

Intel® Desktop Board DX58S02/DX580G Performance Tuning Guide

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 **WARNING**

Altering clock frequency and/or voltage may (i) reduce system stability and useful life of the system and processor; (ii) cause the processor and other system components to fail; (iii) cause reductions in system performance; (iv) cause additional heat or other damage; and (v) affect system data integrity. Intel has not tested and does not warranty the operation of the processor beyond its specifications.

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Contents

1 Introduction	
1.1 Intel® Extreme Tuning Utility	8
2 Intel® Core™ Processor Family and Intel® X58 Express Chipset General Concepts	
2.1 Architecture.....	9
3 Intel Desktop Board DX58SO2/DX58OG Performance Tuning Using BIOS Setup	
3.1 Hardware Considerations for Performance Tuning	11
3.1.1 Board	11
3.1.2 Processor	11
3.1.3 Memory	11
3.1.4 Power Supply.....	12
3.1.5 System Cooling.....	12
3.2 Suggestions for Effective Tuning.....	12
3.3 Accessing BIOS Setup	13
3.4 Recovering from an Unstable System	13
3.4.1 Hardware Watchdog Timer	14
3.4.2 Back to BIOS (B2B) Button.....	15
3.4.3 BIOS Configuration Jumper.....	15
3.4.4 Remove Power and Reboot	16
3.5 Intel Desktop Board DX58SO2/DX58OG Performance Tuning Process.....	16
3.5.1 Simplified Tuning Process for Intel® Core™ i7 Extreme Edition Processors.....	16
3.5.2 Simplified Tuning Process for Intel® Core™ i7 Non-Extreme Edition Processors	17
3.5.3 Detailed Performance Tuning Process Steps	18
3.5.3.1 Configure BIOS for Performance Tuning	19
3.5.3.2 Set Processor Overrides (Voltage, Current, and Power)	20
3.5.3.3 Decrease Memory Speed.....	21
3.5.3.4 Decrease QPI Data Rate.....	23
3.5.3.5 Increase Core Ratio Limits (Also Referred to as Multipliers or Turbo Ratios) and/or Host Clock Frequency.....	23
3.5.3.6 Check Stability	26
3.5.3.7 Tune Memory	27
3.5.3.8 Tune QPI	30
3.5.3.9 Recheck Stability	30
3.5.3.10 Balance Settings Between Processor, Memory, and QPI	31

3.5.3.11	Fine Tune Voltage and Power Settings	31
3.5.3.12	Recheck Stability	31
3.5.3.13	Archive Performance Settings	31

4 Performance Tuning Examples

4.1	Intel Core i7-990X Extreme Edition Processor on Intel Desktop Board DX58SO2	33
4.2	Intel Core i7-920 Non-Extreme Edition Processor on Intel Desktop Board DX58SO2	34
4.3	Intel Core i7-920 non-Extreme Edition Processor on Intel Desktop Board DX58OG.....	35

A Parameter Descriptions for BIOS Performance Settings

B Parameter Descriptions for Memory Performance Settings

Figures

2.1.	Intel Desktop Board DX58SO2/DX58OG Simplified Block Diagram	10
3.1.	Screen Displayed When the Watchdog Timer Detects an Issue	14
3.2.	Screen Displayed When the System is Started with the Back to BIOS Button Depressed.....	15
3.3.	BIOS Performance Tuning Disclaimer	19
3.4.	Processor Overrides BIOS Screen Showing Default Settings with an Intel Core i7-990X Extreme Edition Processor Installed	20
3.5.	BIOS Screen Showing Memory Multiplier Selection Options.....	22
3.6.	BIOS Screen Showing QPI Data Rate Change Options.....	23
3.7.	Performance BIOS Screen Showing Multiplier (Core Ratios) Increased to 33 and Host Clock Frequency Increased to 136 MHz	25
3.8.	Intel Extreme Tuning Utility Showing Passing Stress Test Result on a Performance Tuned System Using an Intel Core i7-990X Processor and XMP 2133 MHz Memory.....	27
3.9.	BIOS Screen Showing Selection of XMP 2133 Profile From the Options List	28
3.10.	BIOS Memory Performance Settings Screen	29
3.11.	Storing Performance Profiles in the BIOS	32
4.1.	4.50 GHz on an Intel Desktop Board DX58SO2 with an Intel Core i7-990X Extreme Edition Processor Using Core Ratio and Host Clock Changes	33
4.2.	4.09 GHz on an Intel Desktop Board DX58SO2 with an Intel Core i7-920 Processor Using Host Clock Changes.....	34
4.3.	3.98 GHz on an Intel Desktop Board DX58OG with an Intel Core i7-920 Processor Using Host Clock Changes.....	35

Tables

3-1. Resulting CPU Frequency Values for Various Multipliers	24
3-2. Resulting Memory Frequency Values for Various Multipliers	30
A-1. BIOS Performance Settings.....	37
B-1. Memory Performance Settings.....	39

1 Introduction

Performance tuning of Intel® Desktop Board DX58SO2/DX58OG enables useful gains that can enhance overall system performance for gaming, video editing, computation, performance benchmarking, and other uses. Performance tuning can be done using the board BIOS or the Intel® Extreme Tuning Utility.

The Intel Extreme Tuning Utility was developed for the user wanting performance benefits while minimizing their time and involvement in the tuning process. A brief introduction to this utility is provided in Section 1.1. Even those not considering use of the Intel Extreme Tuning Utility for performance tuning will find the system monitoring and stress testing features included with this software to be useful.

This remainder of this guide focuses on using the BIOS for performance tuning of Intel Desktop Board DX58SO2/DX58OG. The main performance tuning focus areas include the Intel® Core™ processors and the memory subsystem. The procedures and examples included in this guide are for reference only and may not work in all situations and system configurations.

The board is designed with a number of enhancements to support performance tuning. These enhancements include:

- Fan speed control — the processor and system fan speeds automatically increase when elevated temperatures are sensed.
- Processor thermal protection — the electrical current applied to the processor is automatically reduced when the thermal protection temperature set point is reached.
- IOH heat pipe (DX58SO2) or IOH heat sink (DX58OG) — these provide increased cooling capability for the IOH component and the processor voltage regulator.
- Processor voltage regulator heat pipes (DX58SO2 only) — these provide increased cooling capability to the voltage regulation system components.
- Eight-phase processor voltage regulator (DX58SO2) or five phase processor voltage regulator (DX58OG) — component stress is reduced since overall electrical load is distributed among multiple phases.
- Processor voltage regulator thermal protection — the voltage regulator current is automatically reduced when the thermal protection temperature set point is reached.

1.1 Intel® Extreme Tuning Utility

The Intel Extreme Tuning Utility software allows performance tuning and monitoring of critical system parameters in a run-time environment on Intel Desktop Boards using the Intel® X58, Intel® P55, and Intel® P67 Express Chipsets. Additionally, the Intel Extreme Tuning Utility is a useful tool for monitoring most Intel desktop board-based systems and is available for download from Intel at <http://www.intel.com/design/motherbd/software/xtu/>.

Although beyond the scope of this guide, the Intel Extreme Tuning Utility is another valuable resource for performance tuning.

2 Intel[®] Core[™] Processor Family and Intel[®] X58 Express Chipset General Concepts

2.1 Architecture

Intel Desktop Board DX58SO2/DX58OG consists of the Intel Core i7 processor and the Intel X58 Chipset including the IOH (I/O Hub) and the ICH10R (I/O Controller Hub). The Intel Core i7 processor integrates the system memory controller and accesses DDR3 memory through three independent memory channels. The IOH provides support for two PCI Express* x16 graphics slots, the PCI Express x4 slot, and connects to the processor via the Quick Path Interconnect[™] (QPI[™]) bus. The ICH10R provides support for SATA, USB, and other system interfaces in addition to communicating with the IOH via the DMI bus.

BIOS performance tuning controls include the host clock, processor turbo ratios, QPI data rate, IOH, and processor and memory voltages. A simplified system block diagram is shown in Figure 2.1.

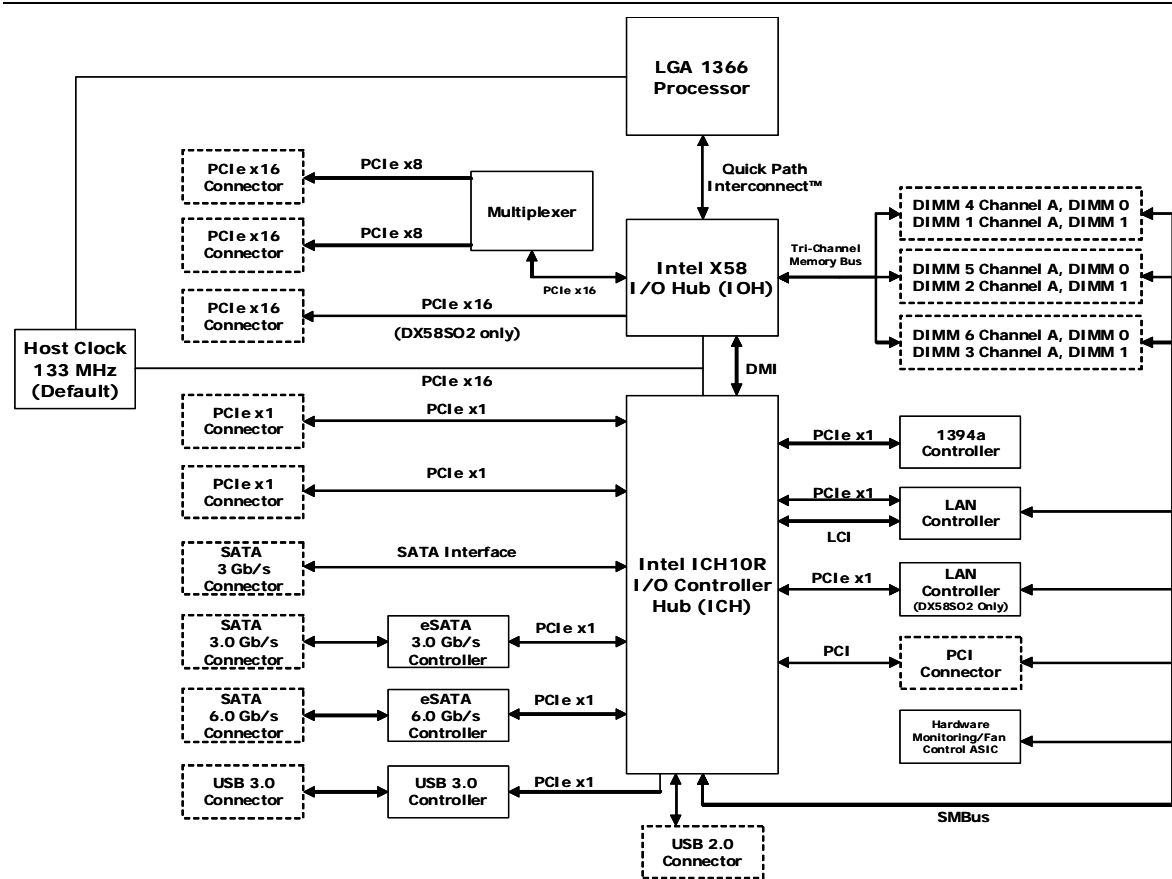


Figure 2.1. Intel Desktop Board DX58SO2/DX58OG Simplified Block Diagram

3 Intel Desktop Board DX58SO2/DX58OG Performance Tuning Using BIOS Setup

3.1 Hardware Considerations for Performance Tuning

Performance tuning in this guide was developed using Intel Desktop Board DX58SO2 and Intel Desktop Board DX58OG using both Intel® Core™ i7 Extreme Edition and non-Extreme Edition processors. The processor was air cooled using an Intel E88216-001 fan heat sink.

3.1.1 Board

The additional processor voltage regulator phases and heat pipe cooling on Intel Desktop Board DX58SO2 enable greater performance tuning capability in comparison to Intel Desktop DX58OG.

3.1.2 Processor

Intel Desktop Board DX58SO2 and Intel Desktop Board DX58OG support Intel Core i7 processors. These processors include the Intel Core Extreme Edition processors, the Intel Core i7 processors, and some Intel® Xeon® processors. All performance tuning controls are available with the Extreme Edition processors. With non-Extreme Edition Intel Core processors, turbo ratios are locked and not adjustable. A list of supported processors for the boards can be found at:

[Intel Desktop Board DX58SO2](#)

<http://processormatch.intel.com/CompDB/SearchResult.aspx?BoardName=DX58SO2>

[Intel Desktop Board DX58OG](#)

<http://processormatch.intel.com/CompDB/SearchResult.aspx?BoardName=DX58OG>

3.1.3 Memory

Memory modules with XMP profiles have preprogrammed optimized performance settings created by the manufacturer that can be selected in the BIOS. Using XMP profiles can simplify memory performance tuning. Capability for memory performance tuning will likely be limited if low speed, low cost DIMMs are being used.

For specific memory support information, see the Technical Product Specification for your board located at <http://downloadcenter.intel.com>.

3.1.4 Power Supply

Performance tuning will increase the demand on the system power supply. Lower wattage power supplies may have insufficient capacity once the load imposed by the board, graphics card(s), the processor cooler, other system fans, hard drives, CD/DVD drives, and other accessories are combined. Inadequate power supply capacity will result in system shutdowns and stability problems when performance tuning is attempted or later when a performance tuned system is being operated.

For Intel Desktop Board DX58SO2/DX58OG, the power supply should have at least 200 watts of unused capacity to accommodate the typical needs of performance tuned processor and memory. For more extreme performance, additional capacity beyond the extra 200 watts will be needed. Additional power supply capacity will also be needed if a performance tuned graphics card or pair of graphics cards will be included in the system. Consult the graphics card manufacturer's specifications to determine these additional capacity requirements.

3.1.5 System Cooling

Performance tuning will result in additional system heat generation. Increased cooling capability may be required to allow performance tuning and stable operation of a performance tuned system. Considerations for increasing cooling capability may include, but are not limited to, chassis type, selection of air or liquid cooling, processor cooler design, memory module design, and overall system airflow. Extreme performance tuning requires system designs with increasingly sophisticated cooling capabilities. It is beyond the scope of this guide to provide detailed recommendations for system cooling.



CAUTION

Cooling induced moisture condensation from refrigerant systems, dry ice, liquid nitrogen, or other uncommon cooling methods will result in risk for electrical shorting and subsequent damage to the board and/or the system.

3.2 Suggestions for Effective Tuning

Optimal results will occur if tuning efforts are directed appropriately. For example, if performance improvements with a certain gaming application are desired, then tuning efforts should be directed at the system resources used by the game. If the game software has intensive processor computational work, but relatively light demands on system memory, then focusing performance tuning efforts on memory will not yield significant improvements.

System resource (processor, memory, etc.) utilization can be determined by running your software application while monitoring resource usage. Resource usage can be monitored with the Intel Extreme Tuning Utility. Also, your software supplier should be able to provide information about system resource utilization with their application.

Video graphics performance increases may be needed to improve the overall performance of gaming software. The supplier of the graphics card should be contacted for information about performance tuning their hardware. External graphics tuning is specific to the graphics card manufacturer and cannot be done using either the Intel Desktop Board DX58SO2/DX58OG BIOS or the Intel Extreme Tuning Utility.

Keeping a written log of performance tuning settings and the results will be extremely helpful. Your tuning efforts will be much more efficient if you can refer to the log for settings that you have already tried. If you need to restore BIOS parameters to something that worked previously, then information recorded in the log can be used. The log will also be convenient for entering parameters if profiles will be setup using the Intel Extreme Tuning Utility.

The user may have different performance setting profiles that are needed, depending on the software applications being run. The Intel Desktop Board DX58SO2/DX58OG BIOS supports multiple BIOS parameter settings (profiles). Storage and retrieval of BIOS profiles is described in Section 3.5.3.13.

3.3 Accessing BIOS Setup

The BIOS setup screen can be accessed at system startup by pressing the F2 key at the BIOS screen prompt. It is advisable to run the most recent revision of the BIOS to ensure that performance features are at the highest level of optimization. The latest version BIOS can be obtained from <http://downloadcenter.intel.com>. Instructions for loading the BIOS into the board can also be found at this link.

Before initiating performance tuning, ensure that the BIOS setup defaults have been loaded by pressing the F9 key while in BIOS setup mode and then pressing the F10 key to save those settings.



NOTE


If you configured your system to boot to RAID or IDE, pressing the F9 key will reset your SATA configuration to AHCI. If you are not using AHCI, be sure to restore your SATA configuration prior to pressing the F10 key to save the settings.

3.4 Recovering from an Unstable System

Should performance values be set beyond the point of stable system operation, the system may exhibit a failure to boot, a blue screen, a system hang, or a recovery screen as described in the sections below. Exceeding the system stability limits is a normal, expected occurrence during the performance tuning process and there are multiple reliable and easy to use options for restoring system operation as described in the following subsections.

3.4.1 Hardware Watchdog Timer

A hardware watchdog timer is included as part of the board circuitry and is enabled by default in the BIOS. This timer will automatically enable the board to startup if unstable system operation or a failure to boot is detected. If the watchdog timer detects an issue, the screen shown in Figure 3.1 will be displayed. In addition, on Intel Desktop Board DX58SO2/DX58OG, at the Diagnostic LED bank, the red WD Fire/B2B LED will light when the Watchdog Timer is activated. The user can then go into the BIOS screen and manually reset performance parameters or use the F9 key to reset all BIOS defaults to restore system stability. This process can be repeated over and over, so if the user's parameter changes do not restore system stability, the watchdog timer will again intervene and allow the user another opportunity to adjust the BIOS settings. The watchdog timer works in many, but not all, cases. If the watchdog timer did not detect an issue or was disabled by the user, then one of the alternate recovery options described in Section 3.4.2, 3.4.3, or 3.4.4 can be used.

A screenshot of a BIOS error message displayed on a black background with white text. The text reads: "The system BIOS has detected unsuccessful POST attempt(s). Possible causes include recent changes to BIOS Performance options or recent hardware changes. Press 'Y' to enter BIOS Setup or press 'N' to cancel and attempt to boot with previous settings." The text is centered and occupies the top portion of the screenshot area.

```
The system BIOS has detected unsuccessful POST attempt(s).
Possible causes include recent changes to BIOS Performance options or recent hardware changes.
Press 'Y' to enter BIOS Setup or press 'N' to cancel and attempt to boot with previous settings.
```

Figure 3.1. Screen Displayed When the Watchdog Timer Detects an Issue

3.4.2 Back to BIOS (B2B) Button

A second recovery option is to use the Back to BIOS button that is located on the board's back panel. This button provides a convenient method of invoking the BIOS setup menu, as shown in Figure 3.2, in a safe, bootable mode without opening the system chassis to access the BIOS configuration jumper. When the Back to BIOS button is depressed, both the button and the red WD Fire/B2B LED located on the Intel Desktop Board DX58SO2/DX58OG Diagnostic LED bank will light. The F9 key can then be used to restore all BIOS settings to defaults at this point or specific performance settings can be individually revised by the user to restore system stability. Additional information regarding this feature can be found in the *Intel Desktop Board DX58SO2 (or DX58OG) Product Guide*.

```

Intel® Desktop Board DX58SO2 - BIOS Version 0779 - 04/06/2011
Main Configuration Performance Security Power Boot Exit

=====> NOTE: System is booted in Back-to-BIOS mode! <=====
=====> (the B2B switch on the back panel is red) <=====

BIOS Version                SOX5820J.86A.0779.2011.0406.1511
Processor Type               Intel(R) Core(TM) i7 CPU    X
                             990 @ 3.47GHz
Overridden Host Clock Frequency 133 MHz
Overridden Processor Turbo Speed 3.73 GHz
Overridden Memory Speed      DDR3-1333
Overridden QPI Data Rate     6.400 GT/s

L2 Cache RAM                 6 x 256 KB
L3 Cache RAM                 12 MB
Total Memory                 4 GB
DIMM 4 (Mem Chan-A Slot-1) BLACK Not Installed
DIMM 1 (Mem Chan-A Slot-0) BLUE  2 GB
DIMM 5 (Mem Chan-B Slot-1) BLACK Not Installed
DIMM 2 (Mem Chan-B Slot-0) BLUE  2 GB
DIMM 6 (Mem Chan-C Slot-1) BLACK Not Installed
DIMM 3 (Mem Chan-C Slot-0) BLUE  Not Installed

> System Identification Information
System Date                  [05/04/2011]
System Time                  [04:33:57]

Press <Enter> to
display a sub-screen
with some SMBIOS
information fields
that often must be
viewable by customers.
This sub-screen also
displays processor
stepping, Microcode
version, and the LAN
MAC address for any
Onboard LAN device.

←=Select Screen
↑=Select Item
Enter=Select Submenu
F9=Setup Defaults
F10=Save and Exit
Esc = Exit Setup

```

Figure 3.2. Screen Displayed When the System is Started with the Back to BIOS Button Depressed

3.4.3 BIOS Configuration Jumper

A third recovery option is to use the BIOS configuration jumper on the board to force the board to boot to BIOS Setup in a safe mode. The user will need to open their system chassis to access this jumper. Refer to the *Intel Desktop Board DX58SO2 (or DX58OG) Product Guide* for additional information on using the BIOS jumper for resetting purposes.

3.4.4 Remove Power and Reboot

For a system hang, resetting your system or removing, reapplying AC power, and rebooting will allow the system to initiate a reboot. Note that BIOS settings will remain unchanged during a reset or removal of AC power. The watchdog timer, the Back to BIOS button, the BIOS configuration jumper, or pressing the F2 key at the setup screen prompt will allow the user to adjust performance settings in BIOS to restore system stability.

3.5 Intel Desktop Board DX58S02/DX580G Performance Tuning Process

Simplified tuning processes for use with either Intel Extreme Edition or non-Extreme Edition processors are included below. The simplified tuning process allows users to make a significant increase in performance in a few easy steps. More in depth tuning procedures are included in Section 3.5.3 of this guide for users wanting to increase performance levels beyond those obtained with the simplified tuning processes.

3.5.1 Simplified Tuning Process for Intel® Core™ i7 Extreme Edition Processors

These performance settings are applicable with the Intel Core i7 Extreme Edition processors. This includes the Intel Core i7-990X, i7-980X, i7-975, and i7-965 processors. An Intel tower model E88216-001 fan heatsink was used for processor cooling with the performance settings listed below.

Performance Settings

1. Power up the system and press the F2 key to go into BIOS setup mode.
2. These instructions assume default BIOS settings are present and only changes from those defaults are listed below. Optionally, the F9 key may be pressed to load Setup Defaults. If other BIOS configuration changes have been previously made (i.e., SATA Configuration), they will need to be reapplied after loading Setup Defaults.
3. From the BIOS Performance menu where the disclaimer asks if you wish to continue, select Yes. This will enable the Performance screen to be displayed.
4. Scroll down and select the Processor submenu. From the Processor Overrides screen, make the following settings:
 - a. Set the Processor Voltage Override Type to Dynamic.
 - b. Set the Dynamic Processor reference Voltage to 1.3500 volts.
 - c. Set TDC current limit override to 200 amps.
 - d. Set TDP Power Limit Override 150 watts.
 - e. Set core ratio limits (also referred to as multipliers or Turbo ratios) to 31 for each processor core.

5. If you have compatible XMP based memory, an XMP profile can be selected from the Memory settings BIOS subpage under the performance settings. See <http://www.intel.com/consumer/game/extreme-memory.htm> for more information on XMP memory.
6. Press the F10 key to save settings and exit BIOS. The system will automatically reboot with the new performance settings enabled. If the system fails to boot, see Section 3.4 on recovering from an unstable system.

3.5.2 Simplified Tuning Process for Intel® Core™ i7 Non-Extreme Edition Processors

These performance settings will result in a processor frequency of about 4 GHz and are applicable with the Intel Core i7 non-Extreme Edition processors. This includes the Intel Core i7-970, i7-960, i7-950, i7-940, i7-930, and i7-920 processors. An Intel tower model E88216-001 fan heatsink was used for processor cooling with these performance settings.

Performance Settings

1. Power up system and press the F2 key to go into BIOS setup mode
2. These instructions assume default BIOS settings are present and only changes from those defaults are listed below. Optionally, the F9 key may be pressed to load Setup Defaults. If other BIOS configuration changes have been previously made (i.e., SATA Configuration), they will need to be reapplied after loading Setup Defaults.
3. From the BIOS Performance menu where the disclaimer asks if you wish to continue, select Yes. This will enable the Performance screen to be displayed.
4. Scroll down to the Processor submenu and set the Processor Voltage Override type to Dynamic and set the Dynamic Processor Reference Voltage to 1.3500 volts. Press the ESC key to go back to the Performance screen.
5. Scroll up to the Host Clock Frequency (MHz) menu and set the Host Clock Frequency according to the table below.

Processor	Processor Frequency	Host Clock Frequency Setting
Intel Core i7-970	3.20 GHz	153 MHz
Intel Core i7-960	3.20 GHz	153 MHz
Intel Core i7-950	3.06 GHz	160 MHz
Intel Core i7-940	2.93 GHz	167 MHz
Intel Core i7-930	2.80 GHz	173 MHz
Intel Core i7-920	2.66 GHz	181 MHz

6. Increasing the host clock frequency will increase the memory frequency. It may be necessary to reduce the memory speed to restore memory stability. This can be done in the Performance Memory Profiles submenu by selecting Manual – User Defined and then scrolling down to the memory multiplier. The memory frequency can be reduced by selecting a lower memory multiplier value.
7. If you have compatible XMP based memory, an XMP profile can be selected from the Memory settings BIOS subpage under the performance settings. Note that XMP profile memory frequencies will also be increased when the host clock frequency is increased. See <http://www.intel.com/consumer/game/extreme-memory.htm> for more information on XMP memory.
8. Press the F10 key when you are ready to save settings and exit BIOS. The system will automatically attempt reboot with the new performance settings enabled. If the system fails to boot, see Section 3.4 on recovering from an unstable system.

3.5.3 Detailed Performance Tuning Process Steps

There are various sequences of steps possible for doing board performance tuning. The approach presented in this guide is a general starting point, but may not be optimal for all cases.

Intel Desktop Board DX58SO2 and Intel Desktop Board DX58OG allow performance tuning using the host clock, turbo ratios, or a combination of both. The applicable tuning method depends on what type of processor is being used. If a non-Extreme Edition processor is being used, then performance tuning will be done by increasing the frequency of the host clock. If an Extreme Edition processor is being used, then performance tuning using turbo ratios, host clock settings, or a combination of turbo ratios and host clock settings are options.

A full processor and memory tuning sequence consists of the steps suggested below. Depending on your objectives, it may not be necessary to complete all of the steps in this sequence. More discussion about these steps is included in Sections 3.5.3.1 through 3.5.3.13. Detailed descriptions of the various BIOS controls are included in Appendix A, Table A-1. Checking system stability appears frequently during this sequence. This check ensures that the work done up to that point will provide stable system performance. If instability is encountered, the source of the problem can be more easily determined if regular stability checks have been completed.

Performance tuning is an iterative process. The settings made for one parameter may affect which settings will work for another parameter. For example, increasing the host clock frequency may require that previous tuning adjustments for system memory be revised to maintain memory stability. The sequence of steps below was designed to minimize the number of iterations required for performance tuning.

1. Configure the BIOS for performance tuning.
2. Set processor overrides (voltage, current and power).
3. Decrease memory speed.
4. Decrease QPI data rate.
5. Increase core ratio limits and/or host clock frequency.

6. Check stability.
7. Tune memory.
8. Recheck stability.
9. Tune QPI.
10. Recheck stability.
11. Balance settings between processor, QPI, and memory.
12. Recheck stability.
13. Fine tune voltage and power settings.
14. Recheck stability.
15. Archive performance settings.

3.5.3.1 Configure BIOS for Performance Tuning

Power up the system and press the F2 key at the BIOS screen prompt to go into BIOS setup mode.

3.5.3.1.1 Performance Disclaimer

Performance tuning options are located in the menu section labeled "Performance". Reading and agreeing to the disclaimer by selecting "Yes", as shown in Figure 3.3, allows the detailed BIOS performance menu to be displayed.

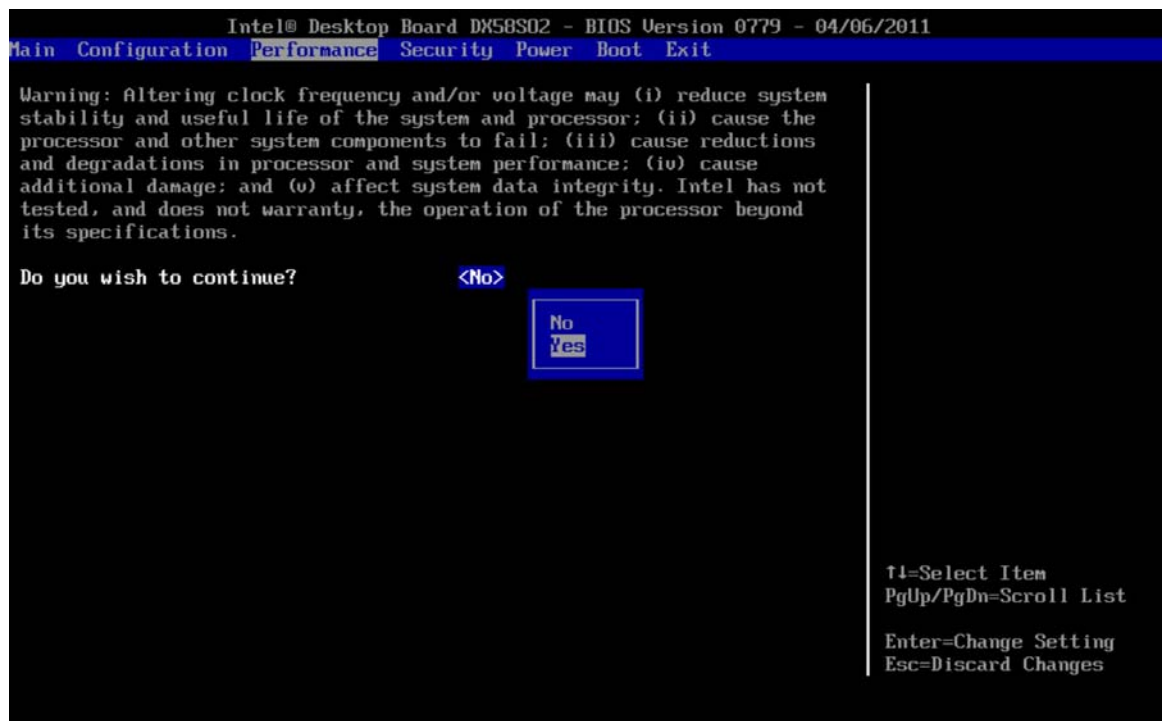


Figure 3.3. BIOS Performance Tuning Disclaimer

3.5.3.2 Set Processor Overrides (Voltage, Current, and Power)

From the Performance page, processor tuning options are under the Processor submenu section shown in Figure 3.4.

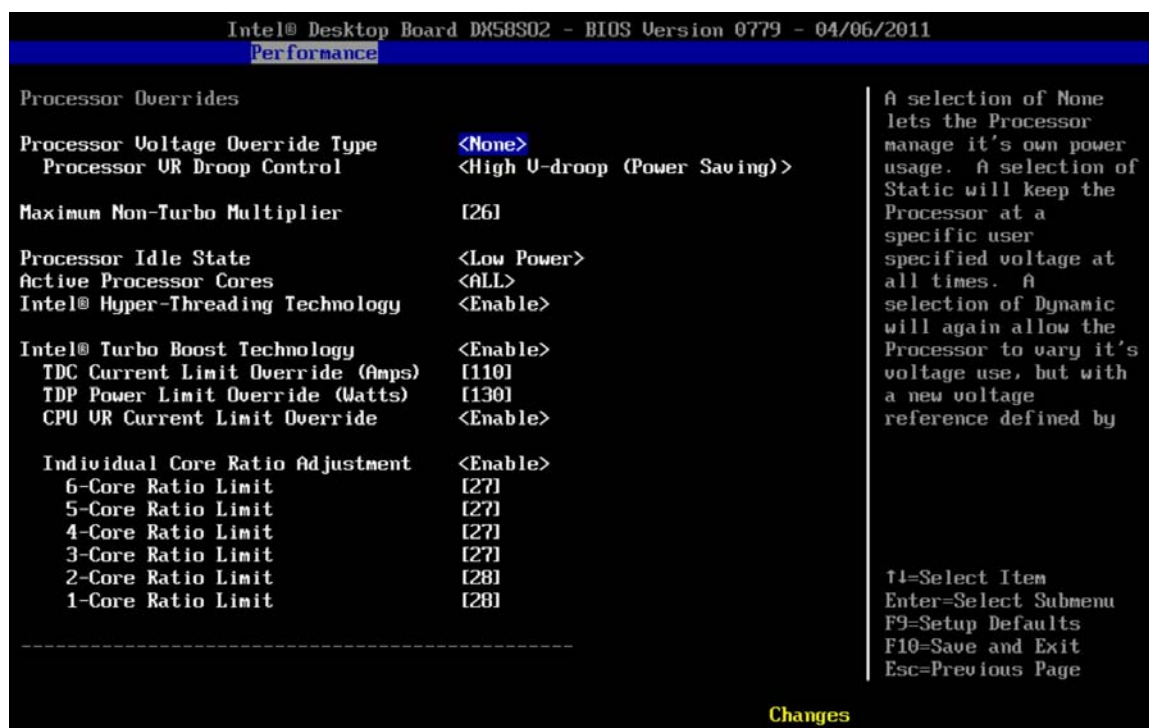


Figure 3.4. Processor Overrides BIOS Screen Showing Default Settings with an Intel Core i7-990X Extreme Edition Processor Installed

3.5.3.2.1 Processor Voltage Override Type

For CPU Override Type, select Static. This setting prevents dynamic adjustments that could confuse tuning efforts. At the end of the tuning procedure, this setting can be changed to dynamic for more energy efficient operation.

3.5.3.2.2 Processor Voltage Override

At the CPU Voltage Override, increase the voltage setting. This needs to be done to provide the extra voltage to support performance tuning. The amount of voltage increase needed depends on the amount of performance increase that is desired. The objective is to provide just enough voltage so the processor can sustain the desired level of performance. Use the voltage provided in the simplified tuning procedures described in Section 3.5.1 or Section 3.5.2, as a starting point. Note that high voltage settings may potentially cause processor damage. At the end of the tuning process, the voltage will be reduced to the lowest level that provides stability.

3.5.3.2.3 Processor VR Droop Control

Set Processor VReg Droop Control to Low V-droop (Performance) if you are attempting to maximize processor performance. If you are attempting moderate performance increases, then the Mid or the High V-droop (Power Saving) selection is acceptable.

3.5.3.2.4 Maximum Non-Turbo Multiplier

Leave this multiplier at the default setting provided in the BIOS. Note that this setting may be different depending on the processor that is being used.

3.5.3.2.5 Processor Idle State

Leave setting at Low Power.

3.5.3.2.6 Active Processor Cores

Leave setting at ALL.

3.5.3.2.7 Intel® Hyper-Threading Technology

Leave setting at Enable.

3.5.3.2.8 Intel® Turbo Boost Technology

Leave setting at Enable.

3.5.3.2.9 TDC Current Limit Override (Amps)

Set the TDC Current Limit Override (Amps). Use the amps provided in the simplified tuning procedures, Section 3.5.1, as an initial starting point. This control will not be available with some processors.

3.5.3.2.10 TDP Power Limit Override (Watts)

Set the TDP Power Limit Override (Watts). Use the watts provided in the simplified tuning procedure, Section 3.5.1, as an initial starting point. This control will not be available with some processors.

3.5.3.2.11 CPU VR Current Limit Override

Leave set to Enable.

3.5.3.3 Decrease Memory Speed

The memory speed is initially being reduced to help prevent subsequent host clock changes from increasing the memory speed to where it becomes unstable. The memory speed will be reset later in the performance tuning process.

From the Performance menu, scroll down to the Memory submenu and press <Enter>.

3.5.3.3.1 Performance Memory Profiles

Reset this to Manual – User defined.

3.5.3.3.2 Memory Multiplier: DDR3 Speed

Select the lowest memory multiplier speed from the list as shown in Figure 3.5.

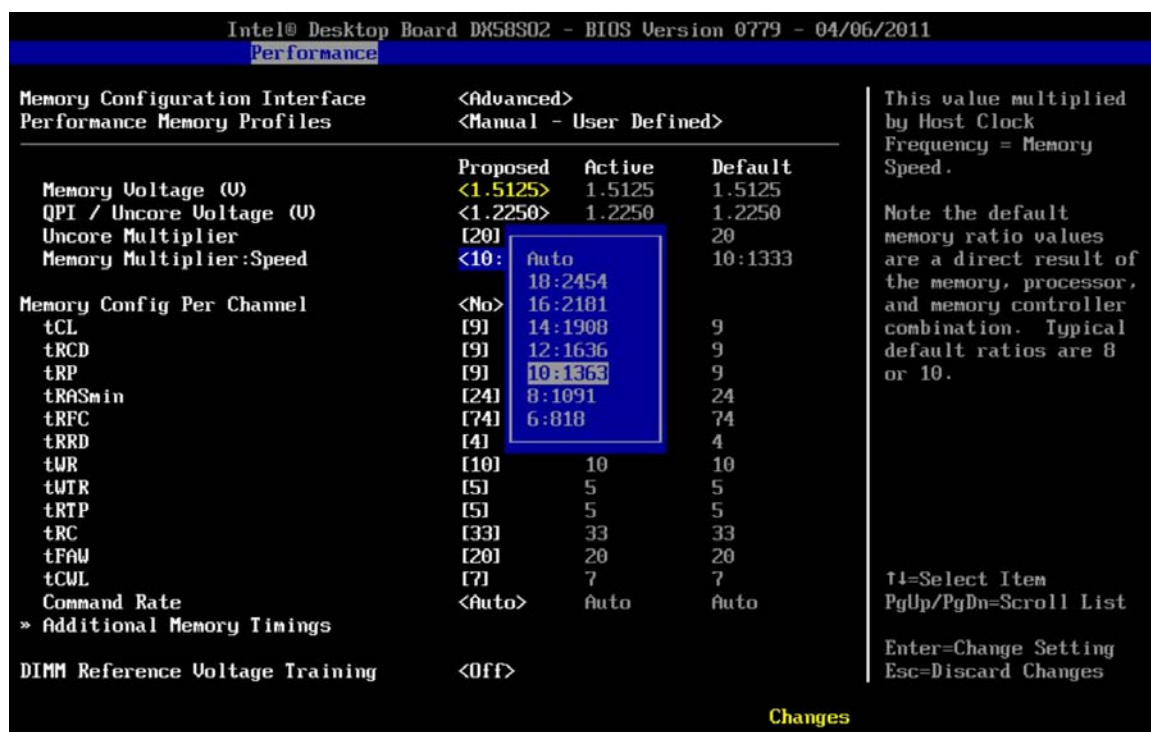


Figure 3.5 BIOS Screen Showing Memory Multiplier Selection Options

3.5.3.4 Decrease QPI Data Rate

The QPI data rate is initially being reduced to help prevent subsequent host clock changes from increasing the QPI bus speed to where it becomes unstable. The QPI speed will be increased later in the performance tuning process.

From the Performance menu, scroll down to the Bus submenu and press <Enter>. On the Bus Overrides screen, scroll down to QPI Data Rate and set the data strap to 4.8 GT/s as shown in Figure 3.6. Note that with some processors, the data strap may already be locked at 4.8 GT/s.

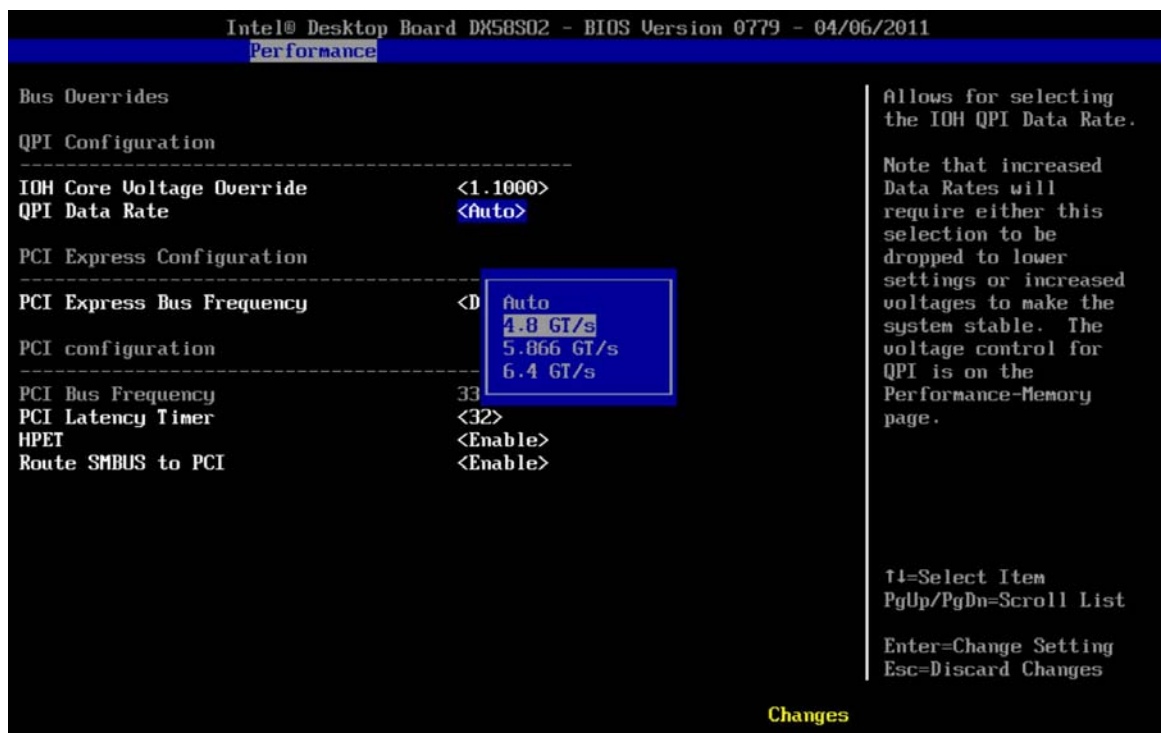


Figure 3.6. BIOS Screen Showing QPI Data Rate Change Options

3.5.3.5 Increase Core Ratio Limits (Also Referred to as Multipliers or Turbo Ratios) and/or Host Clock Frequency



NOTE

Only Extreme Edition processors allow modifying the core ratio limits (also referred to as the multiplier or turbo ratios). Skip this section if you are using a non-Extreme Edition processor since their multipliers are not adjustable. If you have already increased the host clock frequency as much as possible, you may not be able to increase the multipliers without processor stability issues occurring.

3.5.3.5.1 Increase Core Ratio Limits

Gradually increase the multiplier for each of the core ratio limits. Four core processors will have core ratio settings for cores 1-4. Six core processors will have core ratio settings for cores 1-6. The ratio multiplied by the host clock frequency determines the processor frequency that will be obtained. Making these settings is a trial and error process. If ratios are set too high, the processor will be unstable and will not operate. Reducing the ratios or increasing the CPU Voltage Override (Section 3.5.3.2.2) and/or the TDC Current Limit Override (Amps) (Section 3.5.3.2.9) can be used to restore processor stability.

For the default host clock setting of 133 MHz, Table 3-1 shows the resulting processor frequency with various multiplier values.

Table 3-1. Resulting CPU Frequency Values for Various Multipliers

Multiplier	Resulting CPU Core Frequency (GHz)
20	2.66
21	2.80
22	2.93
23	3.06
24	3.20
25	3.33
26	3.46
27	3.60
28	3.72
29	3.86
30	4.00
31	4.12
32	4.26
33	4.40
34	4.52
35	4.66

3.5.3.5.2 Increase Host Clock Frequency

From the BIOS performance screen, gradually increase the frequency of the host clock until the board is unable to boot. If you are using a non-Extreme Edition processor, use the settings provided in the table included with the simplified tuning procedure, Section 3.5.2 as an initial starting point.

In Figure 3.7, the host clock frequency was changed using the BIOS screen as shown. The column labeled “Proposed” shows the results of increasing the system clock setting from 133 MHz to 136 MHz with the resulting processor speed increase from 3.47 GHz to 4.50 GHz ((core ratio multiplier of 33) x (136 MHz host clock frequency) = 4.488 or about 4.50 GHz).

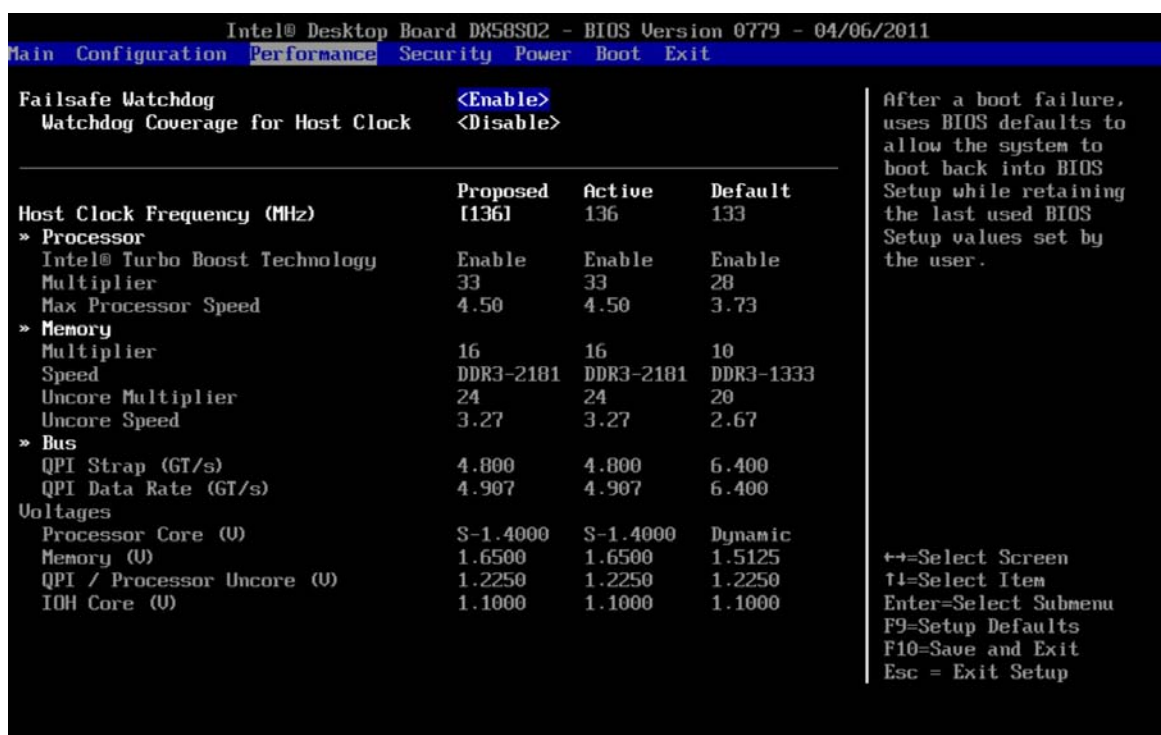


Figure 3.7. Performance BIOS Screen Showing Multiplier (Core Ratios) Increased to 33 and Host Clock Frequency Increased to 136 MHz



NOTE

Since the speeds of the other board subsystems are derived from the host clock, the QPI data rate and memory speed will be increased as well.

3.5.3.6 Check Stability

Establishing stability should be done frequently during the performance tuning process. A good initial check of system stability is to see if the system can boot into the operating system. If the system has become unstable, refer to Section 3.4 for recovery options.

When the system can successfully boot into the operating system, various software applications can be used to stress the processor, memory, and other subsystems. When processor cores are idle, the Intel Core processors will operate at a reduced multiplier value. While running in the operating system, the application of a heavy load will bring all processor cores out of the idle and run them at the multiplier values selected in the BIOS setup. Heavy loads can be applied by using commonly available processor and memory stress testing software.

During stress testing, look for erratic software behavior, a blue screen or a system hang. Any of these are indications of system instability. Solutions to instability include revising the performance settings described in the various areas of Section 3.5. When processor stability issues occur, revising host clock frequency settings, QPI data rates, voltage settings, multipliers, or a combination of these changes will be required.

The Intel Extreme Tuning Utility includes processor and memory stress testing capabilities in addition to allowing the processor temperature to be monitored as shown in Figure 3.8. Being able to stress test subsystems such as the processor and memory with relative independence is helpful. This enables you to determine which subsystem exhibits instability so you know which group of performance parameters to revise. Revising processor parameters will not improve stability if memory settings are actually causing the issue.

If processor temperature is steadily increasing or processor throttling is occurring during stress testing, then additional tuning or improved cooling is needed.

After system stability has been established with stress testing software, confirm stability while running the software applications (games, video editing, etc.) that you normally use.



Figure 3.8. Intel Extreme Tuning Utility Showing Passing Stress Test Result on a Performance Tuned System Using an Intel Core i7-990X Processor and XMP 2133 MHz Memory

3.5.3.7 Tune Memory

A wide variety of memory timing parameters can be adjusted in the BIOS setup as described in the sections below. See Appendix B for a summary description of memory settings and their effects.

In addition, DIMM socket population will also affect system performance. Intel Desktop Board DX58SO2/DX58OG has three independent memory channels which are indicated by blue or black memory DIMM sockets. For best performance, all sockets should be populated with memory matched by manufacturer, size, speed, and type. This matching allows the processor to access data across each of the memory channels concurrently. When installing memory, insert memory in the blue DIMM connectors first. If more than three memory modules will be installed, install the additional memory in the black DIMM connectors.

3.5.3.7.1 XMP Memory Profiles

Although each memory parameter can be modified individually, the easiest method of optimizing performance is to use memory that supports Extreme Memory Profiles (XMP). These profiles are preprogrammed by the manufacturer into the memory module itself and can be selected from the XMP profile list as shown in Figure 3.9. These profiles are validated by the manufacturer and are optimized for both performance and system stability. The listed XMP profiles will vary depending on the memory being used.



CAUTION

Operating memory at voltages higher than JEDEC approved 1.5 volts may reduce processor life.

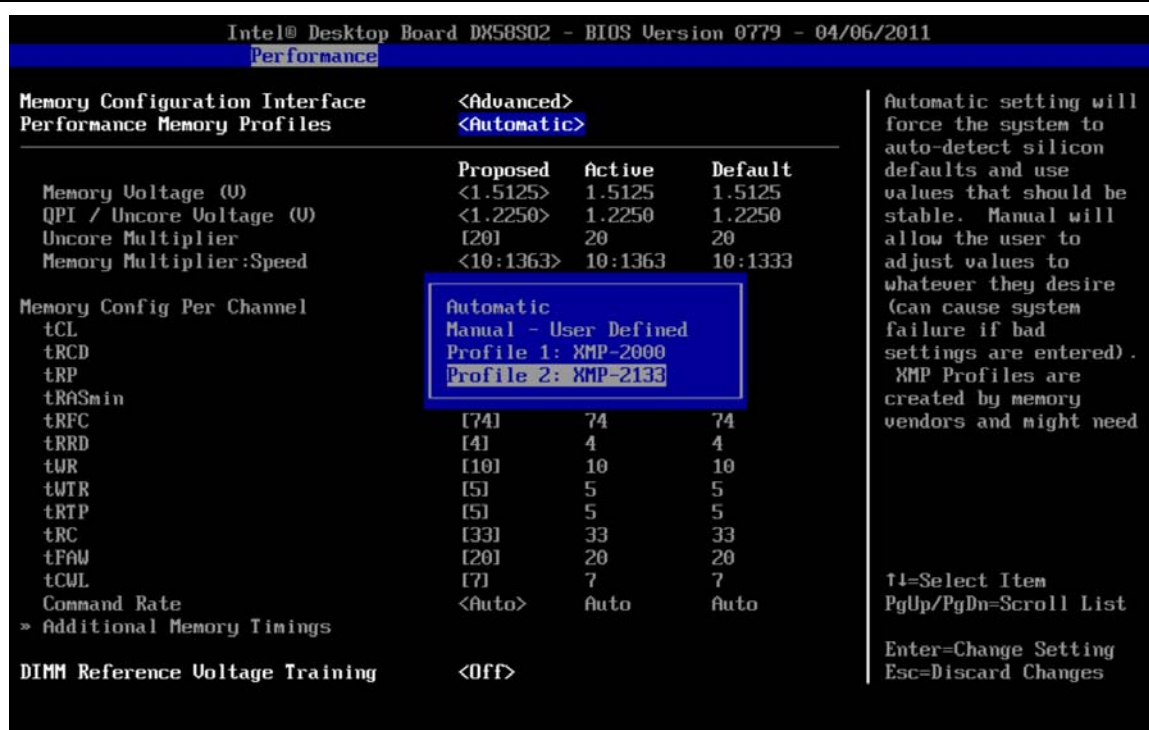


Figure 3.9. BIOS Screen Showing Selection of XMP 2133 Profile From the Options List

3.5.3.7.2 Memory Performance Options

The Memory Configuration BIOS page, shown in Figure 3.10 contains all the memory timing options that can be adjusted.



NOTE

For each of the timings, except the multipliers, lower number settings correspond with higher performance and potential memory system instability.

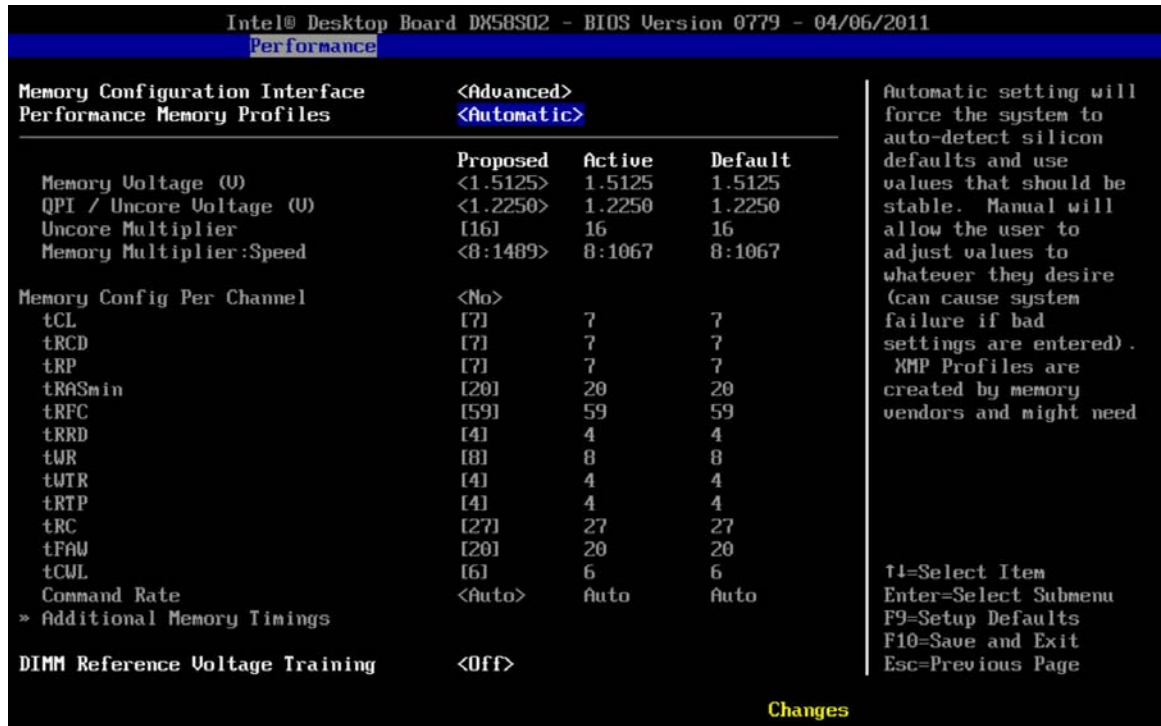


Figure 3.10. BIOS Memory Performance Settings Screen

3.5.3.7.3 Determining Memory Frequency

On the DX58SO2/DX58OG board, memory frequency is controlled directly from the host clock. The default host clock frequency is 133.3 MHz. Increasing the host clock frequency affects the memory frequency according to the following formula:

$$\text{Memory frequency} = (\text{memory multiplier}) * (\text{percent increase in host clock frequency}) * (133.3 \text{ MHz})$$

Example: If the host clock frequency was increased by 1% and a multiplier of 8 was being used, then the new memory frequency would be $(8) * (1.01) * (133.3 \text{ MHz}) = 1077 \text{ MHz}$

For the default 133.3 MHz memory clock, the resulting memory frequency with various multipliers is shown in Table 3-2.

Table 3-2. Resulting Memory Frequency Values for Various Multipliers

Multiplier	Resulting Memory Frequency (MHz)
8	1066
10	1333
12	1600
14	1866
16	2133

3.5.3.7.4 Going Beyond XMP Profiles

Using XMP profiles provides much of the obtainable memory performance benefit with minimum effort. Further increases in memory performance can be obtained by setting the tCL, tRCD, tRP, and tRAS parameters to their maximum values and increasing the system clock in small increments while checking system stability between each clock increase until the system becomes unstable. Note that system clock changes will also affect the processor frequency and may affect processor stability.

Once the point of memory instability has been reached with system clock increases, reduce the system clock frequency until the memory is once again stable (the board will boot again). Next, reduce the tCL, tRCD, tRP, and tRAS parameter values until the system once again becomes unstable, then increase the values by one increment.

3.5.3.8 Tune QPI

If your processor allows, attempt to increase the QPI data rate using the settings shown earlier in Figure 3.6.

The QPI data rate can be determined according to the following formula:

$$\text{QPI Data Rate} = (\text{QPI data strap}) * (\text{percent increase in host clock})$$

Example: If a QPI data strap of 6.4 GT/s was set and the host clock frequency was increased by 1%, then the resulting QPI data rate would be $(6.4) * (1.01) = 6.44$ GT/s.

3.5.3.9 Recheck Stability

Recheck stability as described in Section 3.5.3.6.

3.5.3.10 Balance Settings Between Processor, Memory, and QPI

Best system performance will typically occur by maximizing processor frequency followed by memory frequency and then finally QPI data rate. Intel Extreme Edition processors have greater flexibility for maximizing overall system performance because both core ratios and host clock frequency settings can be used for tuning.

Since Intel non-Extreme Edition processors only support host clock frequency changes, balancing overall system performance will likely require some performance tradeoffs between the processor, memory, and QPI to be made. If a little more memory performance is desired, reducing the host clock frequency slightly may allow a higher memory multiplier to be used and result in greater memory speed. If the host clock frequency is reduced, the processor and QPI speeds will also be reduced. These are the typical adjustments and tradeoffs that are made during this part of the performance tuning process.

If you are attempting to maximize the performance for a particular software application, you may want to compare various possible tradeoff options and determine where the best software performance occurs.

3.5.3.11 Fine Tune Voltage and Power Settings

The processor override voltage type can now be set to dynamic if additional system energy efficiency is desired. Note that the processor voltage override value may also need to be revised if changing from static to dynamic. Gradually reduce voltage and power settings that were made in the applicable portions of Section 3.5.3.2. When instability is encountered, increase the setting(s) as needed to restore stable operation.

3.5.3.12 Recheck Stability

Recheck stability as described in Section 3.5.3.6.

3.5.3.13 Archive Performance Settings

The Intel Desktop Board DX58S02/DX580G BIOS allows storing multiple BIOS profiles (groups of BIOS parameter settings). These profiles may be retrieved or deleted as desired by the user. BIOS profiles may be saved by going to the BIOS Exit menu screen and scrolling down to Save BIOS Profile and selecting New BIOS Profile as shown in Figure 3.11. Type the desired name for the New BIOS profile and then press <Enter> to save the profile.

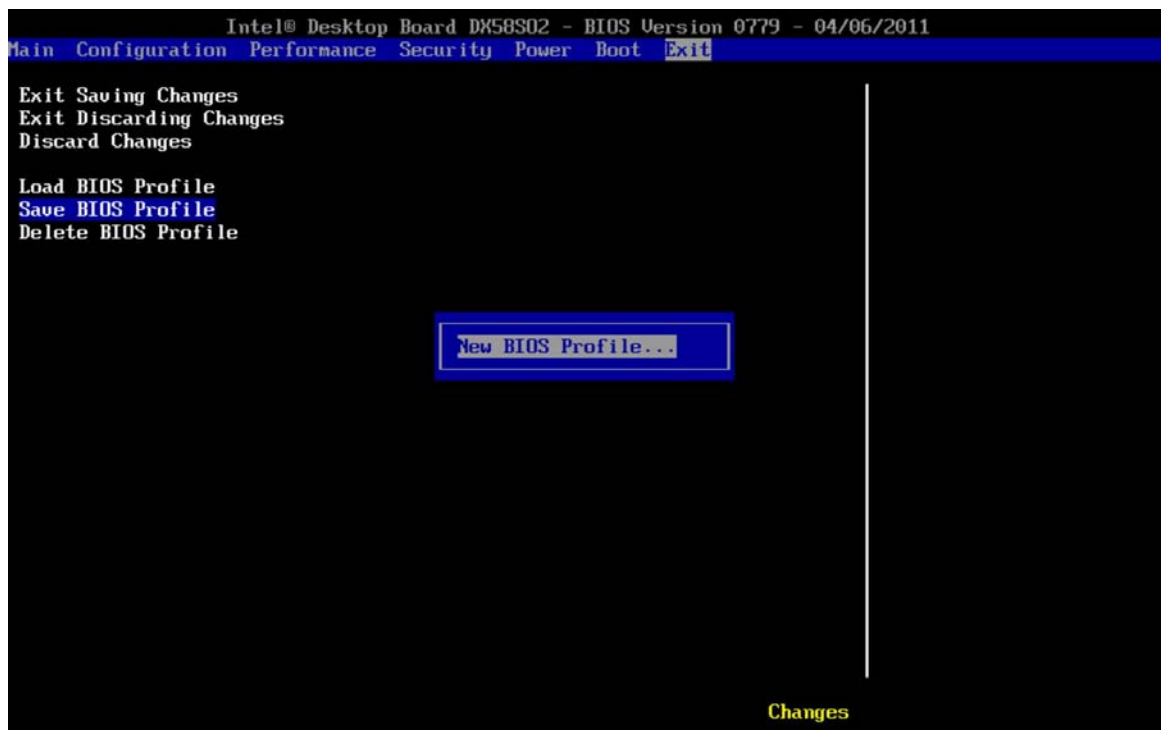


Figure 3.11. Storing Performance Profiles in the BIOS

The Load BIOS profile option allows users to load profiles that have been previously stored in the BIOS. BIOS profiles may be retrieved by going to the BIOS Exit menu screen and scrolling down to Load BIOS Profile and selecting the BIOS profile from the list of stored profiles that appears.

4 Performance Tuning Examples

4.1 Intel Core i7-990X Extreme Edition Processor on Intel Desktop Board DX58SO2

Figure 4.1 shows the BIOS settings to achieve a speed of 4.50 GHz with an Intel Core i7-990X Extreme Edition processor. Core ratios were set at 33 and a host clock setting of 136 MHz was used. A memory speed of 2133 MHz was set using XMP profiles. With a host clock setting of 136 MHz, the resulting memory frequency was 2181 MHz. A QPI data strap of 4.8 GT/s was required in order to allow obtaining memory operation at 2181 MHz. No processor thermal throttling occurred during stress testing with these settings.

These results were obtained on an Intel Desktop Board DX58SO2 with XMP 2133 memory installed. The board was located on an open bench top and the processor was air cooled using an Intel tower model E88216-001 fan heatsink.

Intel® Desktop Board DX58SO2 - BIOS Version 0779 - 04/06/2011				
Main Configuration Performance Security Power Boot Exit				
Failsafe Watchdog				<Enable>
Watchdog Coverage for Host Clock				<Disable>
Host Clock Frequency (MHz)	Proposed	Active	Default	
	[136]	136	133	
» Processor				
Intel® Turbo Boost Technology	Enable	Enable	Enable	
Multiplier	33	33	28	
Max Processor Speed	4.50	4.50	3.73	
» Memory				
Multiplier	16	16	10	
Speed	DDR3-2181	DDR3-2181	DDR3-1333	
Uncore Multiplier	24	24	20	
Uncore Speed	3.27	3.27	2.67	
» Bus				
QPI Strap (GT/s)	4.800	4.800	6.400	
QPI Data Rate (GT/s)	4.907	4.907	6.400	
Voltages				
Processor Core (V)	S-1.4000	S-1.4000	Dynamic	
Memory (V)	1.6500	1.6500	1.5125	
QPI / Processor Uncore (V)	1.2250	1.2250	1.2250	
IOH Core (V)	1.1000	1.1000	1.1000	

After a boot failure, uses BIOS defaults to allow the system to boot back into BIOS Setup while retaining the last used BIOS Setup values set by the user.

←=Select Screen
 F1=Select Item
 Enter=Select Submenu
 F9=Setup Defaults
 F10=Save and Exit
 Esc = Exit Setup

Figure 4.1. 4.50 GHz on an Intel Desktop Board DX58SO2 with an Intel Core i7-990X Extreme Edition Processor Using Core Ratio and Host Clock Changes

4.2 Intel Core i7-920 Non-Extreme Edition Processor on Intel Desktop Board DX58S02

Figure 4.2 shows the BIOS settings to achieve a processor speed of 4.09 GHz with an Intel Core i7-920 processor. A host clock setting of 186 MHz was used. A memory speed of 1489 MHz was obtained using a memory multiplier of 8 when combined with the host clock setting of 186 MHz. With the Intel Core i7-920 processor, the QPI data strap is locked at 4.8 GT/s, resulting in an overall QPI data rate of 6.701 GT/s when combined with the 186 MHz host clock setting. No processor thermal throttling occurred during stress testing with these settings.

These results were obtained on an Intel Desktop Board DX58S02 with XMP 2133 memory installed. The board was located on an open bench top and the processor was air cooled using an Intel tower model E88216-001 fan heatsink.

Intel® Desktop Board DX58S02 - BIOS Version 0779 - 04/06/2011			
Main Configuration Performance Security Power Boot Exit			
Failsafe Watchdog	<Enable>		
Watchdog Coverage for Host Clock	<Disable>		
Host Clock Frequency (MHz)	Proposed	Active	Default
	186	133	133
» Processor			
Intel® Turbo Boost Technology	Enable	Enable	Enable
Multiplier	22	22	22
Max Processor Speed	4.09	2.93	2.93
» Memory			
Multiplier	8	8	8
Speed	DDR3-1489	DDR3-1067	DDR3-1067
Uncore Multiplier	16	16	16
Uncore Speed	2.98	2.13	2.13
» Bus			
QPI Strap (GT/s)	4.800	4.800	4.800
QPI Data Rate (GT/s)	6.701	4.800	4.800
Voltages			
Processor Core (V)	S-1.4000	Dynamic	Dynamic
Memory (V)	1.5125	1.5125	1.5125
QPI / Processor Uncore (V)	1.2250	1.2250	1.2250
IOH Core (V)	1.1000	1.1000	1.1000

Press <Enter> to display System Bus information and make changes to the System Buses

←=Select Screen
↑=Select Item
Enter=Select Submenu
F9=Setup Defaults
F10=Save and Exit
Esc = Exit Setup

Changes

Figure 4.2. 4.09 GHz on an Intel Desktop Board DX58S02 with an Intel Core i7-920 Processor Using Host Clock Changes

4.3 Intel Core i7-920 non-Extreme Edition Processor on Intel Desktop Board DX580G

Figure 4.3 shows the BIOS settings to achieve a processor speed of 3.98 GHz with an Intel Core i7-920 processor. A host clock setting of 181 MHz was used. A memory speed of 1448 MHz was obtained using a memory multiplier of 8 when combined with the host clock setting of 181 MHz. With the Intel Core i7-920 processor, the QPI data strap is locked at 4.8 GT/s, resulting in an overall QPI data rate of 6.518 GT/s when combined with the 181 MHz host clock setting. No processor thermal throttling occurred during stress testing with these settings.

These results were obtained on a Intel Desktop Board DX580G with XMP 2133 memory installed. The board was located on an open bench top and the processor was air cooled using an Intel tower model E88216-001 fan heatsink.

Intel® Desktop Board DX580G - BIOS Version 0779 - 04/06/2011			
Main Configuration Performance Security Power Boot Exit			
Fail-safe Watchdog	<Enable>		
Watchdog Coverage for Host Clock	<Disable>		
Host Clock Frequency (MHz)	Proposed [181]	Active 181	Default 133
» Processor			
Intel® Turbo Boost Technology	Enable	Enable	Enable
Multiplier	22	22	22
Max Processor Speed	3.98	3.98	2.93
» Memory			
Multiplier	8	8	8
Speed	DDR3-1448	DDR3-1448	DDR3-1067
Uncore Multiplier	16	16	16
Uncore Speed	2.90	2.90	2.13
» Bus			
QPI Strap (GT/s)	4.800	4.800	4.800
QPI Data Rate (GT/s)	6.518	6.518	4.800
Voltages			
Processor Core (V)	S-1.4000	S-1.4000	Dynamic
Memory (V)	1.5125	1.5125	1.5125
QPI / Processor Uncore (V)	1.2250	1.2250	1.2250
IOH Core (V)	1.1000	1.1000	1.1000

After a boot failure, uses BIOS defaults to allow the system to boot back into BIOS Setup while retaining the last used BIOS Setup values set by the user.

←=Select Screen
 ↑=Select Item
 Enter=Select Submenu
 F9=Setup Defaults
 F10=Save and Exit
 Esc = Exit Setup

Figure 4.3 3.98 GHz on an Intel Desktop Board DX580G with an Intel Core i7-920 Processor Using Host Clock Changes

A Parameter Descriptions for BIOS Performance Settings

Table A-1. BIOS Performance Settings

Setup Option	Description
Host Clock Frequency	Changing this setting overrides the host clock default frequency of 133.3 MHz. The host clock frequency x processor ratio = processor speed. Changing the host clock frequency also changes the memory and QPI speeds.
Processor Voltage Override Type	None: Allows the processor to manage its power usage Static: Overrides the voltage requested by the processor and allows a user selected Processor Static Voltage to be applied at all times. This option disables the dynamic voltage control of the processor. Dynamic: Defines an offset that will always be applied to the voltage requested by the processor. The offset is the difference between the selected voltage and the voltage at power on. For example, if the selected voltage is 1.3 V and the processor powers on at 1.1 V, an offset of 0.2 V will always be added to the voltage requested by the processor.
Processor VR Droop Control	This field is enabled when an override voltage is selected. CPU Voltage Droop occurs when the processor is put under load. Selecting an option to decrease the voltage droop will generally increase processor stability, but may consume more power and generate heat.
Maximum Non-Turbo Multiplier	Used to lower the maximum non-turbo processor speed. The maximum allowed value is hard coded into your processor model. For overclocking, use the host clock or turbo ratios (core ratios).
Processor Idle State	When "Low Power" is selected, the BIOS will report a full range of available Enhanced Intel SpeedStep Technology frequency steps to the operating system. When "High Performance" is selected, the BIOS will report only the top frequency step. Note: C-states may impact the ability of some frequency monitoring tools to accurately report the full frequency.
Active Processor Cores	This setting allows the user to change the number of cores enabled for the processor.
Intel® Hyper-Threading Technology	Allows Hyper-Threading Technology to be enabled or disabled. When Hyper-Threading is disabled, only one thread per active processor core is available.
Intel® Turbo Boost Technology	Enabling Intel Turbo Boost Technology also enables Enhanced Intel SpeedStep Technology and automatically allows processor cores to run faster than the base operating frequency if the core(s) is operating below power, current, and temperature specification limits.
TDC Current Limit Override (Amps)	Allows the user to set the upper current limit (in amps) that the processor can consume. This parameter is designed to set the maximum current that your processor voltage regulator can support. If this is exceeded, the maximum non-turbo ratio will be used by the processor.

Intel DX58S02/DX580G Desktop Board Performance Tuning Guide

Setup Option	Description
TDP Power Limit Override (Watts)	Defines the maximum power (in watts) that can be used by the processor when Turbo Mode is active. If the processor exceeds this value, Turbo mode will be disengaged and the maximum non-Turbo ratio will be used until the power level average drops below the limit. This parameter allows you to set the maximum wattage in order to prevent exceeding the cooling capability of your thermal solution. If the cooling capability of your thermal solution is exceeded, processor throttling will occur.
CPU VR Current Limit Override	Setting this to Enable will under report the actual TDC current used in the TDC and TDP Overrides.
Individual Core Ratio Adjustment	When this setting is enabled, all core ratio limits can be reset to the same value by making a single adjustment. When this is disabled, each of the core ratios are adjusted individually.
6-Core Ratio Limit	Sets the core multiplier to be used when six processor cores are in use.
5-Core Ratio Limit	Sets the core multiplier to be used when five processor cores are in use.
4-Core Ratio Limit	Sets the core multiplier to be used when four processor cores are in use.
3-Core Ratio Limit	Sets the core multiplier to be used when three processor cores are in use.
2-Core Ratio Limit	Sets the core multiplier to be used when two processor cores are in use.
1-Core Ratio Limit	Sets the core multiplier to be used when one processor core is in use.
IOH Core Voltage Override	This setting allows the user to increase the voltage to the IOH.
QPI Data Rate	Allows the QPI data rate to be selected. Some processors have the QPI data rate locked at 4.8 GT/s and the QPI data rate cannot be changed.
PCI Express Bus Frequency	Allows the user to change the frequency of the PCI express bus.

B Parameter Descriptions for Memory Performance Settings

Table B-1. Memory Performance Settings

Setup Option	Description
Performance Memory Profiles	Automatic setting uses specification compliant values provided by the memory module. If the memory module supports XMP there will be additional selections for each profile stored in the module. Selecting a profile will populate all the settings with values recommended by the DIMM manufacturer. Selecting Manual Mode allows the user to change each of the settings.
Memory Voltage (V)	Allows the user to adjust the voltage applied to the memory DIMMs.
QPI/Uncore Voltage (V)	Allows the user to adjust the QPI/Uncore voltage.
Uncore Multiplier	Allows selection of the uncore frequency of the processor which includes the integrated memory controller. Four core processors require a 2:1 ratio and six core processors require a 1.5:1 ratio with the memory multiplier. BIOS automatically enforces the proper ratios for this setting.
Memory Multiplier: Speed	Allows selection of memory speed from a list of choices.
tCL	Column address strobe (CAS) Latency: The amount of time in cycles between sending a read command and the time to act on it.
tRCD	Row address strobe (RAS) to CAS Delay: The amount of time in cycles for issuing an active command and the read/write commands.
tRP	RAS Precharge Time: This is the minimum time between active commands and the read/writes of the next bank on the memory module.
tRASmin	Minimum RAS Active Time: The amount of time between a row being activated by precharge and deactivated.
tRFC	RAS Refresh Cycle Timing: This determines the amount of cycles to refresh a row on a memory bank.
tRRD	RAS to RAS Delay: The amount of cycles that it takes to activate the next bank of memory.
tWR	Write Recover Time: The amount of cycles that are required after a valid write operation and precharge.
tWTR	Write to Read Delay: The amount of cycles required between a valid write command and the next read command.
tRTP	Controls the number of clocks that are inserted between a row precharge command and an activate command to the same rank.
tRC	Determines the minimum number of clock cycles used to complete row activation to precharging of the active row.
tFAW	Specifies the time window where four activates are allowed in the same rank.
tCWL	Column address strobe Write Latency: The amount of time in cycles between sending a write command and the time to act on it.
Command Rate	The amount of time that commands can be issued.

