



# User Guide

## NVIDIA nForce 590 SLI Technology Chipset Overclocking

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# Document Change History

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01	05/17/06	WZ, TS, NSmith	Initial release.

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# NVIDIA nForce 590 SLI Technology Chipset Overclocking

The purpose of this document is to guide users through overclocking NVIDIA nForce 590 SLI technology chipset and use of the numerous tools and features that will boost system performance, enhancing end-user gaming experience.

Overclocking PCs was once quite difficult and required people to physically change hardware. In the past, companies that designed motherboards, CPUs, memory, and graphics processor units were not supportive of overclocking nor were they supportive of allowing users to tamper with qualified and tested settings.

Things have changed recently, however. Companies are more accommodating of the urgent requests PC enthusiasts make. In fact, ASIC designers now incorporate a lot of performance and overclocking headroom in the chips they produce. Nowadays, with the availability of highly overclockable PC components and the utilities that allow users to easily attain higher performance, overclocking has moved into the mainstream.

NVIDIA® GPUs have enjoyed good reputations as products that are highly overclockable. These products have provided higher performance for PC gaming enthusiasts searching for the ultimate gaming experience.

NVIDIA specifically designed the NVIDIA nForce® 590 SLI™ technology chipset, based on the new AMD AM2 Athlon processor, with overclocking enthusiasts in mind. Even though the chipset itself is highly overclockable, NVIDIA built an entire support platform around the NVIDIA nForce 590 SLI core logic. This platform includes:

- ❑ Software utilities such as the newly redesigned NVIDIA nTune 5.0 and its highly sophisticated SBIOS
- ❑ Special high-performance memory with Enhanced Performance Profiles Technology
- ❑ Recommended CPU coolers
- ❑ NVIDIA SLI™ technology.

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## Key Concepts

Overclocking refers to operating PC components beyond what the manufacturer guarantees. When overclocking is not carried on with care, it may lead to system instability, crashes and loss of data, and may even destroy components. However, when overclocking is performed attentively, it increases overall system performance quite dramatically.

## Cooling

Cooling PC components sufficiently is critical to overclocking. Keeping the CPU, GPU, or overall system cool all contribute to overall system overclockability. Otherwise, higher component temperatures lead to operation instability and increased power consumption.

Theoretically, frequency is directly proportional to power and temperature. The higher the frequency, the more the power consumed and the hotter the device becomes. In order to achieve higher frequencies, component temperatures should be kept as low as possible. With proper cooling, overclocking is highly attainable.

The most commonly cooling techniques are air cooling with fan-mounted heat sinks and water cooling blocks. Even though water cooling is harder to install, it achieves higher overclockability in comparison to air cooling because it keeps temperatures lower. With technological advancements, air cooling has improved in performance providing the means for overclocking. Even so, water cooling CPUs and GPUs is becoming more widely accepted.

For NVIDIA recommended CPU coolers, visit [www.SLIZone.com/nForce](http://www.SLIZone.com/nForce) for a list of components.

## Power Supply Units

Power supply units are also important when it comes to overclocking. Increasing system performance leads to increased power consumption by the overclocked components. Having a power supply that generates enough power with headroom is essential in guaranteeing system stability. Check the following site for a list of power supplies suitable for SLI systems:

[www.slizone.com/object/slizone2\\_build.html#certified\\_powersupplies](http://www.slizone.com/object/slizone2_build.html#certified_powersupplies).

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## Glossary of Terms

<b>3DMark</b>	Synthetic 3D benchmark that provides a measure of graphics performance. It is also often used to test a system for stability.
<b>AMD Cool'n'Quiet™ Technology</b>	Technology that changes CPU frequency dynamically depending on power and thermal requirements of a CPU. Because it limits the overclockability of an AMD CPU, it needs to be turned off for best results. For more information, visit this link <a href="http://www.amd.com/us-en/Processors/ProductInformation/0,,30_118_9485_9487%5E10272_00.html">http://www.amd.com/us-en/Processors/ProductInformation/0,,30_118_9485_9487%5E10272_00.html</a> .
<b>BIOS</b>	Basic Input Output System.
<b>CPU HTT</b>	HyperTransport interface connecting the AMD CPU to NVIDIA nForce 590 SLI SPP. Nominally, it runs at 1 GHz clock or 4 GBps in downstream and upstream directions.
<b>CPU HTT Reference Clock</b>	Clock signal of the CPU HyperTransport link. It has impact on HyperTransport bus speed, CPU frequency, as well as memory frequency. It is 200 MHz nominally.
<b>Multiplier</b>	Multiplier for your front-side bus (FSB). Multiply this value by the speed of your FSB to get the end CPU clock speed: CPU Clock Speed = Multiplier x FSB
<b>Prime95</b>	Program that searches for very large prime number. It contains stability tests and is an indication of how robust a system is.
<b>Serious Sam</b>	Video game which is used by overclockers to test system robustness.
<b>t<sub>RAS</sub></b>	Row Address Strobe time is the amount of time between a row being activated by precharge and deactivated. A row cannot be deactivated until t <sub>RAS</sub> has completed. The lower t <sub>RAS</sub> is, the faster the performance. If it is set too low, it can cause data corruption by deactivating the row too soon.
<b>t<sub>WR</sub></b>	Write Recovery time is the memory timing that determines the delay between a write command and when a precharge command is set to the same bank of memory.
<b>t<sub>WRRD</sub></b>	W to R Termination Turnaround time is the number of clock cycles between the last write data pair and the subsequent READ command to the same physical bank.
<b>t<sub>RCD</sub></b>	RAS to CAS Access time is the amount of time in cycles for issuing an active command and the read/write commands.

<b>t<sub>RRD</sub></b>	RAS to RAS Delay is the amount of cycles that it takes to activate the next bank of memory. The lower the timing, the better the performance but it can cause instability.
<b>t<sub>REF</sub></b>	Refresh Rate is the amount of time it takes before a charge is refreshed. If the charge is not refreshed enough, the signal loses its charge and corrupts data. It is measured in microseconds.
<b>t<sub>RP</sub></b>	Row Precharge time is the minimum time between active commands and the read/writes of the next bank of the memory module.
<b>t<sub>RWT</sub></b>	Read to Write Delay is when a write command is received, this is the amount of cycles for the command to be executed.
<b>t<sub>RDRD</sub></b>	Read to Read Timing is the number of clock cycles between the last read and the subsequent READ command to the same physical bank.
<b>t<sub>RC</sub></b>	Row Cycle time is the minimum time in cycles it takes a row to complete a full cycle. This can be determined by $t_{RC} = t_{RAS} + t_{RP}$ . If $t_{RC}$ is set too short, it can cause data corruption. If $t_{RC}$ is set too long, stability increases at the expense of performance.
<b>t<sub>WTR</sub></b>	Write to Read Delay is the amount of cycles required between a valid write command and the next read command. Lower is better performance but can cause instability.
<b>t<sub>WRWR</sub></b>	Write to Write time is the number of clock cycles between the last write and the subsequent WRITE command to the same physical bank.
<b>t<sub>CL</sub></b>	CAS latency is the number of clock cycles between the memory receiving a <b>READ</b> command and actually starting to read
<b>t<sub>CPC</sub></b>	Command per Clock has only two values: 1 and 2. When set to 1, it provides the best performance but limits memory frequency. In order to overclock memory frequency, a value of 2 is more reasonable.



# Overclocking the NVIDIA nForce 590 SLI Technology Chipset

This section describes how to maximize the performance of an NVIDIA nForce 590 SLI PC system. It provides a systematic approach to unleashing its immense performance potential. Bus speeds, bandwidth and processor core speeds — both CPU and GPU core speeds — are the main contributing factors to boosting overall system performance.

This section describes how to adjust settings for the major chip interconnects and components that affect performance. Figure 1 shows a high-level diagram of components in a PC system:

- ❑ AMD Athlon CPU core frequency
- ❑ DDR2 memory interface bandwidth and latency
- ❑ CPU-NVIDIA nForce 590 SLI SPP HyperTransport bus
- ❑ NVIDIA nForce 590 SLI SPP-NVIDIA nForce 590 SLI MCP HyperTransport bus
- ❑ NVIDIA nForce 590 SLI SPP/MCP PCI Express bus
- ❑ GPU core and memory frequency

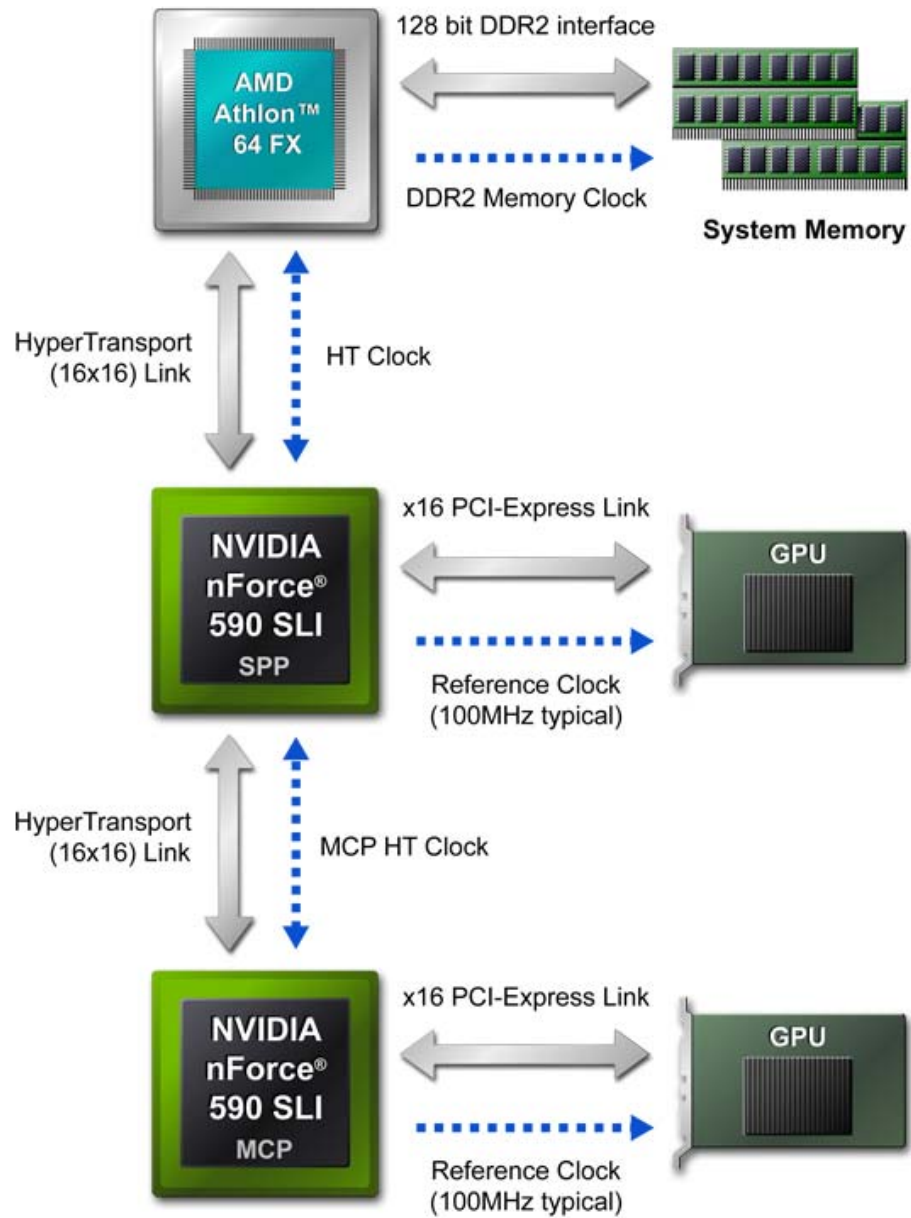


Figure 1. High-level System Diagram

# Disable AMD Cool'n'Quiet Technology

Before overclocking, disable the AMD Cool'n'Quiet™ technology.

The AMD Cool'n'Quiet technology must be disabled in order to enable stable overclocking without limiting maximum achieved CPU performance. Use the following procedure to disable this feature:

1. Set AMD Cool'n'Quiet to Disable on the Advanced Power Management BIOS menu as shown in Figure 2.

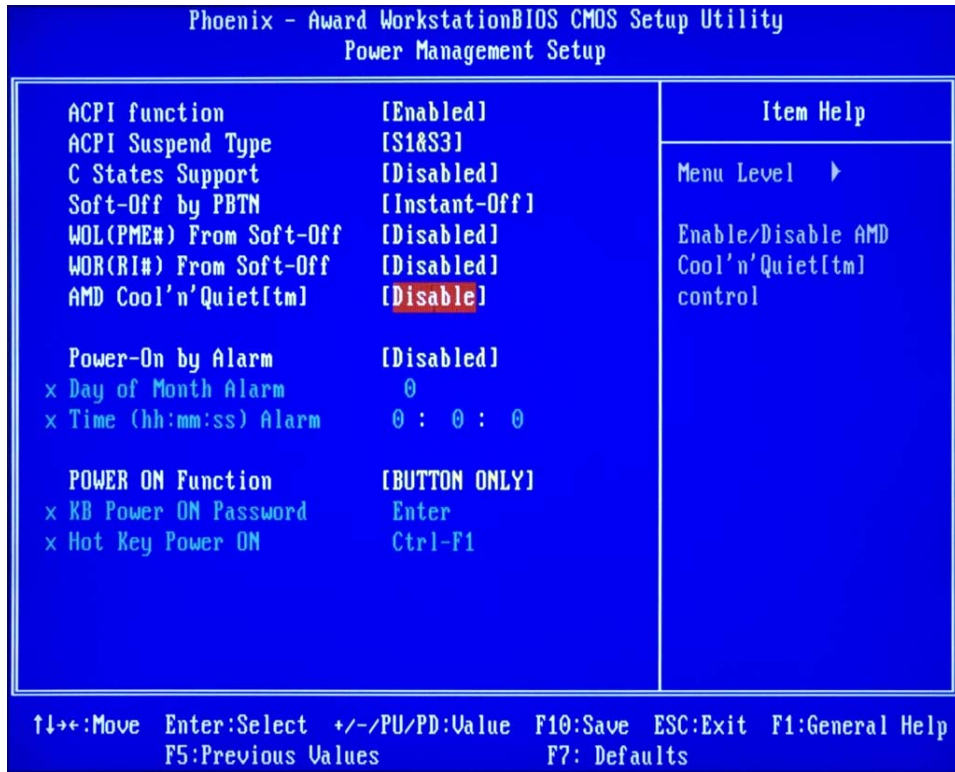


Figure 2. Power Management Setup SBIOS Menu

2. Save the configuration.
3. Exit from the BIOS.

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## A Systematic Approach

A step-by-step approach helps simplify the complex task of overclocking, described in the following steps:

1. CPU reference clock (HTT)
2. CPU HyperTransport interface speed
3. CPU core clock frequency
4. DDR2 memory interface frequency & timing
5. Balance the results achieved with CPU frequency, HyperTransport, and memory overclocking
6. Overclock the PCI Express x16 buses
7. Increase the NVIDIA nForce 590 SLI MCP HyperTransport bus frequency
8. Boost the GPU core and memory frequencies

Each of the following sections provides guidance on how to tweak an NVIDIA nForce 590-SLI technology chipset based PC system based on this step-by-step approach.

The first steps for overclocking the CPU reference clock, CPU HyperTransport bus, CPU frequency, memory interface, PCI Express, and MCP HyperTransport link are done in the SBIOS. Some system settings, such as CPU multiplier and memory drive strength parameters, can only be adjusted in the SBIOS.

Once you use the SBIOS for an initial pass at overclocking, you then fine-tune the settings with NVIDIA nTune 5.0. NVIDIA nTune provides flexibility to adjust majority of parameters that affect overclocking in a Windows environment, allowing for dynamic system overclocking and stability testing without the need for constant system reboots.

**Note:** Start NVIDIA nTune 5.0 from **Programs > NVIDIA Corporation > nTune**. Refer to the application's on-line help for more information about the nTune 5.0 features and settings.

The system configuration used in developing this guide is as follows:

- ❑ **CPU:** AMD Athlon™ FX-62
- ❑ **Motherboard:** Foxconn C51XEM2AA
- ❑ **Graphics:** Dual NVIDIA GeForce 7900GTX SLI
- ❑ **CPU Cooler:** Zalman CNPS9500AM2
- ❑ **Memory:** Corsair TWIN2X2048-8500C5 with Enhanced Performance Profiles (EPP) Technology

## CPU Reference Clock

CPU reference clock refers to the HyperTransport reference clock signal of the bus connecting the CPU to NVIDIA nForce 590 SLI SPP chip. Typically, CPU reference clock frequency is 200 MHz.

Updating the CPU reference clock requires several steps, described in this section:

1. Change system clocks in system BIOS menu.
2. Change memory timings in system BIOS menu.
3. Change system voltages in system BIOS menu.
4. Fine-tune the CPU reference clock in the motherboard settings control panel of nTune.
5. Test the stability of the system

Because the CPU reference clock value directly impacts CPU core frequency and HyperTransport bandwidth, take some time to determine the maximum attainable CPU reference clock. To do so, use the following formulas:

$$\text{CPU core frequency} = \text{CPU reference clock (MHz)} \times \text{CPU multiplier}$$

$$\text{HyperTransport bus speed} = \text{CPU reference clock (MHz)} \times \text{HT multiplier}$$

## Change System Clocks

Before you can find the maximum CPU reference clock the NVIDIA nForce 590 SLI motherboard is capable of achieving, you must make sure all reasons for instability in the system are eliminated. Possible causes of instability include undesirable values for CPU core clock, HyperTransport frequency, and memory frequency. Make sure these are set well within their specifications in order to isolate the root cause of issues that may arise from increasing the CPU reference clock frequency.

When the system shows signs of instability, use the following procedure and the BIOS menu shown in Figure 3 to reconfigure the system to better isolate the root cause of issues:

1. Lower the **CPU Multiplier** to **x9** (for FX-62 CPU, this value is sufficient; for other AM2 CPUs x5 will work) in **System Clocks** BIOS menu.
2. Change **CPU <-> nForce SPP** multiplier to **x3**.
3. Set the **Ref Clock (HTT)** to **250 MHz** as a starting point. You can fine-tune the CPU reference clock later using nTune.

Figure 3 shows the proper configuration in preparation for overclocking the CPU reference clock.

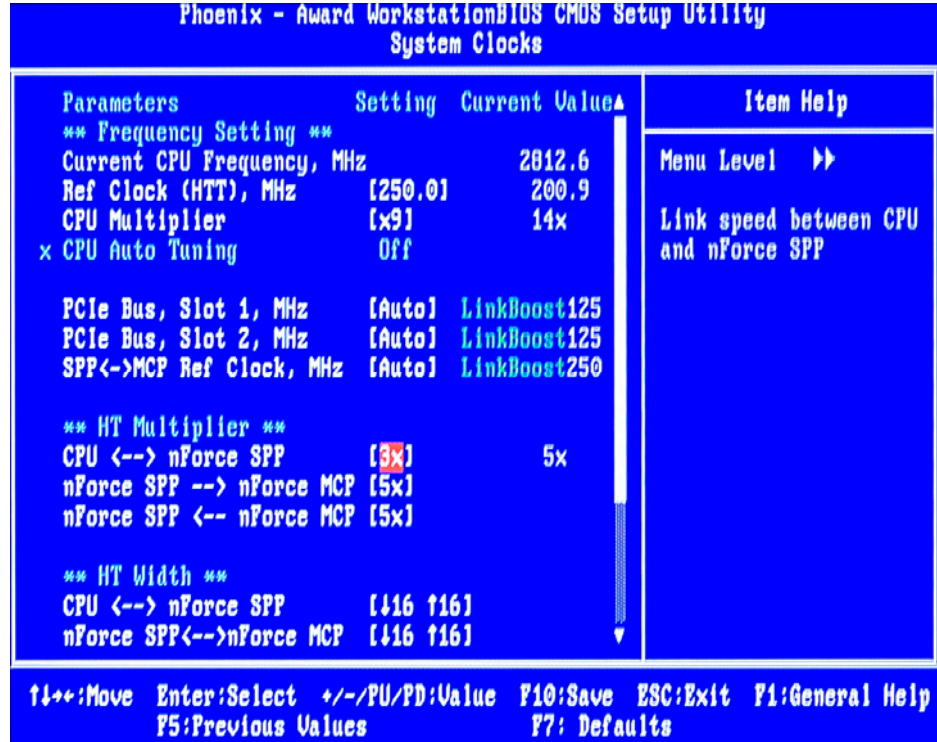


Figure 3. System Clock Setup for CPU Reference Clock Overclocking

## Set Memory Timings

Set memory frequency as low as possible from the **Memory Timings** BIOS menu, as shown in Figure 4:

1. Set **Timing Mode** to **[User limit]**.
2. Set **Memory Clock Limit** to **[DDR2 400]**.

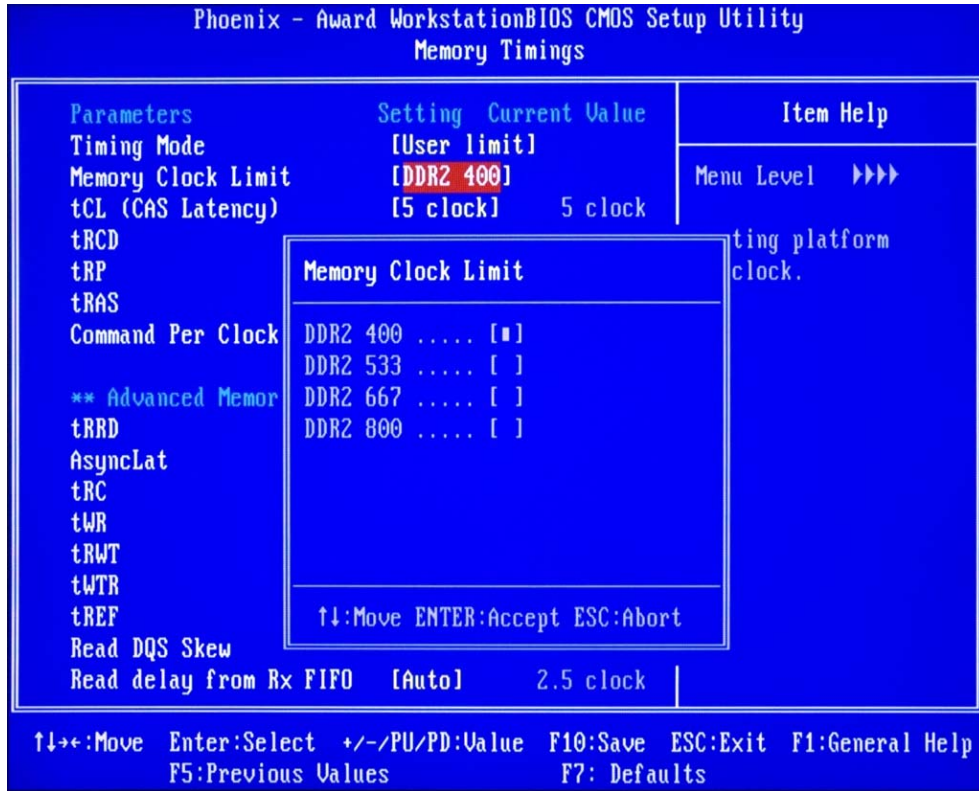


Figure 4. Memory Settings for CPU Reference Clock Overclocking

## Change System Voltages

To enable increases in the CPU reference clock frequency, increase the following voltages. Go to the **System Voltages** BIOS menu and change the following to match the values shown in Figure 5:

1. Change CPU core voltage, **CPU**.
2. Change HyperTransport interface core voltage, **HT CPU <-> nForce SPP**.
3. Change NVIDIA nForce 590 SLI SPP and MCP core voltage, **nForce SPP** and **nForce MCP**.

Phoenix - Award Workstation BIOS CMOS Setup Utility			
System Voltages			
Parameters	Setting	Current Value	Item Help
CPU	[1.5250V]	1.45V	
Memory	[2.125V]	1.88V	Menu Level ▶▶
HT CPU <-> nForce SPP	[1.400V]	1.20V	
HT nForce SPP <-> MCP	[1.400V]	1.30V	Core Voltage level for nForce MCP
nForce SPP	[1.400V]	1.19V	
nForce MCP	[1.600V]	1.49V	
Auxiliary	[Auto]	1.50V	

↑↓: Move    Enter: Select    +/-/PU/PD: Value    F10: Save    ESC: Exit    F1: General Help  
 F5: Previous Values    F7: Defaults

Figure 5. System Voltages for Reference Clock Overclocking

4. Save all BIOS settings.
5. Reboot to Windows.



## Fine-Tune CPU Reference Clock

Go to NVIDIA nTune 5.0 to adjust the frequency using the **Reference Clock (HTT)** setting from NVIDIA nTune **Motherboard Settings** control panel as shown in Figure 6. This action incrementally adjusts the reference clock and allows for dynamically testing for system stability.

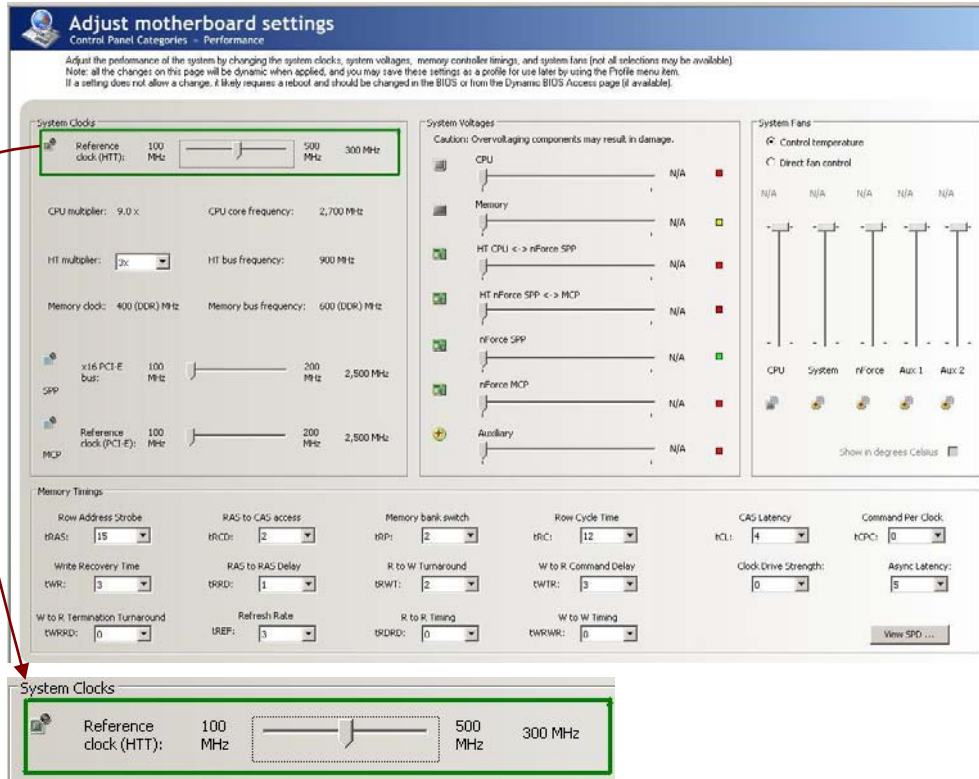


Figure 6. Adjusting CPU Reference Clock using NVIDIA nTune 5.0

**Tip:** In nTune, use **Left** and **Right** keyboard buttons to make small increments or decrements for the CPU **Reference clock (HTT)** slider value. Incrementing voltages slightly can provide more overclockability.

A CPU reference clock value of 300 MHz is an achievable target, and in some cases the interface can be overclocked much more depending on the speed of the AMD FX-62 CPU and nForce 590 SPP chips. Chip speeds vary due to the manufacturing process variations of the ASICs—application specific integrated circuits.

## Test System Stability

To test system stability, run the NVIDIA Stability Test for at least two hours as seen in Figure 7. Additionally, running 3DMark, Prime95, or a GPU intensive game like Serious Sam II for an extended period of time allows you to get a sense of overall system stability.

**Note:** CPU reference clock values between 314 MHz to 320 MHz may not provide system stability.

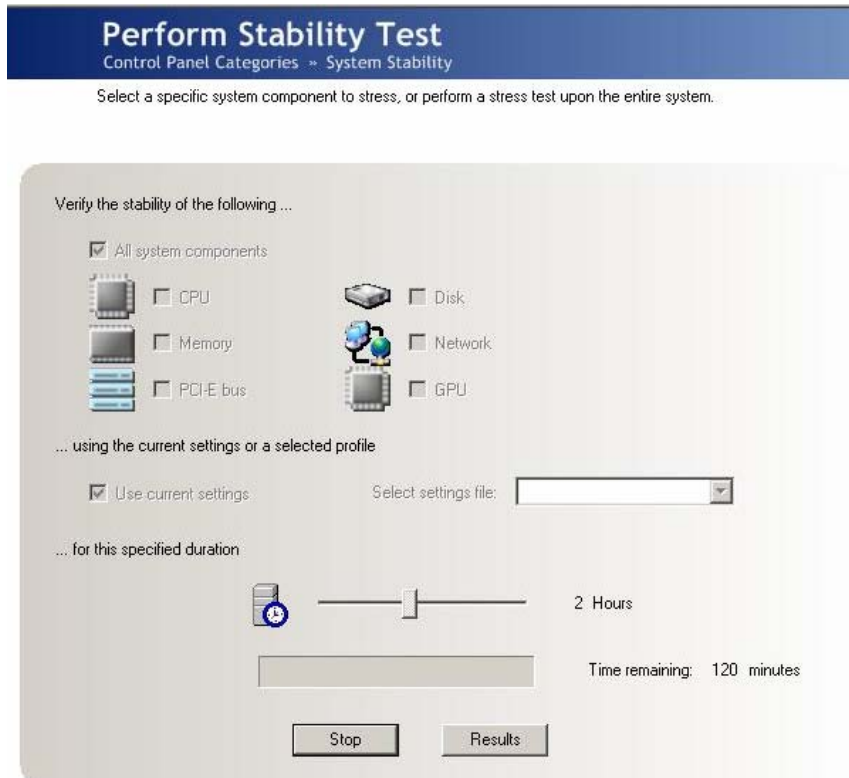


Figure 7. NVIDIA nTune 5.0 Stability Test

## CPU HyperTransport Overclocking

CPU HyperTransport (HTT) bandwidth (speed) is an important contributing factor to overall system performance. Its nominal effective bandwidth is 4 GBps running at 1 GHz (200 MHz × 5) upstream and downstream. CPU HTT bandwidth is directly proportional to CPU reference clock as mentioned earlier in *CPU Reference Clock* on page 9. It defines how fast data propagates between PC devices and CPU and system memory to maximize throughput. Furthermore, CPU HTT bus speed has a tremendous impact on memory performance.

Use the following procedure to overclock CPU HyperTransport bandwidth:

1. Eliminate all sources of instability by configuring **System Clocks** BIOS settings as shown in Figure 8.
  - a) Lower the **CPU Multiplier** to **x10** (for FX-62 CPU, this value is sufficient and to be safe a x8 multiplier will work; for other AM2 CPUs x5 will work) in System Clocks BIOS menu.
  - b) Change **CPU <-> nForce SPP** multiplier to **x5**.
  - c) Set the **Ref Clock (HTT)** to **200 MHz** as a starting point. You can fine-tune the CPU reference clock later using nTune.

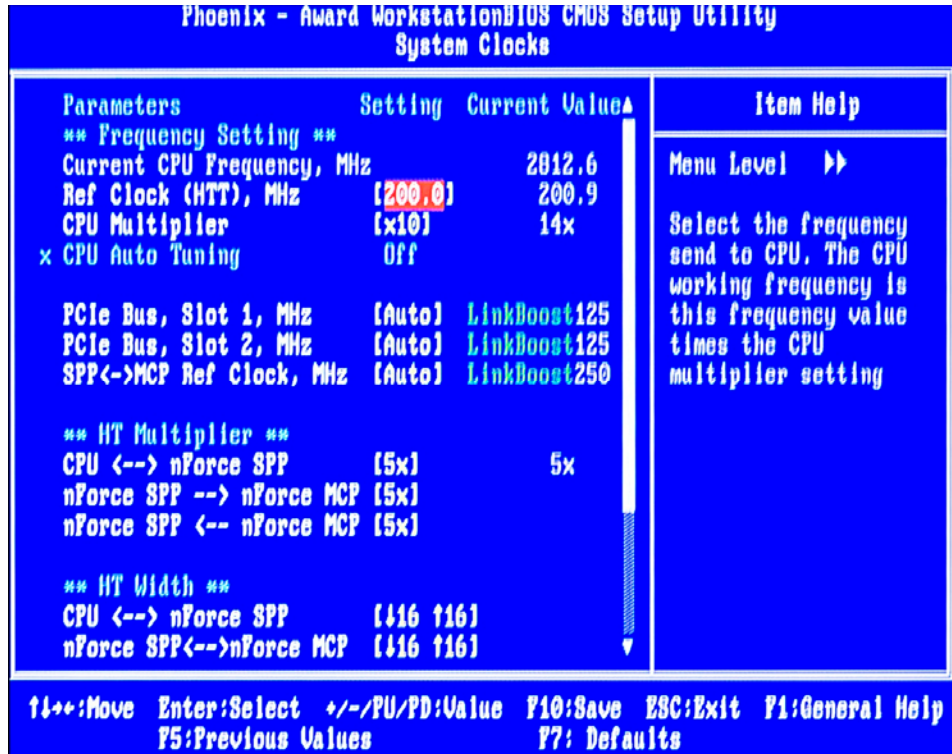


Figure 8. System Clocks BIOS Configuration for CPU HTT Overclocking

**Note:** In the **Memory Timings** BIOS menu, make sure **Memory Clock Limit** is set to **[DDR2 400]** as shown in Figure 4.

- Go to NVIDIA nTune to incrementally adjust and test the CPU HTT bus in Windows. Increasing the **Reference clock (HTT)** to 281 MHz provides a stable setting that effectively increases the CPU HyperTransport speed by 40% to 1.4 GHz, up from 1 GHz. (Check in using the NVIDIA nTune **Motherboard Settings** control panel shown in Figure 9).

The CPU HTT interface of NVIDIA nForce 590 SLI motherboards can support much higher speeds. Adjusting the voltage can help you reach increases of 50 to 60%.

You can achieve more overclocking by using better cooling systems or by incrementing voltages slightly (both through the BIOS settings and nTune). Remember that ASIC and board process variation affects the overclockability of a system.

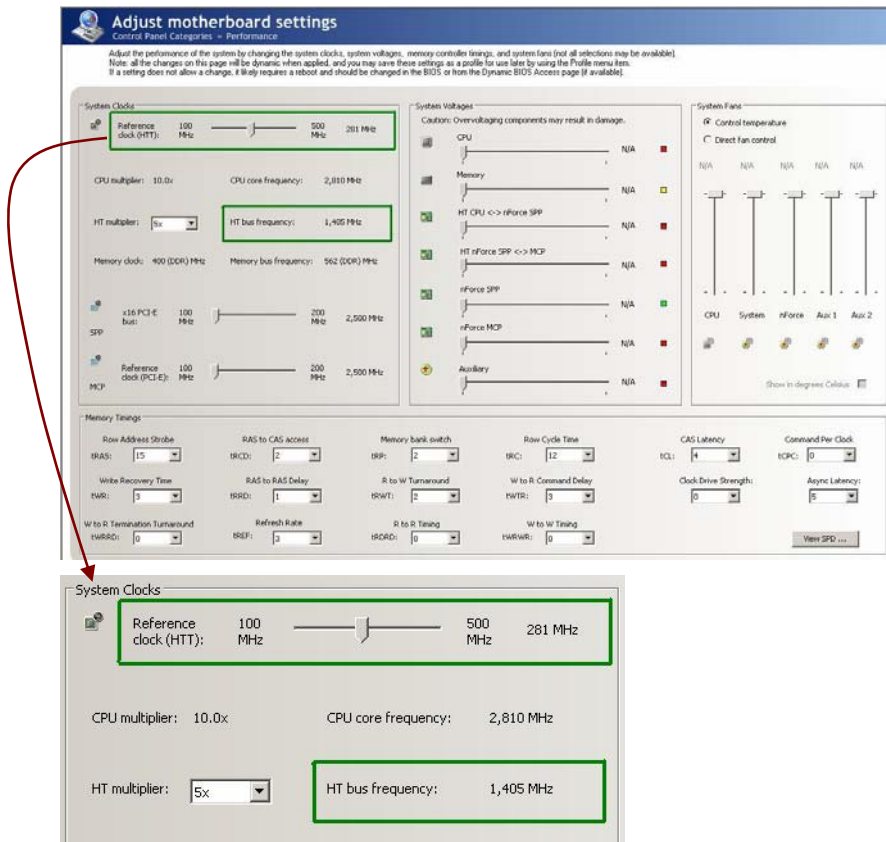


Figure 9. Adjusting HT Bus Frequency Using NVIDIA nTune 5.0

- Run a Stability Test or another application (for example, 3DMark or Serious Sam) to test system stability.

## CPU Core Clock

This section discusses how to effectively increase the CPU core clock of the AMD Athlon FX-62 CPU on NVIDIA nForce 590 SLI chipset. Before you proceed to overclock the CPU core clock, eliminate all other sources of system instability. Do so by keeping memory and CPU HyperTransport frequencies low.

Use the following procedure to overclock the FX-62 CPU:

1. Go to the **System Voltages** BIOS menu to change the following voltages (so they have exactly the same values as shown in Figure 5):
  - **CPU** core voltage
  - HyperTransport interface core voltage, **HT CPU <-> nForce SPP**
  - NVIDIA nForce 590 SLI SPP core voltage, **nForce SPP** and **nForce MCP**
2. Set memory frequency as low as possible from the **Memory Timings** BIOS menu so they have exactly the same values as shown in Figure 4.
  - a) Set **Timing Mode** to **[User limit]**.
  - b) Set **Memory Clock Limit** to **[DDR2 400]**.
3. Change the **System Clocks** settings to the values shown in Figure 10.
  - a) Change the **CPU Multiplier** to **x12** (for FX-62 CPU, this value is sufficient; for other AM2 CPUs x5 will work) in **System Clocks** BIOS menu.
  - b) Change **CPU <-> nForce SPP** multiplier to **x3**.
  - c) Set the Ref **Clock (HTT)** to **200 MHz** as a starting point.

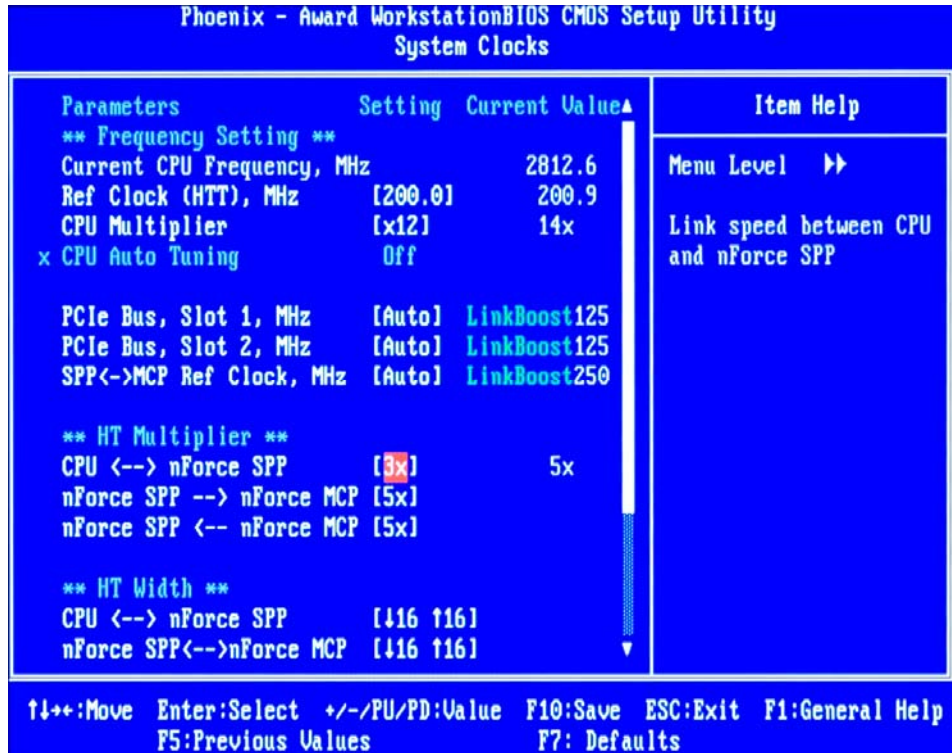


Figure 10. BIOS System Clocks Configuration for CPU Overclocking

- Save BIOS settings and exit.
- Use NVIDIA nTune 5.0 to change the CPU reference clock by changing the **Reference Clock (HTT)** setting.

The AMD Athlon FX-62 CPU runs at 2.8 GHz nominally. When you increase the reference clock, for instance, to 246 MHz from 200 MHz, you have overclocked the CPU to 3.07 GHz (256 MHz × 12). You can reach a higher CPU frequency with by using a better cooling system, by increasing CPU voltage, or both.

**Note:** Due to CPU manufacturing process variations, the overclock potential for CPUs varies. However, AMD FX-62 CPUs typically can overclock to 3.1 to 3.2 GHz using air cooling solutions with a NVIDIA nForce 590 SLI chipset.

## DDR2 Memory Interface Overclocking

Because so much of the memory controller settings can be tuned and because memory speeds depend on the CPU HTT reference clock and CPU multiplier, overclocking memory is complicated.

The two approaches to overclocking memory are to:

- Increase memory bandwidth by increasing frequency
- Decrease memory latency which may lead to frequency reductions

Since different memory devices exhibit different overclocking limitations, some are more suited for higher frequency while others are best for achieving low CAS latency. Because this memory device used with the nForce 590 provides higher performance with increased memory frequency than with reduced latency, this document focuses on techniques to increase memory bandwidth using Corsair TWIN2X2048-8500C5 with Enhanced Performance Profiles (EPP) technology.

**Rule of Thumb:** To decide which approach to overclocking memory works better for your memory device, calculate the reduction of CAS latency when the memory is overclocked and divide that value by the operating memory frequency. The smaller the value, the higher the throughput and performance will be.

Your two basic options are a faster clock with longer CAS latency (like  $t_{CL} = 5$ ) or a slower clock with shorter latency (like  $t_{CL} = 4$ ).

For example,  $5 \div CLK1$  might be smaller than  $4 \div CLK2$ . The settings with the smallest result will likely provide better performance, you would choose CLK and  $t_{CL} = 5$ .

The AM2 processor's memory controller architecture is such that the effective memory frequency is a function of the CPU's frequency and an internal memory clock divider. The CPU frequency is also a function of CPU reference clock, or CPU HyperTransport reference clock, as well as the CPU multiplier. The relationships are as follows:

$$\text{Memory frequency} = \text{CPU frequency (MHz)} \div \text{internal integer clock divider}$$

$$\text{CPU core frequency} = \text{CPU reference clock (MHz)} \times \text{CPU multiplier}$$

A built-in memory clock divider lookup table is used to calculate the memory frequency. The divider varies based on the memory timings selected (200 MHz, 533 MHz, 667 MHz, and 800 MHz). It increases as the CPU multiplier increase. For DDR-800 memory setting with an even-numbered CPU multiplier of 10 or above, it is easy to calculate the memory frequency without knowing what the internal clock divider is. Multiply 800 MHz by the increase in CPU reference clock with respect to 200 MHz:

$$\text{Memory frequency} = 800 \text{ MHz} \times \text{CPU reference clock} \div 200 \text{ MHz}$$

Before you proceed to overclock the CPU core clock, eliminate all other sources of system instability.

Use the following procedure to systematically overclock the DDR2 memory interface:

1. Turn off **SLI-Ready Memory** feature in the **Memory Configuration** BIOS menu as shown in Figure 11.

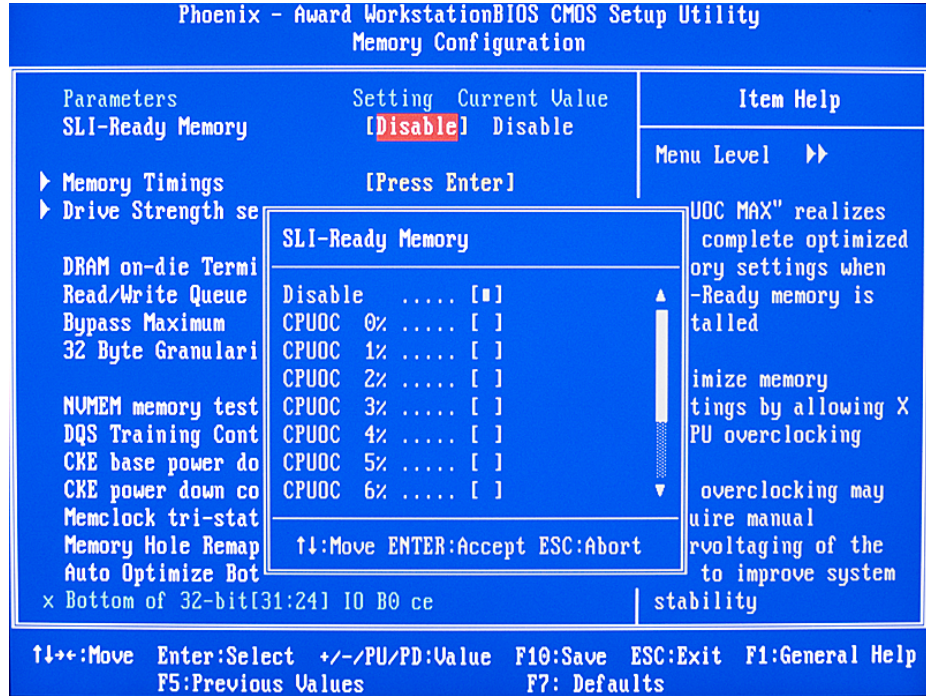


Figure 11. Disabling SLI-Ready Memory in BIOS

2. Go to the **System Voltages** BIOS menu shown in Figure 12 to increase the **Memory** voltage to 2.125 V. To achieve higher clocks, it is often required to increase voltage levels while maintaining low device temperatures.

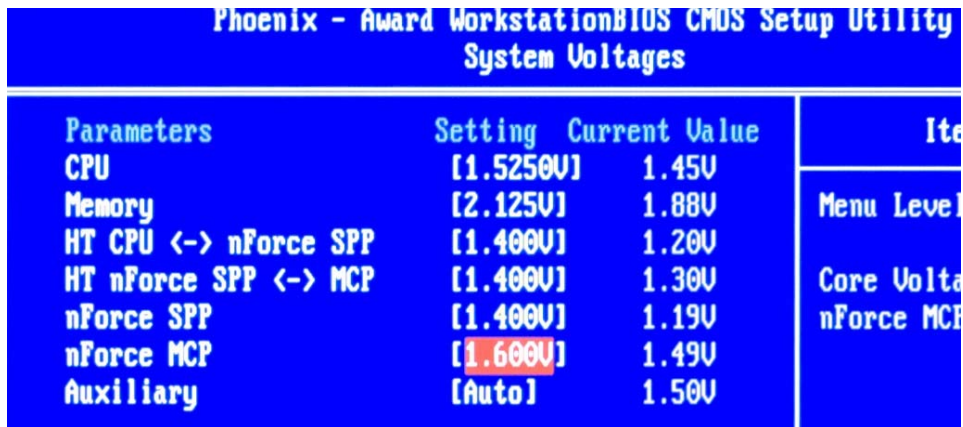


Figure 12. BIOS System Voltages Configuration for Memory Overclocking



3. Change the **System Clocks** BIOS menu settings so they have exactly the same values as shown in Figure 10.
  - a) Change the **CPU Multiplier** to **x12** (for FX-62 CPU, this value is sufficient; for other AM2 CPUs x5 will work) in System Clocks BIOS menu.
  - b) Change **CPU <-> nForce SPP** multiplier to **x3**.
4. Go to the **Memory Timings** BIOS menu shown in Figure 13 and set the values to match.

Enhanced Performance Profiles (EPP) Technology provides a baseline for overclocking. Enabling this technology reveals some key memory performance settings. Adjustments however, are needed to overclock beyond what EPP technology can provide.

The **Memory Timings** BIOS menu displays EPP settings when SLI memory is enabled and the system is rebooted.

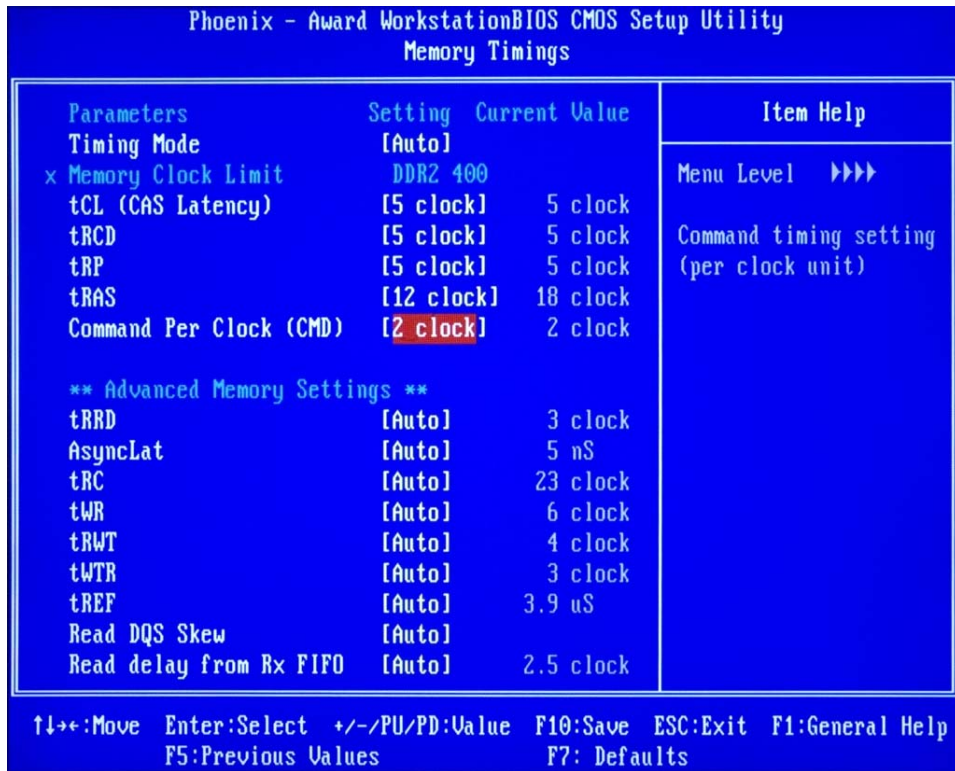


Figure 13. BIOS Memory Timings Settings for Memory Overclocking

- Go to the **Driver Strength Settings** BIOS menu shown in Figure 14.  
The Corsair TWIN2X2048-8500C5 memories can overclock further when you lower the chip-select (**CS**), address (**MA**), and clock (**MCLK**) drive strength settings. Drive strength defines how sharp the edge of a signal transition is. Lowering the signal drive strength reduces noise injected to neighboring signals and helps increase frequency.

**Note:** If you use different memory types, you may discover other tricks and optimizations by experimenting. For instance, raising the drive strength may be more a more effective way to tune memory for low latency but less effective for increasing frequency.

For example, OCZ Technology memories with EPP, lowering data (**MD**) and **DQS** drive strengths by 0.75x produces higher overclocking results.

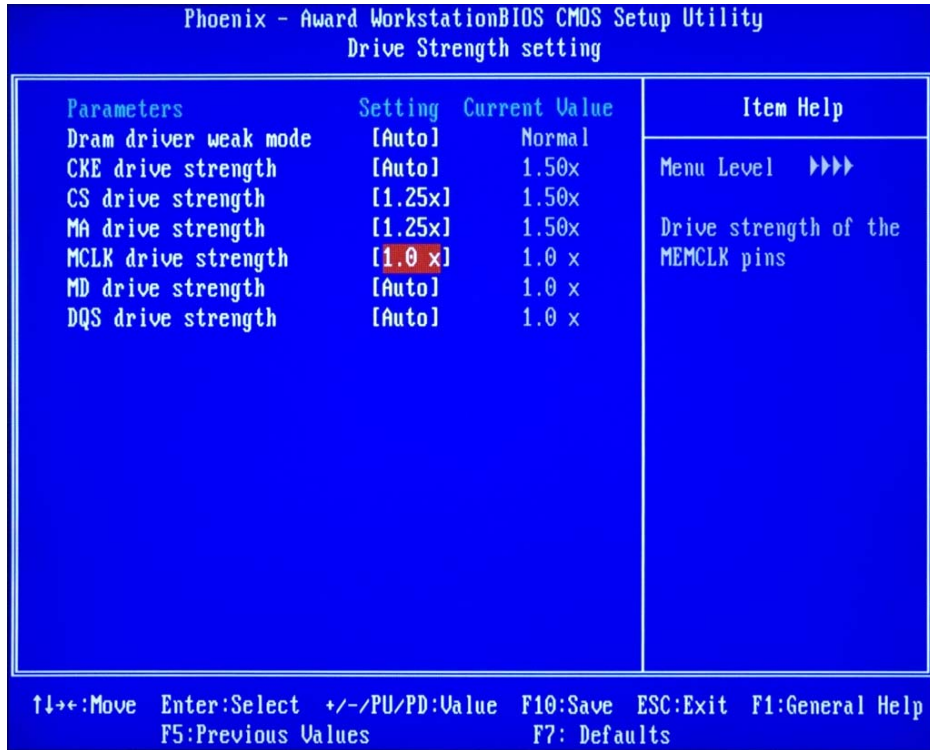


Figure 14. BIOS Drive Strength Setting for Memory Overclocking

- Save BIOS settings and exit.
- Using NVIDIA nTune 5.0 in Windows, adjust **Reference Clock (HTT)** to directly change memory frequency, shown in Figure 15.

For DDR2-800 memory, use an even-numbered CPU multiplier of 10 and above:

$$\text{Effective Memory Frequency} = 400 \text{ MHz DDR} \times \text{Reference Clock (HTT) Increase}$$

For example, if the reference clock HTT is set to 250 MHz, the effective memory frequency will be 500 MHz DDR or 1 GHz:

$$400 \text{ MHz DDR} \times (250 \text{ MHz} \div 200 \text{ MHz})$$

NVIDIA nTune will report the effective frequency of memory in megahertz.

Figure 15 shows how nTune can be used to overclock memory. Adjusting memory timings drive strengths, and possible memory and CPU voltages ever so slightly might be necessary to achieve higher overclockability. Note that the **Clock Drive Strength** is **2** rather than 0. Also, the **Reference clock (HTT)** setting is 277 MHz rather than 300 MHz.

- Run the Stability Test or 3DMark for an extended period of time to test system stability with the overclocked memory. The Corsair TWIN2X2048-8500C5 memories can run well beyond 1.1 GHz.

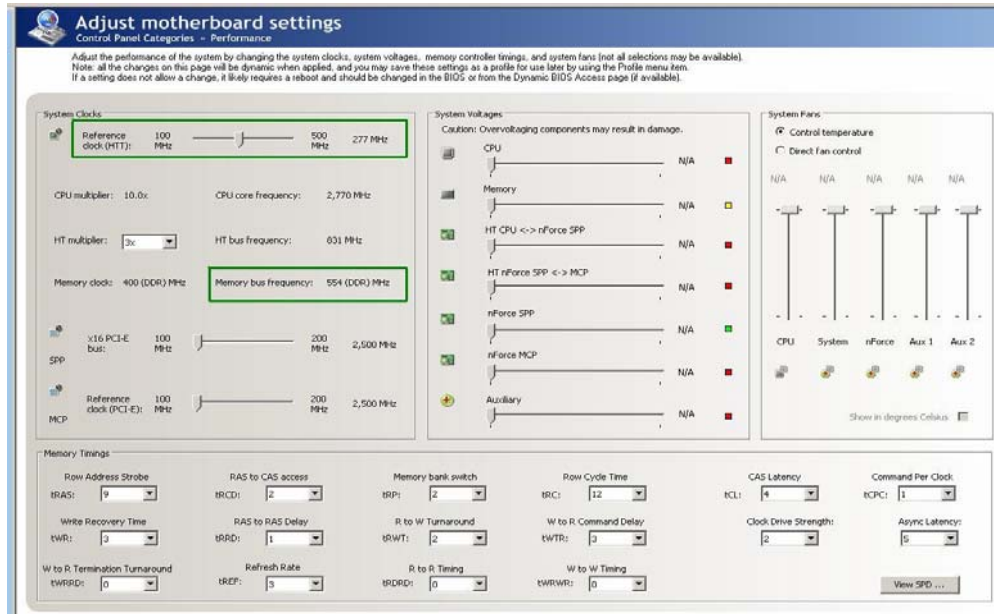


Figure 15. Memory Overclocking using NVIDIA nTune 5.0

**Note:** Using odd-numbered CPU multipliers generate lower memory frequency values than even-numbered multipliers even when using the same reference clock (HTT) value.

## Balance CPU Frequency, HyperTransport, and Memory Overclocking Results

Since CPU frequency, HyperTransport bandwidth, and memory frequency overclocking all depend on CPU HTT reference clock, it is often difficult to obtain a specific configuration that would generate a maximum overclocking for all. Hence, overclocking tradeoffs must be made in order to generate the optimum achievable performance. Higher CPU frequency generally influences performance the most in comparison to HyperTransport and memory interfaces. 3D applications are generally CPU-bound, so increasing CPU frequency tremendously boosts performance. A frequency combination that maximizes CPU frequency is often the best tradeoff.

Review what you have achieved by following the steps in the previous sections will provide some guidance as to how a combination can be obtained. As described in the section called “*CPU HyperTransport Overclocking*” on page 15, the CPU HyperTransport interface is capable of running at about 1.4 GHz (280 MHz × 5). The CPU frequency achieved is 3.07 GHz (256 MHz × 12). Memory is capable of running at 1,108 MHz:

$$400 \text{ MHz for even-numbered CPU multiplier} \times \text{percentage overclocking of reference clock}$$

$$400 \text{ MHz} \times 277 \text{ MHz} \div 200 \text{ MHz} = 1,108 \text{ MHz}$$

Since all three variables have different CPU HTT reference clock settings to achieve independent overclocking, a value for the reference clock must be selected to achieve maximum performance for all.

In this case, using 256 MHz as a reference clock generates:

- ❑ 3.07 GHz CPU frequency.
- ❑ 1,280 MHz HyperTransport frequency
- ❑ 1,024 MHz memory frequency

Under other circumstances, however, increasing CPU HTT reference clock and reducing CPU multiplier while maintaining the same CPU frequency may produce better results.

It is all about balance. Make it a priority to maximize CPU frequency (sometimes by lowering the multiplier and raising the CPU HTT). Next, consider memory timings. In the example setup discussed earlier, the memory frequency is a bit lower than the physical modules are capable of running. To alleviate this performance reduction impact, tune latency to improve memory throughput. A memory timing configuration that reduces  $t_{CL}$ ,  $t_{RCD}$ ,  $t_{RP}$ ,  $t_{RAS}$ ,  $t_{RD}$ ,  $t_{RC}$ ,  $t_{WTR}$ , or  $t_{RAS}$  will boost performance but might cause instability. Only trial-and-error will help optimize memory latency. Finally, focus on HyperTransport speed. HyperTransport overclocking provides some added performance benefit, but its impact is not as significant as altering CPU frequency and memory performance settings.

Fortunately, NVIDIA nTune 5.0 provides a complete, easy-to-use solution to optimize memory performance in a Windows environment.

## PCI Express Overclocking

The NVIDIA nForce 590 SLI technology chipset is highly overclockable by design. One of the main features it supports is NVIDIA LinkBoost™ technology. LinkBoost technology is only supported on this chipset and high-end NVIDIA GeForce products such as the GeForce 7900GTX. LinkBoost technology increases the PCI Express and HyperTransport link between NVIDIA nForce 590 MCP and SPP chips by 25% out of the box. PCI Express, however, is far more overclockable than 25%.

Use the following procedure to overclock the PCI Express interface:

1. Load system configuration defaults in BIOS using Load Defaults option.
2. Go to the **System Voltages** BIOS menu to change the following voltages so they have exactly the same values as shown in Figure 5:
  - **HT nForce SPP <-> MCP**
  - **nForce SPP**
  - **nForce MCP**
3. Use the NVIDIA nTune 5.0 to dynamically change and test each x16 PCI Express link within the Windows environment.

This will overclock PCI Express on the NVIDIA nForce 590 SLI chipset. The NVIDIA nForce 590 SLI chipset can sustain PCI Express overclocking more than 50% nominal. Figure 16 shows how to overclock each of the x16 PCI Express links.

Overclock PCI Express in increments, then test using Stability Test or another system stress application to ensure proper system functionality after each increment. Even though the NVIDIA nForce 590 SLI SPP PCI Express interface might overclock more than its MCP counterpart, there is no performance impact if the two x16 PCI Express interfaces are not balanced.

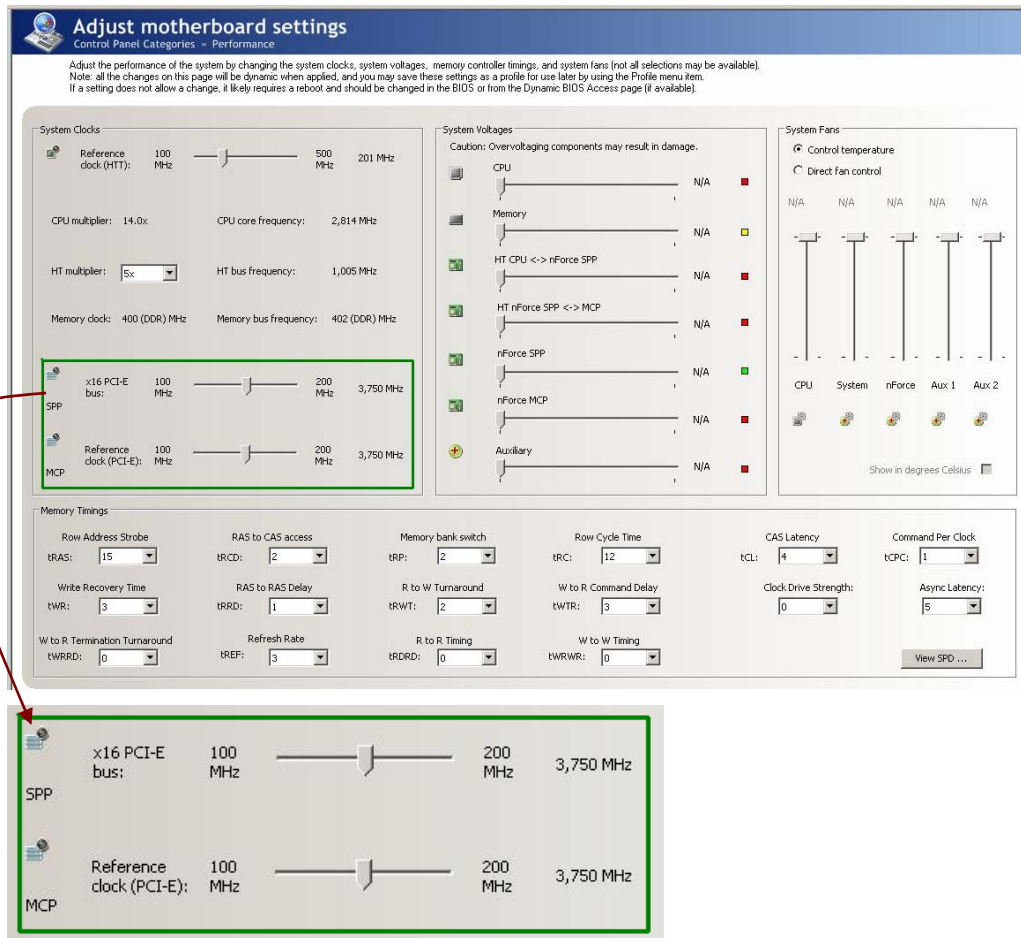


Figure 16. Overclocking PCI Express using NVIDIA nTune 5.0

## NVIDIA nForce 590 SLI MCP HyperTransport Interface

The link between NVIDIA nForce 590 SLI MCP and SPP is a 16-bit upstream and downstream HyperTransport interface operating at 1 GHz, similar to CPU HyperTransport interconnect. The NVIDIA LinkBoost technology increases this bus bandwidth by 25%. Bandwidth increases help with overall system performance. MCP HyperTransport (HTT) is designed to overclock by up to 50 to 60%.

Overclocking the MCP HTT interface through the BIOS:

1. Load system configuration defaults in BIOS using **Load Defaults** option
2. Configure system voltage settings as shown in Figure 17.

Phoenix - Award Workstation BIOS CMOS Setup Utility			
System Voltages			
Parameters	Setting	Current Value	Item
CPU	[1.5250V]	1.45V	
Memory	[2.125V]	1.88V	Menu Level
HT CPU <-> nForce SPP	[1.400V]	1.20V	
HT nForce SPP <-> MCP	[1.400V]	1.30V	Core Volta
nForce SPP	[1.400V]	1.19V	nForce MCP
nForce MCP	[1.600V]	1.49V	
Auxiliary	[Auto]	1.50V	

Figure 17. BIOS System Voltages Configuration for MCP HTT Overclocking

- To change the frequency, adjust **SPP <-> MCP Ref Clock** setting in **System Clocks** BIOS menu as illustrated in Figure 18. Gradually increment MCP HTT clock to determine the highest passing value. MCP HTT clock can run at 300 MHz and higher.

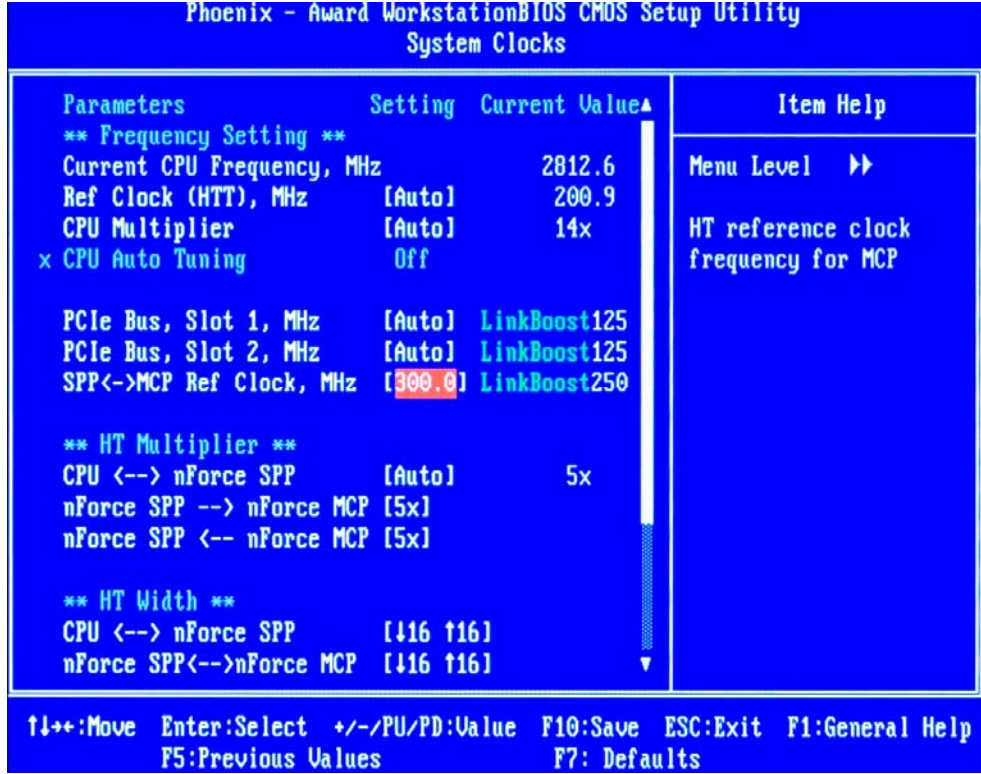


Figure 18. Adjusting MCP HTT Frequency in BIOS

- Run a stability test in Windows to test the overclocking.



## GPU Overclocking

GPU overclocking adds a tremendous boost to system gaming performance. Overclocking the two settings that have the most to do with 3D performance and gaming will increase GPU performance:

- ❑ 3D frequency
- ❑ Memory frequency
- ❑ 2D core frequency

Overclocking the GPU can be done using NVIDIA nTune 5.0 as shown in Figure 19. Although increasing 2D core frequency does not affect 3D applications and gaming performance, the setting impact 2D applications such as DVD playback.

The GeForce 7900GTX GPU can overclock to 675 MHz to 710 MHz core frequency and from 850 MHz to 900 MHz memory frequency using the stock cooling solution. This alone significantly boosting graphics performance. With water cooling, the GPU can be overclocked further. Be sure to run Stability Test or 3DMark to test the new overclocked settings.

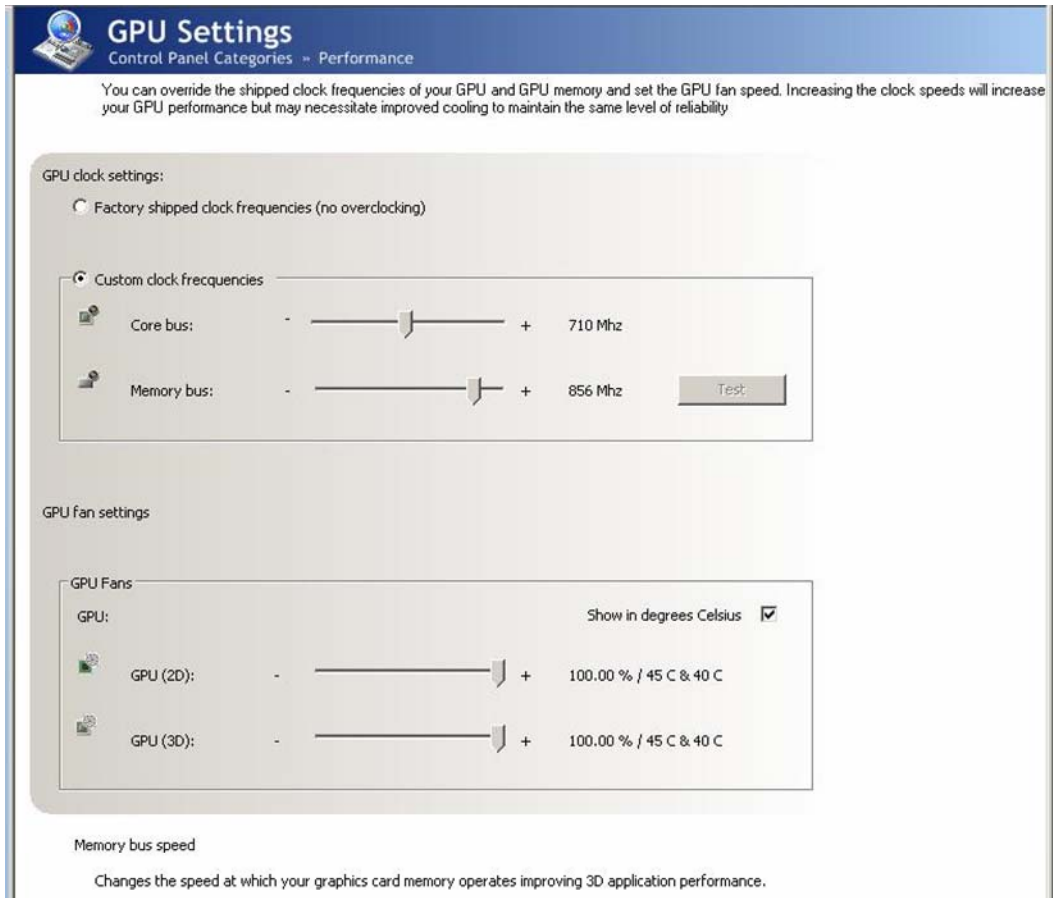


Figure 19. Overclocking GPU using NVIDIA nTune 5.0

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## Overclocking the System

Now that the individual interfaces and system components have been overclocked independently, combining the new settings generates the best system performance enhancing the gaming experience.

Conduct overall system stability and burn-in testing to ensure that the new settings do not impede system stability robustness. Typically, running 3DMark for 24 hours tests the new system settings adequately. If a system fails, tweak the overclocked settings to find a stable system configuration. The order of component overclocking importance relative to performance is as follows:

1. CPU core frequency
2. Optimizing memory performance
3. GPU core and memory frequencies
4. CPU HyperTransport interface bandwidth
5. PCI Express and MCP HyperTransport bus speeds

Upon achieving a stable system configuration, store the new settings and reload them when starting a new Windows session. NVIDIA nTune 5.0 provides a comprehensive solution for customizing and retaining settings and retaining overclock settings. The new **Dynamic BIOS Access** feature, shown in Figure 20, provides easy access to BIOS within a Windows environment. The new clock settings as well as memory settings are automatically written to BIOS and kick into effect upon a system reboot.

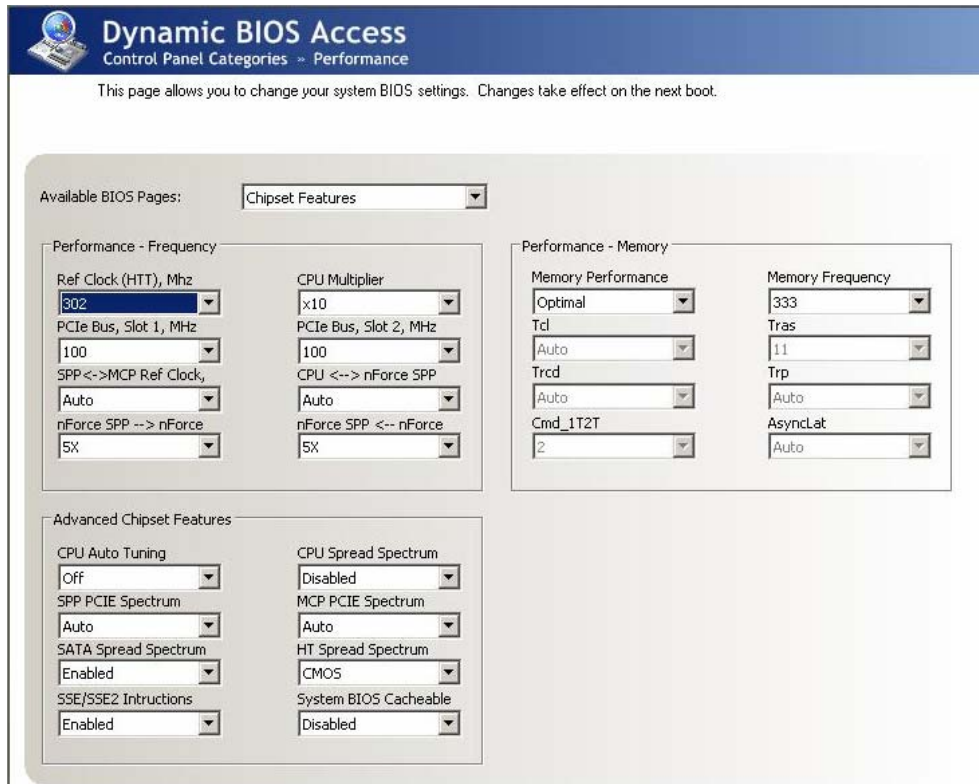


Figure 20. NVIDIA nTune 5.0 Dynamic BIOS Access

To retain a complete system configuration of overclocked settings in Windows, including GPU overclocking, the NVIDIA nTune 5.0 **Profiles** feature, shown in Figure 21. The **Profiles** feature lets end users save overclock settings. Once the settings are configured properly in nTune, save a profile as an “\*.nsu” file on the hard disk drive.

Use the **Custom Rules** feature in nTune 5.0 to configure the overclocked settings to load upon Windows OS initialization. Figure 22 demonstrates how the new settings can be configured to load upon Windows start up.

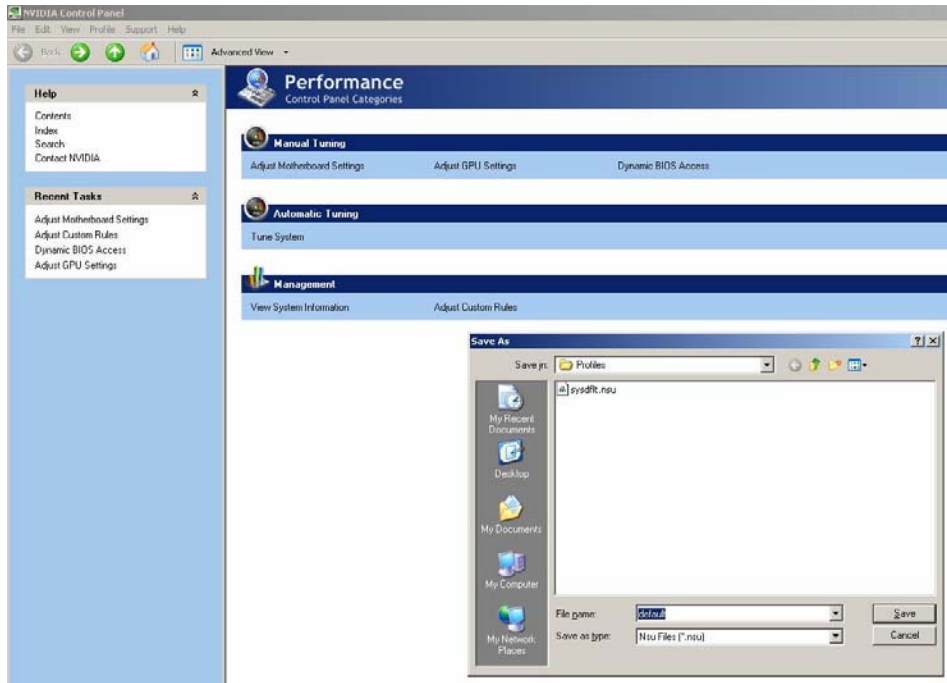


Figure 21. Storing Profiles in NVIDIA nTune 5.0

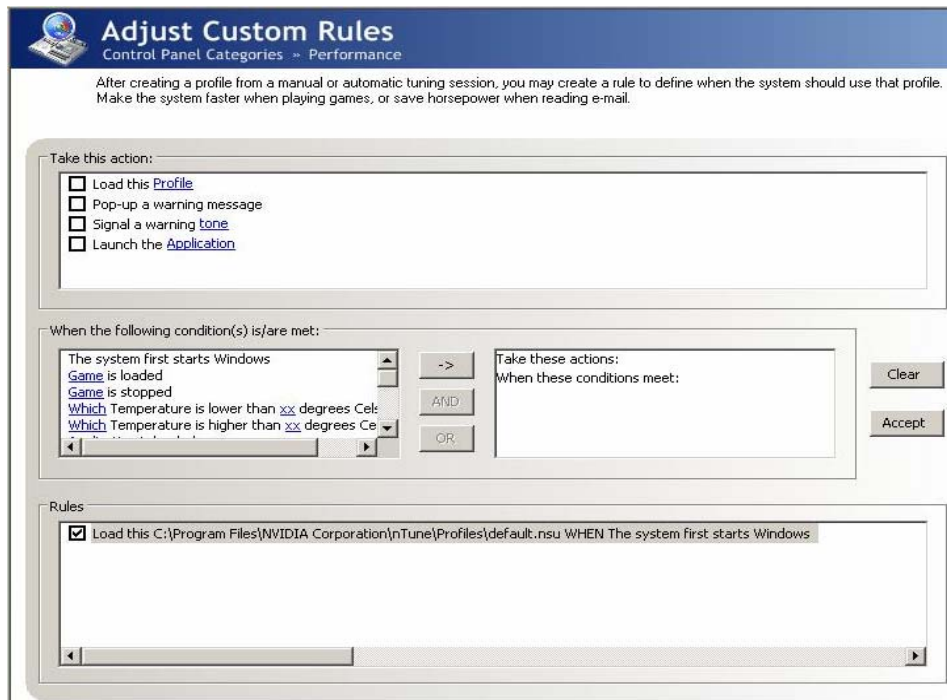


Figure 22. Loading Automated Settings Using NVIDIA nTune 5.0 Custom Rules



## Final Thoughts

Overclocking is becoming mainstream practice due to technological advancements in device manufacturing and the availability of easy-to-use utilities to tune a PC system. The NVIDIA nForce 590 SLI chipset has been engineered with enthusiasts and overclockers in mind. An entire platform solution is designed to provide gaming enthusiasts and overclockers the necessary means to improve their gaming experience. With new features such as NVIDIA LinkBoost technology, Enhanced Memory Profiles technology, and NVIDIA nTune 5.0 utility, overclocking enthusiasts can propel their experiences to new heights.



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