sufficient for the initial boot-up attempt. CrossFire Xpress 3200 based motherboards usually handle speeds up to 130MHz or more.

**NB Voltage** – Selects the voltage of the northbridge chip. The selectable values range from **1.22** to **1.5V**. Set this to **1.32V** for the initial boot.

**HT Link VDD** – Determines the voltage used for the HT Link. Set this to **1.29V** for the first boot attempt. Higher settings may enable better HT Link values. With CrossFire Xpress 3200 boards optimal HT Link speed is reached with HT Link Voltage of 1.3 or 1.4V



**PCIE VDD** – internal PCIe voltage. Set to **1.29V** for the initial boot attempt.

**PCIE PHY** – Keep the default value of **1.8V**.

**DRAM Voltage VDD**, RAM Voltage – Memory voltage. Different values should be used here depending on the type of memory module being used. Winbond BH5 or UTT based modules allow voltages of up to **3.2-3.6V**. In the case of Samsung TCCD modules, **2.6-2.9V** is recommended.

**DRAM Voltage VTT** – The default setting of **0%** is sufficient in most cases. Winbond UTT modules tend to reach higher speeds when this value is changed to **-2.3** or **-3.1%**.

**DDR Drive Strength Control** – The default value is correct for air-cooled systems. Select “**weakest**” for cooling systems that operate below room temperature. „**Weaker**” and „**Weakest**” can also be used for “lightly loaded” Samsung TCCD configurations with normal air-cooling. This item is not present in the ASUS BIOS; DFI has it but optimal value is unknown.

### Hyper Transport Configuration

#### **CPU:RD580 NB HT Link Speed:**

This setting determines the HT Link speed (MHz). It is a multiple of the CPU/HT Clock value. By default, it is set to **x5 1000MHz**. Note: Changing the CPU/HT frequency by 1 MHz increases the HT Link speed by 5MHz.

With CrossFire Xpress 3200 boards the full speed mode (X5) can usually be used all the way up to 300MHz HTT or more.

**CPU:RD580 NB HT Link width:** - The default value of **16bit** can be used under all conditions

**RD580 HT Drive Strength:** - Set this to **Optimal** for maximum HT overclocking.

**HT Receiver Comp. Ctrl:** - Set this to **Optimal** for maximum HT overclocking.

**RD580 HT PLL Control:** Set to **High Speed** mode for maximum HT overclocking.

#### **MPS Configuration,**

**MPS Revision** – Select **1.4**.

#### **AMD Cool 'N Quiet Configuration**

**Cool 'N Quiet** – Select **Disabled**.

#### **PCIPnP tab,**

**Plug & Play O/S** – Set to **Yes**.

## Chipset Menu

### Northbridge Configuration,

**Memory Configuration** – This section contains a number of settings pertaining to memory speed. The values listed below can be used as a reference but you may want to experiment with different settings to find the optimal values for your CPU and DIMM modules.

**Memclock Mode** – Possible settings are **AUTO** and **Limit**. If you are unsure what type of RAM you are using, leave this set to **AUTO**.

**Memclock Value** – Determines the desired memory speed. This value is based on the CPU's overall MHz and utilizes the RAM divider. The default value of **200** is sufficient for the majority of systems. (See also section on RAM Dividers).

**MCT Timing Mode** – Leave this set to **AUTO** if you don't know what type of memory module your system uses. Selecting "Manual" unlocks extensive settings for adjusting the memory timings.

**CAS Latency (CL)** – Set this to **2** for Winbond BH5, UTT and Samsung TCCD Module (for TCCD, this only applies to RAM frequencies under 215MHz). **2.5 or 3** for TCCD when the memory frequency exceeds 215MHz. Select **3** if Micron-based memory modules are used (e.g. Crucial Ballistix).  
Safe setting **3**

**TRAS** – According to various documentations, TRAS should consist of CAS+Trp+Trcd. A value of **5** or **6** is recommended for Winbond BH5/UTT and TCCD (<215MHz). Set to **7** for TCCD >215MHz. Micron requires values of **6-8**.  
Safe setting **8**

**TRP** – Set to **2** for Winbond BH5/UTT, Micron (OCZ EB, Ballistix) and TCCD (<215MHz). Für TCCD with 215-330MHz, select **3**.  
Safe setting **4**

**TRCD** – Select **2** for BH5/UTT, **2** for Micron (OCZ EB, Ballistix) and TCCD at <215MHz, **3** for TCCD at 215-290MHz and **4** for TCCD at 290-340MHz.  
Safe setting **4**

**TRRD** – Set to **2**.  
Safe setting **3**

**TRC** – Select **7** or **8**.  
Safe setting **12**

**TRFC** – Set to **12** for BH5, **15** or **16** for UTT and **14** for TCCD.  
Safe setting **16**

**TRWT** – Set to **1** or **2** for BH5/UTT/TCCD, **2-3** for Micron.  
Safe setting **4**

**TWCL** – Set to **1**.

**TREF** – Select **200MHz 7.8us** or **200MHz 3.9us**.

**TWTR** – Set to **1** (if the modules allow it; this is the best setting for maximum performance).  
Safe setting **2**

**TWR** – Set to **2** (if the modules allow it; this is the best setting for maximum performance).  
Safe setting **3**

**User Config Mode** – Leave this setting on **Auto**, if you don't know what kind of memory modules your system uses. Select **Manual** to unlock additional settings.

**Read Preamble** – Set to **5.0** or **5.5ns**.

**Async Latency** - **6.0ns** for maximum performance. **7.0ns** at higher frequencies.

**CMD-ADDR Timings Mode** – Set to **1T**. **This is the most important memory setting.**

**Queue Pass Count** – Set to **16x**.

**Dynamic Idle Cycle Counter** – Keep default setting, **disabled**.

**Idle Cycle Limit** – Set to **16CLK**.

**Bypass Max** – Set to **7**.

**Memory DQ Drive Strength** – Select **Not reduced**, for processors using the CG and D revisions / steppings. For revision E processors, it is necessary to reduce the drive strength to achieve maximum clock speeds. Example: Samsung TCCD 512Mb memory modules with a revision E processor require a setting of **50%**.

**Odd Divisor Correct** – Select **Disable**.

**DRAM Drive strength** – Unless using Samsung TCCD modules, set to **Normal drive**.

**DQS Hysteresis** – Unless using Winbond UTT/BH5/CH5 modules, set to **Enable**.

**DLL Disable** – Select **Enable**.

**Burst2Op** – Set to **Enable** for revision E CPUs.

**Burst Length** – Set to **8 Beats**.

**SoftWare Memory Hole** – Select **Enable**.

**HardWare Memory Hole** – Select **Disabled**.

#### **ATI R(S/X) 48x NB Configuration**

(these settings only apply for ATI RD480 based boards).

**PCI Express Configuration** – This section offers settings for PCI Express, mainly activating / deactivating CrossFire dual-GPU support.

**Dual Slot GFX Configuration** – Select **Disable** when only one PCI Express graphics card is present. Choose **Enabled** if two graphics cards are used in CrossFire mode.

**PCIE GFX0(/1) Link Width** – Set to **x16** for optimal performance when only one graphics card is being used. Reducing the link width to **x8** may yield better overclocking results for graphics cards. Set both values to **x8** for CrossFire mode.

**EXIT tab: Save Changes and Exit** – Saves the settings and exits the BIOS.

## Ready for Operation Overclock



Sami Maekinen and Sampsa Kurri

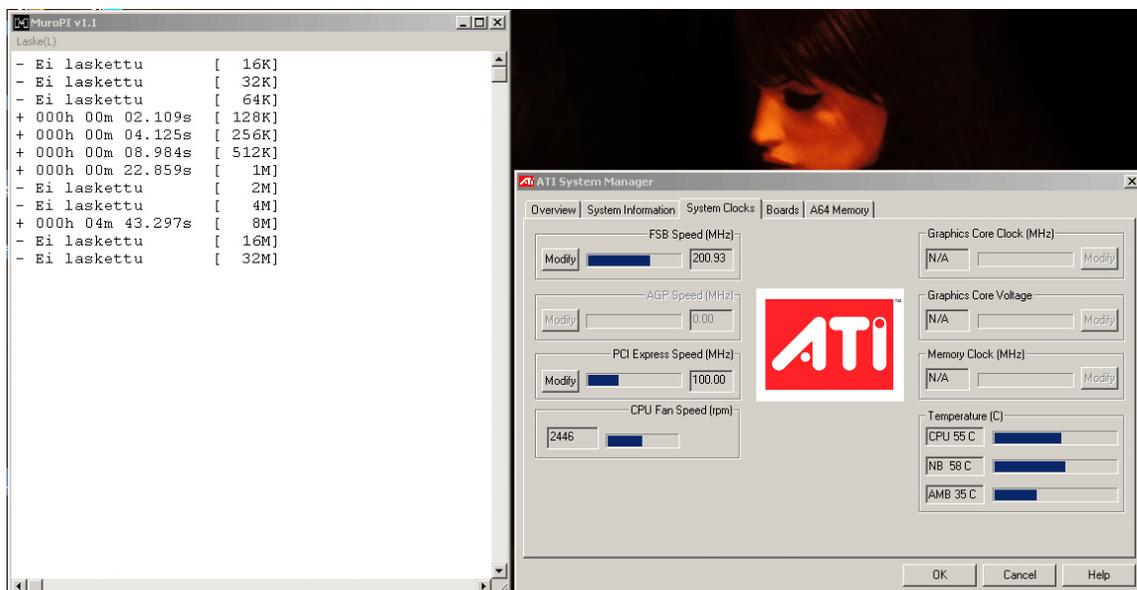
Now that the BIOS settings are where we want them and the system is optimally prepared, we're ready for some serious overclocking. Before attempting to boot up the operating system with the new settings for the first time, it is important to see whether they even work. A good and simple method to test this is to create a bootable CD containing the newest version of memtest86 (available at [www.memtest.org](http://www.memtest.org)).

Make sure that the optical drive (CD/DVD) is selected as the first boot device in the BIOS, and then restart the computer, booting from CD. Memtest will run until aborted by the user and reports any error it encounters.

If no errors are reported after about ten to twenty minutes, you can be reasonably sure that the system runs stable at the new settings and will boot into the OS. The way is now clear for a few overclocking experiments.

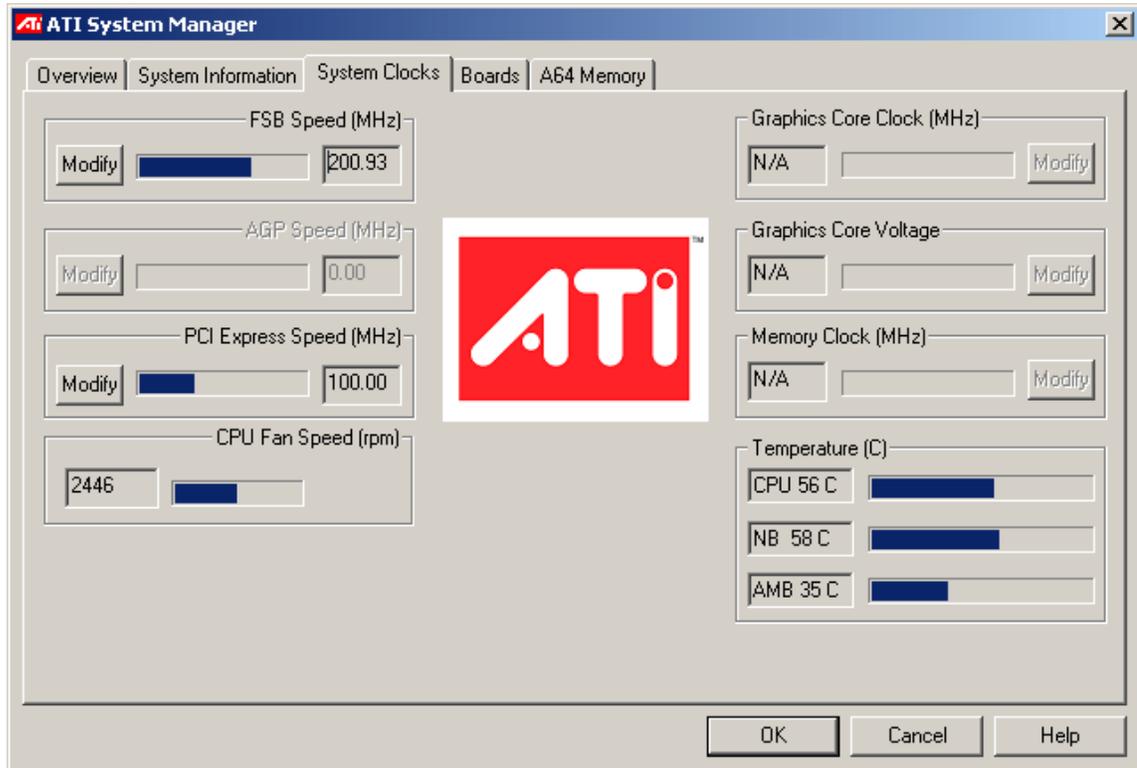
## Overclocking the CPU

Our overclocking endeavors will begin with the CPU, since this is one of the most critical components in any system. To ensure an optimal overclock, a good motherboard platform, a solid power supply and a sufficient cooling solution are required. It is advisable to begin with the CPU's stock cooling solution and standard voltage. The settings required for overclocking the CPU don't necessarily have to be changed in the BIOS. It is also possible to adjust them from within Windows XP during operation (even voltages can be adjusted with a main board which supports ATI System Manager). Once Windows has finished loading, launch the SuperPI benchmark and the ATI System Manager overclocking tool. SuperPI is the ideal benchmark to use at this point in our overclocking experiment, since it doesn't take too long to run and immediately detects possible errors (e.g. system instability).



The next steps are very simple. Use the ATI System Manager or SysTool (Systool works with ASUS A8R32-MVP, <http://www.techpowerup.com/systool/> ) to increase the FSB frequency and then run the 1M SuperPI to test stability with the new settings. The safe approach is to increase the FSB in 2MHz increments, but in most cases, the CPU frequency can be increased by 100MHz on the first try. (With most CPUs, a jump from 2200 MHz to 2300 MHz should not cause any problems). This initial shortcut saves some time.

On AMD's Athlon FX line of processors, the multiplier can be changed in addition to the FSB, which opens up additional options. It is worthwhile using both settings to achieve the ideal overclock. The multiplier can be adjusted with the tool Program Sys.



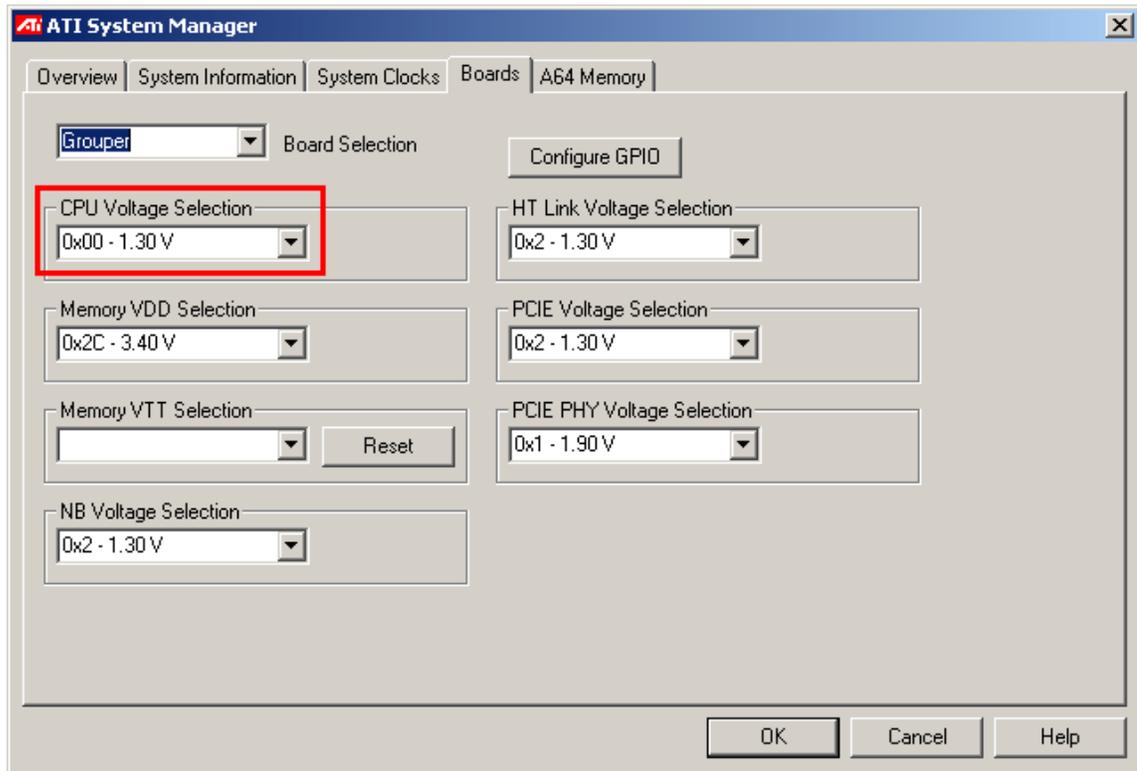
As soon as you reach a clock speed at which SuperPI reports an error, crashes or even reboots the entire system it is time to make sure that it is really the CPU that is limiting further overclocking. Here is the necessary checklist:

- Ensure that the memory is not running too fast. If only the FSB was increased while the multiplier stayed constant, it is advisable to reduce the memory frequency. This can either be achieved in the BIOS (reduce RAM frequency from 200 (standard) to 183 or 166) or by using a Windows tool such as Sys Tool (<http://www.techpowerup.com/systool/>) or A64 Tweaker. Setting the memory frequency to 183 or 166 ensures that the memory won't be holding the CPU back during the next overclocking attempts.
- If the FSB is running between 240 and 250 MHz or more and the HT Link Speed is set to 5x, reduce the HT Link Speed to 4x in the motherboard's BIOS. This ensures that an excessive HT Link Speed won't hold the CPU back.

If you've followed our checklist and have determined the highest possible CPU frequency at which SuperPI's 1M test will run without errors, it is time to see how much more we can achieve by tweaking the CPU's core voltage. Now we can ascertain how far we can push the CPU with the standard cooling solution. To do so, launch SuperPI and the ATI System Manager tool again. In the latter, go to the menu tab labeled "Boards" and select "Grouper" from the list. This menu offers the most extensive selection of core voltage settings available in Windows today for current motherboards. Since we are attempting to find the maximum processor speed, we are only

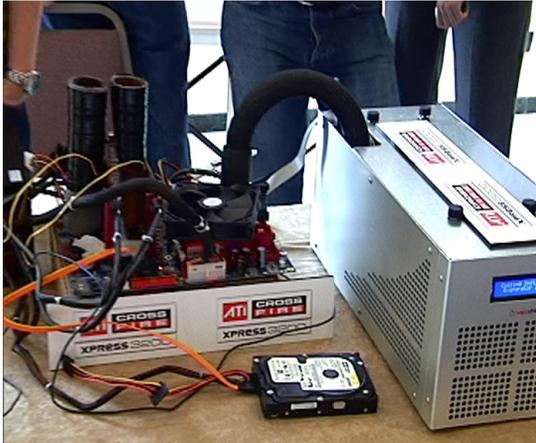
interested in the CPU voltage menu for now. Starting from the default value, increase the CPU voltage in increments of 0.04V (in this case, from 1.45V to 1.49V). After raising the voltage, set the FSB frequency back to the first speed at which SuperPI reported errors. Continue increasing the FSB until the 1M SuperPI test fails again. When this happens, return to the Voltage menu and increase the CPU voltage by another 0.04V.

If ATI System Manager can not be used with your main board you need to reboot, enter BIOS and adjust the CPU Voltage from there.



Keep repeating this procedure until increasing the CPU voltage no longer has any effect. Once you reach this point (on an Athlon FX-57 this should be between 1.55V and 1.6V) you have hit the limit of what can be achieved with conventional air-cooling. These values should definitely be written down for later overclocking experiments. The level we have now reached is called "SuperPI 1M stable speed". Although it's not quite the speed which can be called 100% stable, i.e. one which should be used for a PC that runs 24 hours a day, it does give us a good idea what the specific CPU we're looking at is capable of. Usually, the point at which the system becomes 100% stable is only about 50 to 100 MHz below the maximum SuperPI 1M level.

## Cooling Matters



What else can you do to help in pushing your CPU to higher levels? The answer, quite simply, is COOLING. Over the last few years, the term “Thermal Acceleration” has come into use among system integrators. As the name already implies, this refers to systems that come overclocked directly from the manufacturer and use special “sub-zero” cooling solutions, i.e. coolers that operate at temperatures below the freezing point. As a rule, lower temperatures allow CMOS chips to run at higher clock speeds. In practice, this means that reducing a CPU’s temperature from 50°C to 0°C results in a clock speed increase of ten to fifteen percent. For example, an Athlon FX-57 that can be overclocked to at 3000 MHz at an operating temperature of 50°C should theoretically be able to reach 3250 – 2250 MHz at

0°C. Although most chips will run without difficulty at 0°C and even at temperatures as low as -60°C, there is a limit to how low a chip can be cooled before problems occur. This limit depends on several factors, including the specific CPU in use, the type of CPU and the motherboard platform.

Compared to standard air-cooling solutions, high-quality heatsinks paired with (loud) high-rpm fans usually allow a clock speed boost of 30 to 80 MHz. The next step is water-cooling, which typically enables gains of between 50 and 100 MHz. Beyond this lies the realm of “subzero phase change” coolers that are based on the same operating principle as refrigerator and can cool CPUs as low as -40°C. Our FX-57 should be able to reach about 3450 – 3550 MHz with such a setup. The most extreme representatives of this cooling genre are so-called “cascades” in which several such sub-zero coolers are daisy chained, freezing the chips down to about -80/-90°C. At this temperature, the FX-57 might well achieve a clock speed of 3600 – 3800 MHz. The (extreme) end of the line is currently marked by liquid nitrogen cooling solutions. Operating at the boiling point of nitrogen, -196°C, such a cooler would clear the way for our FX-57 to breach 4000 MHz barrier.



As described above, the correct application of voltage and cooling is a decisive factor in overclocking. However, the motherboard also plays an important part, as a strong and stable voltage regulation is essential for reaching high frequencies through overclocking. The reason is that overclocked CPUs require a very high current to operate correctly. If the motherboard’s voltage regulation is too weak, the system can quickly become instable, hampering overclocking experiments from the start. Not so with the ATI Radeon Xpress 200 CrossFire motherboard – it was designed especially with overclocking in mind and thus features a very strong voltage regulation for the CPU.

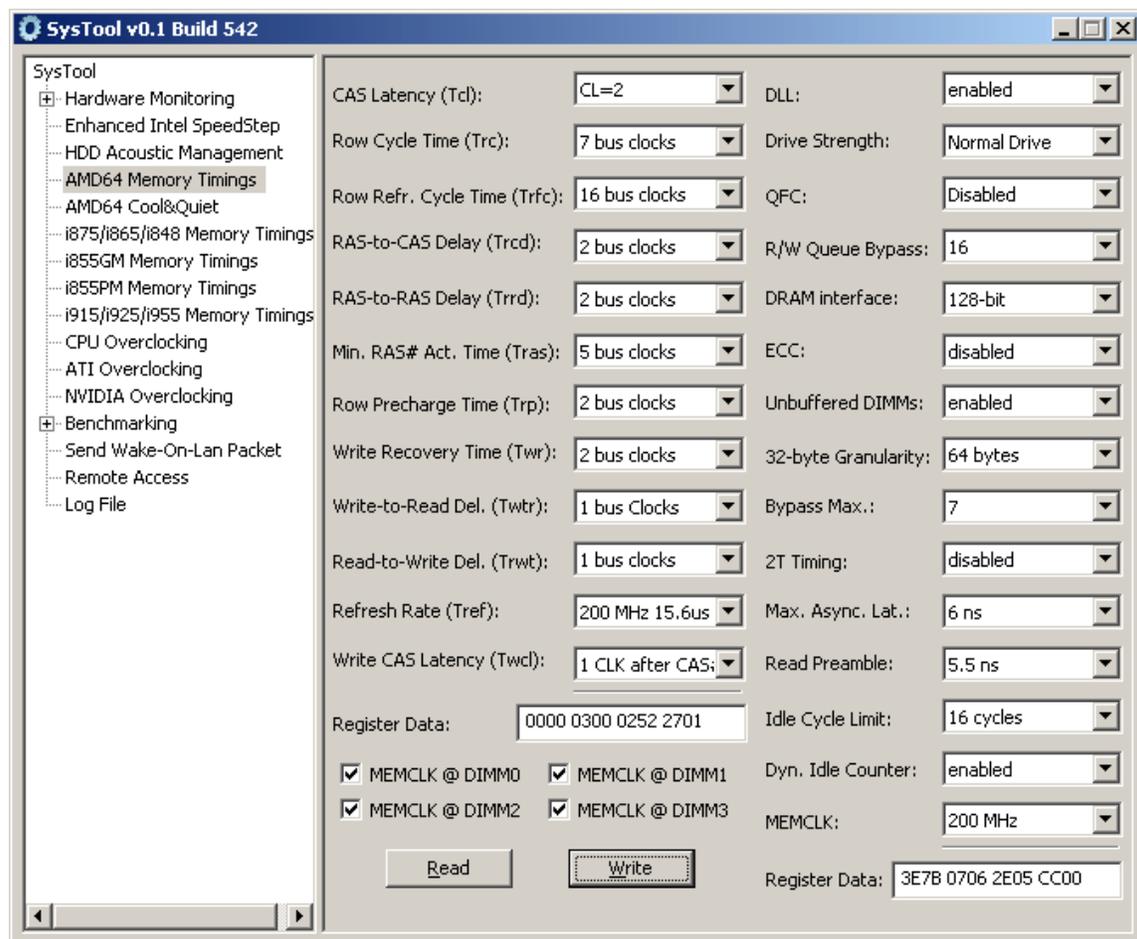
## Overclocking the Memory

Next we need to determine the memory's overclocking potential. This is slightly more complicated than overclocking the CPU. Instead of simply increasing the voltages and improving the cooling, multitudinous memory timings need to be taken into consideration, since they affect both performance and overclocking potential. Indeed, the highest clock speeds are not necessarily the ideal choice when trying to coax more performance out of the memory modules. Here's an example of how memory timings can affect performance.

220MHz (using CL2-2-2-5) = 260 MHz (using CL2.5-3-3-7) = 300 MHz (using CL2.5-4-3-7)  
(Timings: CAS-Trcd-Trp-Tras)

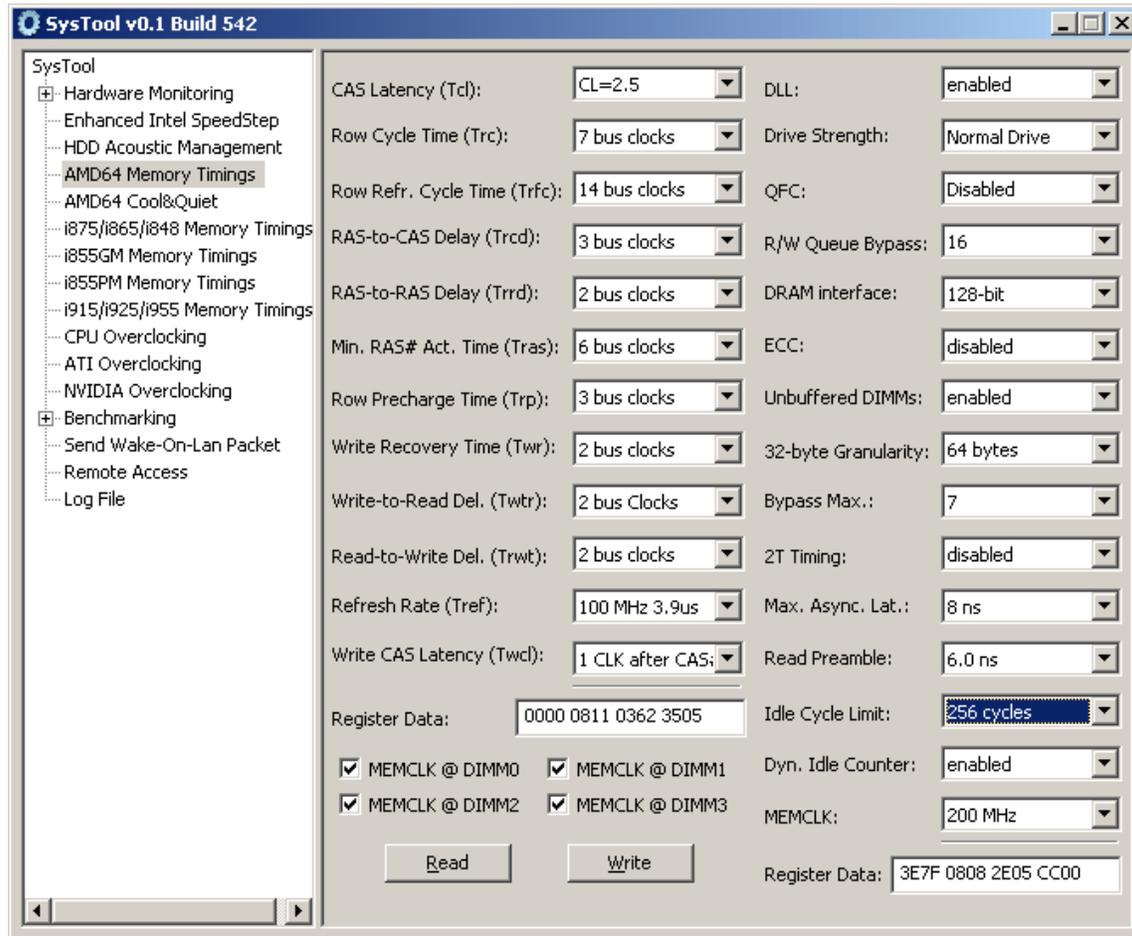
In other words, memory running at 220 MHz with faster timings performs the same as memory running at 300MHz with slower timings. This is something to always keep in mind when overclocking the memory.

The setting of choice for Winbond BH5 / UTT modules is always CL2-2-2-5. Below is a detailed table listing the memory settings for this type of module.

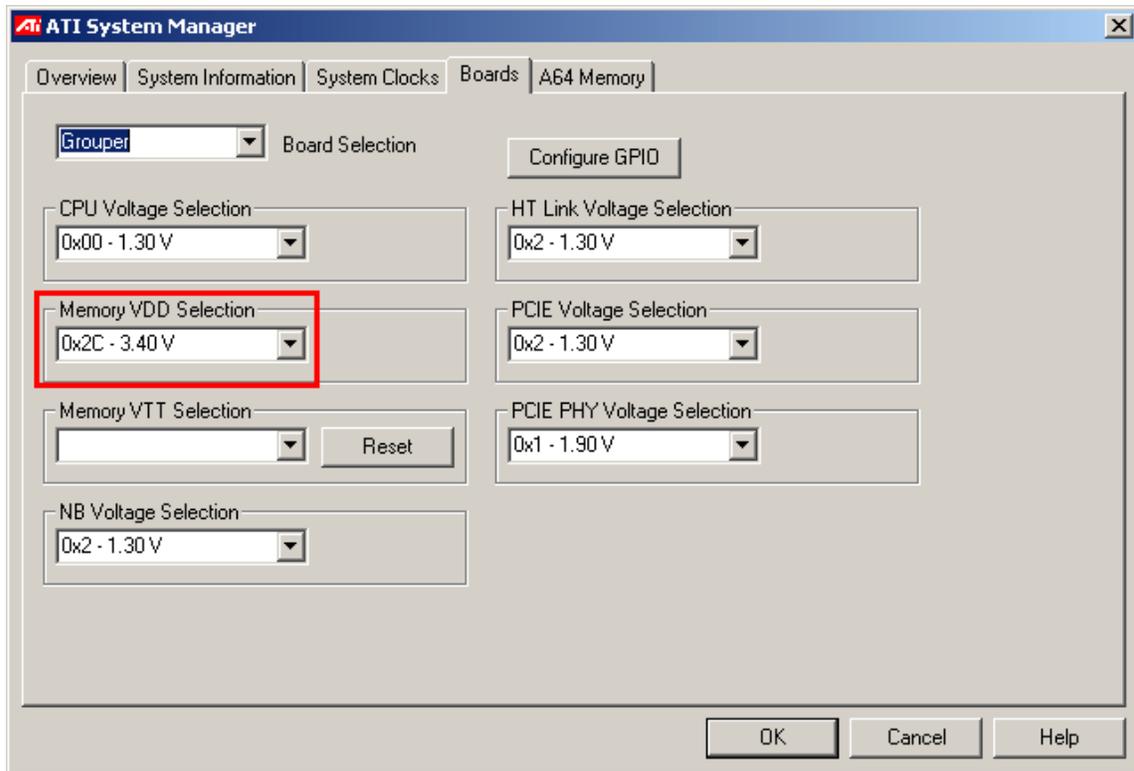


These are the fastest settings for this type of memory. If you want to try to push the memory to higher frequencies, change the Twtr and Trwt values to 2 and the Asyn latency to 7.0ns. At a voltage of 3.5V, these modules should be able to reach 240 – 260MHz with CL2-2-2-5 timings.

For modules based on Samsung's TCCD chips, use the above settings from 210 to 215 MHz. Beyond that, the following values should be selected.



To reach even higher clock speeds, reduce Trcd from 3 to 4. Please note that TCCD modules are able to reach very high speeds with these “moderate” settings. Under optimal conditions, 270 – 290 MHz can be achieved using CL2.5-3-3-7 timings. At CL2.5-4-3-7, even 300 MHz is possible.



To determine how far your memory modules can be overclocked, follow the same procedure as with the CPU. The ATI System Manager can be used to regulate the voltages here as well. This time, you should **reduce the CPU multiplier** though to ensure that the CPU frequency does not interfere when overclocking the memory. The HT Links speed should also be reduced to x4 or x3 if RD480 based board is used. For CrossFire Xpress 3200 based boards HT Link speed of X5 can be used all the way up to 300MHz if not more. BH5 / UTT modules should reach their maximum speed at 3.5 to 3.7V. Samsung TCCD chips don't benefit from higher voltages to the same extent, so that 2.7V can be considered the optimal setting.

## Overclocking CPU and Memory Together

Now that we know the how high we can push the memory and the CPU, the time has come to overclock them together to let the system achieve its optimal performance. For example, if the CPU's limit is 2900 MHz and the memory runs fine at 240 MHz, then the ideal setting would be  $12 \times 240 = 2880$  MHz. However, if the CPU can reach 3000 MHz, increasing the multiplier and reducing the memory frequency is the way to go:  $13 \times 231 = 3000$  MHz. Then again, if you're using memory that can cope with 260MHz, it is better to reduce the CPU frequency a little and use the memory to its fullest potential. As a result of the faster memory, a system running at  $260 \times 11 = 2860$  MHz will often outpace one configured for  $12 \times 241 = 2892$  MHz.

When using a CPU with a locked multiplier, such as an AMD Athlon 64 3000+ whose highest multiplier is x9, it becomes necessary to operate the HT-Link and the memory asynchronously. This way, the memory frequency will not limit the CPU's clock speed. In practice, this means reducing the memory speed to 183 MHz or even 166 MHz in the BIOS. To achieve the highest performance, i.e. the maximum memory speed coupled with the fastest processor frequency, it can also help to reduce the processor's multiplier. This allows HTT / FSB speeds of over 300 MHz to be used.

On AMD's Athlon 64 processor, the memory frequency is determined by the RAM dividers.

Memory frequency (MHz) = CPU frequency (MHz) / RAM divider

For example:

Memory frequency =  $2600 / 13 = 200$  MHz

Since the divider is always an integer, the CPU may not use half-steps such as 9.5. On the next page is a complete table with all memory frequencies and the corresponding dividers.

The table is showing all memory frequencies and the corresponding dividers:

DRAM Freq In BIOS		200	183	166.67	150	143	133.34	125	100
CPU Frequency	CPU Multiplier	RAM Divider							
800.00	4.00	5.00	5.00	5.00	6.00	6.00	6.00	7.00	8.00
900.00	4.50	5.00	5.00	6.00	6.00	7.00	7.00	8.00	9.00
1000.00	5.00	5.00	6.00	6.00	7.00	7.00	8.00	8.00	10.00
1100.00	5.50	6.00	7.00	7.00	8.00	8.00	9.00	9.00	11.00
1200.00	6.00	6.00	7.00	8.00	8.00	9.00	9.00	10.00	12.00
1300.00	6.50	7.00	8.00	8.00	9.00	10.00	10.00	11.00	13.00
1400.00	7.00	7.00	8.00	9.00	10.00	10.00	11.00	12.00	14.00
1500.00	7.50	8.00	9.00	9.00	10.00	11.00	12.00	12.00	15.00
1600.00	8.00	8.00	9.00	10.00	11.00	12.00	12.00	13.00	16.00
1700.00	8.50	9.00	10.00	11.00	12.00	12.00	13.00	14.00	17.00
1800.00	9.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	18.00
1900.00	9.50	10.00	11.00	12.00	13.00	14.00	15.00	16.00	19.00
2000.00	10.00	10.00	11.00	12.00	14.00	14.00	15.00	16.00	20.00
2100.00	10.50	11.00	12.00	13.00	14.00	15.00	16.00	17.00	21.00
2200.00	11.00	11.00	13.00	14.00	15.00	16.00	17.00	18.00	22.00
2300.00	11.50	12.00	13.00	14.00	16.00	17.00	18.00	19.00	23.00
2400.00	12.00	12.00	14.00	15.00	16.00	17.00	18.00	20.00	24.00
2500.00	12.50	13.00	14.00	15.00	17.00	18.00	19.00	20.00	25.00
2600.00	13.00	13.00	15.00	16.00	18.00	19.00	20.00	21.00	26.00
2700.00	13.50	14.00	15.00	17.00	18.00	19.00	21.00	22.00	27.00
2800.00	14.00	14.00	16.00	17.00	19.00	20.00	21.00	23.00	28.00
2900.00	14.50	15.00	16.00	18.00	20.00	21.00	22.00	24.00	29.00
3000.00	15.00	15.00	17.00	18.00	20.00	21.00	23.00	24.00	30.00
3100.00	15.50	16.00	17.00	19.00	21.00	22.00	24.00	25.00	31.00
3200.00	16.00	16.00	18.00	20.00	22.00	23.00	24.00	26.00	32.00
3300.00	16.50	17.00	19.00	20.00	22.00	24.00	25.00	27.00	33.00
3400.00	17.00	17.00	19.00	21.00	23.00	24.00	26.00	28.00	34.00
3500.00	17.50	18.00	20.00	21.00	24.00	25.00	27.00	28.00	35.00
3600.00	18.00	18.00	20.00	22.00	24.00	26.00	27.00	29.00	36.00
3700.00	18.50	19.00	21.00	23.00	25.00	26.00	28.00	30.00	37.00
3800.00	19.00	19.00	21.00	23.00	26.00	27.00	29.00	31.00	38.00
3900.00	19.50	20.00	22.00	24.00	26.00	28.00	30.00	32.00	39.00
4000.00	20.00	20.00	22.00	24.00	27.00	28.00	30.00	32.00	40.00
4100.00	20.50	21.00	23.00	25.00	28.00	29.00	31.00	33.00	41.00
4200.00	21.00	21.00	23.00	26.00	28.00	30.00	32.00	34.00	42.00
4300.00	21.50	22.00	24.00	26.00	29.00	31.00	33.00	35.00	43.00
4400.00	22.00	22.00	25.00	27.00	30.00	31.00	33.00	36.00	44.00
4500.00	22.50	23.00	25.00	27.00	30.00	32.00	34.00	36.00	45.00
4600.00	23.00	23.00	26.00	28.00	31.00	33.00	35.00	37.00	46.00
4700.00	23.50	24.00	26.00	29.00	32.00	33.00	36.00	38.00	47.00
4800.00	24.00	24.00	27.00	29.00	32.00	34.00	36.00	39.00	48.00
4900.00	24.50	25.00	27.00	30.00	33.00	35.00	37.00	40.00	49.00
5000.00	25.00	25.00	28.00	30.00	34.00	35.00	38.00	40.00	50.00

## Overclocking the Graphics Card



*ATI Radeon X1900 XTX*

An easy way to specifically increase our computers 3D-performance is to overclock the graphics card. In the case of ATI graphics cards, a utility called ATI Tool is recommendable (<http://www.techpowerup.com/atitool/>). It also includes an artifact detection routine that let's the user see at a glance when the overclocking settings are too high. Proceed in overclocking steps of 5 MHz for the graphics processor and the memory. Test each new setting with ATI Tool's artifact detection routine as well as a 3DMark05 benchmark run. Additionally, you can (and should) also run some 3D games to check for artifacts and ensure the system's stability. If you find any artifacts, reduce the frequency by 5 – 10 MHz.

The same limiting factors apply to graphics cards and CPUs, namely voltage and cooling. There are a great number of third-party upgrades that can improve the graphics card cooling. Advanced air-cooling solutions can enable a speed increase of 10 – 30 MHz. Water coolers, sub-zero kits and even liquid-nitrogen solutions are also available for graphics cards, helping to push their chips to the limit.

## Overclocking ATI Radeon X1k series in CrossFire Mode

Tools needed:

ATI Tool Beta 12

Download from: <http://www.techpowerup.com/downloads/220>

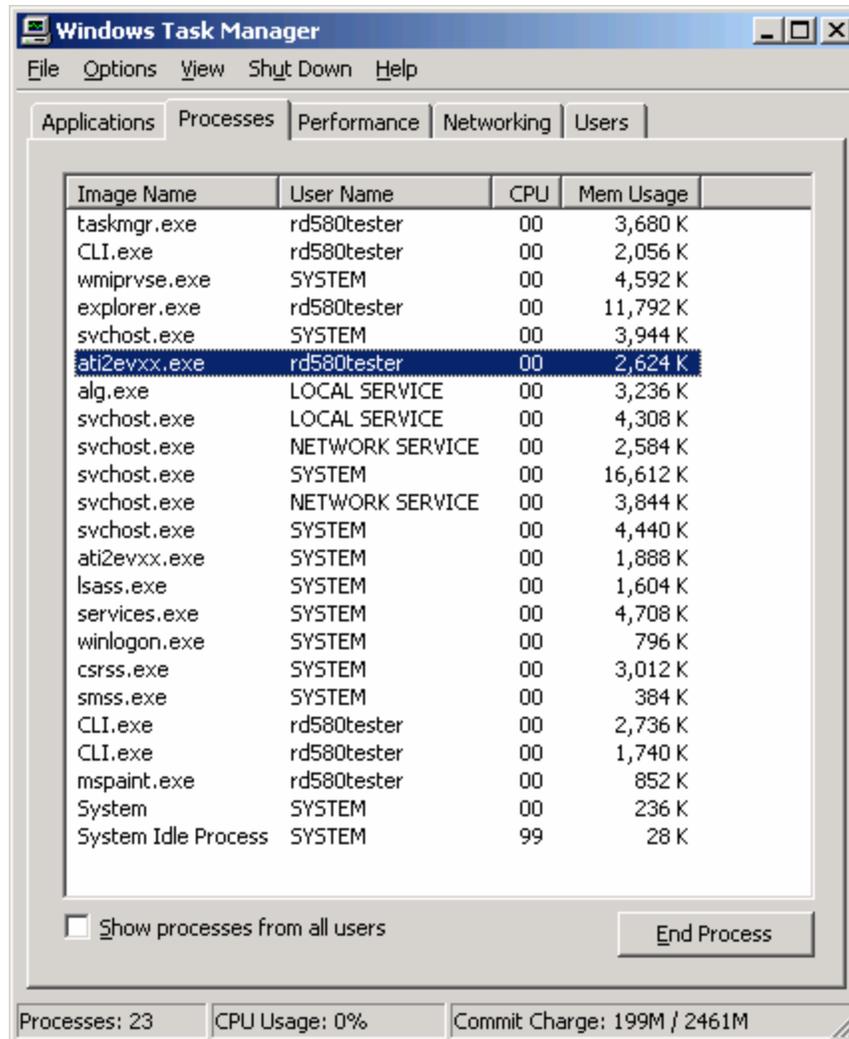
### Step 1:

Enable CrossFire from the ATI Catalyst Control Center



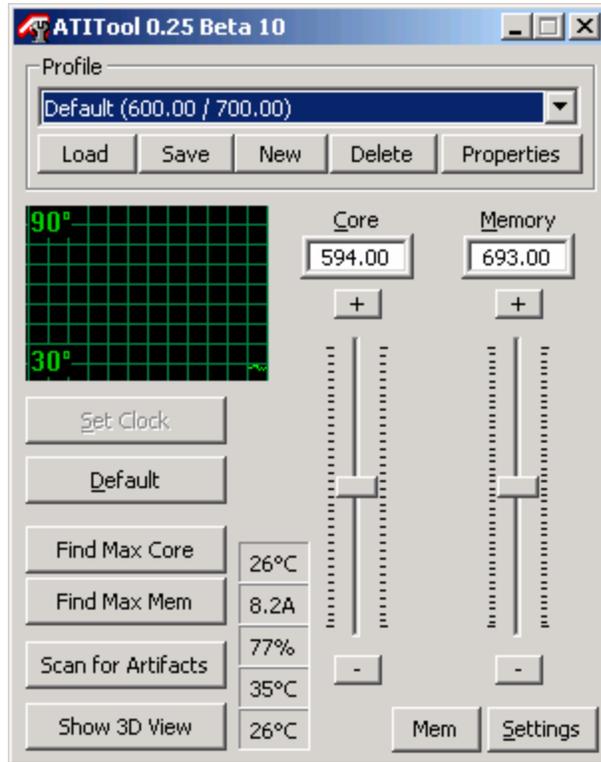
**Step 2:**

Shut down Ati2evxx.exe services. Press Ctrl+Alt+Del to bring up the Windows Task Manager and select the ati2evxx.exe service from the list press the "End Process" button. Do the same for the second ati2evxx.exe service too.



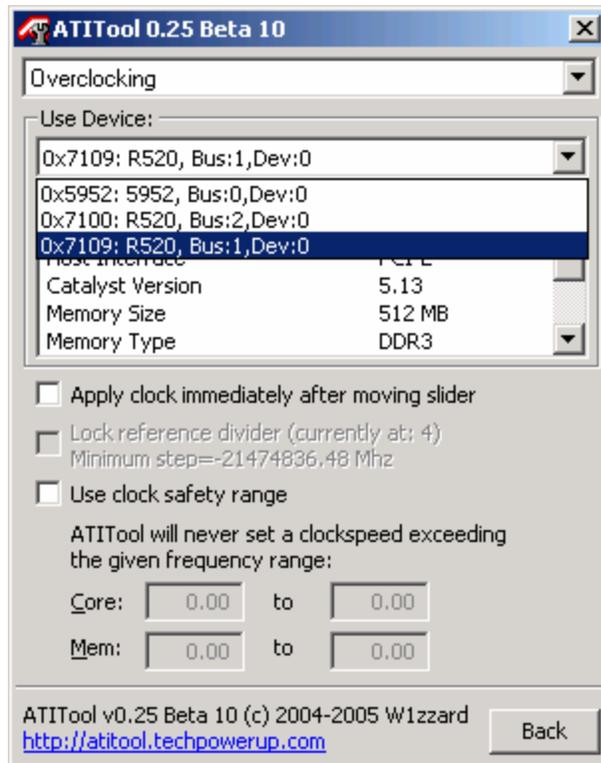
**Step 3:**

Download and install ATI Tool Beta 12 (<http://www.techpowerup.com/downloads/220> ). Once installed open up the tool and click the "Settings" button to access the device selection and fan and voltage adjustment.



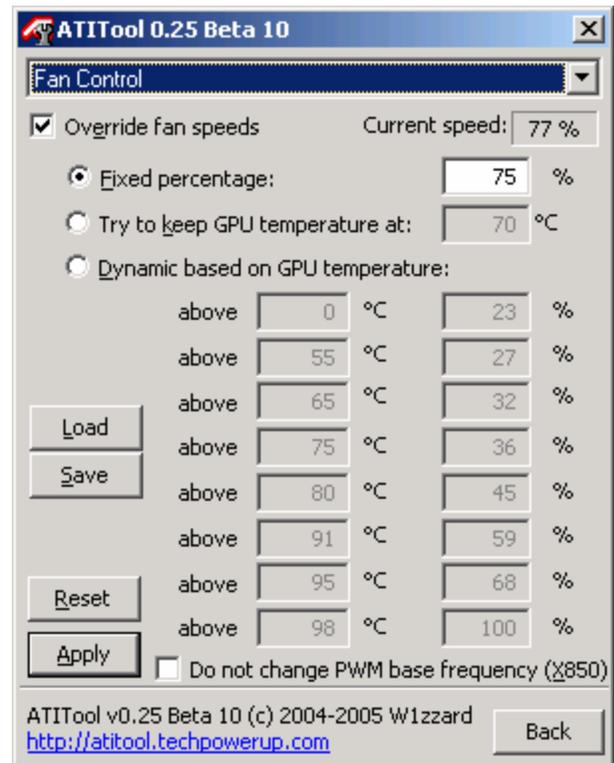
**Step 4:**

You can select the adapter you wish to Overclock from the "Use Device" menu, for X1800XT 0x7100 is the Slave card and 0x7109 is the Master card.

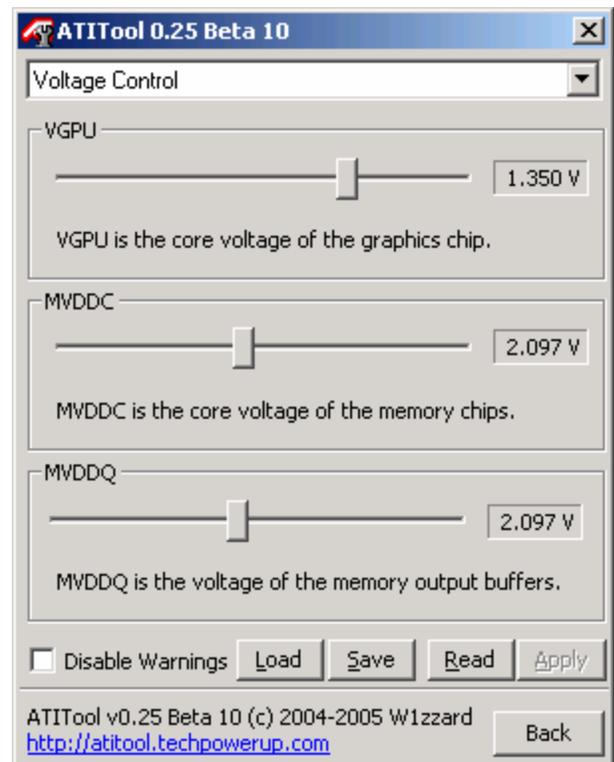


**Step 5:**

Before you push the “Back” button and adjust the clock speed for the selected device it is recommended to adjust the fan speed and GPU voltage to correct level. The recommended settings (for R520) are shown aside.



Click “Apply” to set the desired value.

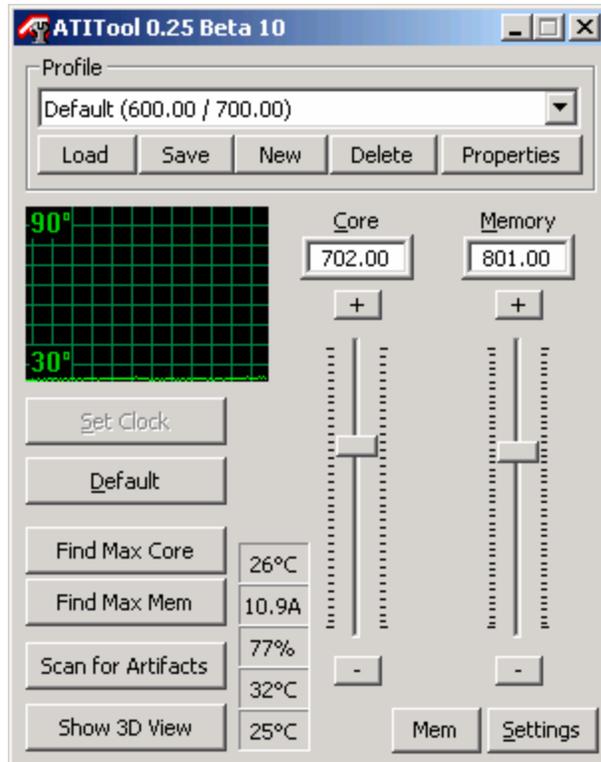


Click “Apply” to set the desired value.

**Step 6:**

Once fan speed and VGPU are at correct levels you can click the “Back” button and adjust the clock speeds for the selected device.

Example



**Repeat Steps 4 – 6** and adjust identical values to the other adapter.

If you face problems using this method there is an alternative approach available. It's described in detail in the following location.

<http://www.muropaketti.com/3dmark/r520/cf/oc/>

## General Advice

Here are a few tips to help improve the overclocking results and system performance:

- The heat exchange between the (graphics-)processor and the heatsink can be improved by using a high-quality thermal interface material (e.g. Arctic Silver 5).
- Smoothing the contact area of the heatsink with sandpaper (also called "lapping") further improves heat exchange.
- Don't forget that the voltage regulators on the mainboard and the graphics card also require extra cooling when overclocked. Consider placing an extra fan in the case to increase airflow and cool specific components.
- Always use the most recent drivers for your graphics card.
- Ensure that no other programs are running in the background when determining benchmark scores.

## Sami's Recommended Hardware for Overclocking

Motherboards: ASUS A8R32-MVP (ATI CrossFire Xpress 3200)

CPU: AMD FX-57 (SanDiego), AMD A64 3000-3500+ (Venice), AMD A64 3700+ (SanDiego)

RAM: OCZ VX4000 2x512MB (UTT), Mushkin RedLine 4000 2x512MB (UTT), Crucial Ballistix (Micron), Kingston HyperX PC3200UL 2x512MB (TCCD), OCZ EL PC3200 Rev2 (TCCD)

Graphics Cards: ATI Radeon X1900 series, ATI Radeon X1800 series, ATI Radeon X8x0 series

PSU: PC Power&Cooling 850W SLI, OCZ PowerStream 520W, FSP Group Epsilon 700W

AIRCOOLING: ThermalRight XP-90C / XP-90, AeroCool GT-1000, Zalman CNPS 7700CU

WATERCOOLING: Asetek Antarctica Waterblock, Danger Den RBX, Silverprop Cyclone Evolutions V2.0, Swiftech MCW6000

PHASE CHANGE COOLING: Asetek VapoChill LS, ExtremePrometeia

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