Intel® Desktop Boards DZ77GA-70K, DZ77RE-75K

Performance Tuning Guide

Revision 1.0

⚠ **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.

⚠ **WARNING**

Altering PC memory frequency and/or voltage may (i) reduce system stability and useful life of the system, memory 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 assumes no responsibility that the memory included, if used with altered clock frequencies and/or voltages, will be fit for any particular purpose. Check with the memory manufacturer for warranty and additional details.

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1 Introduction

Performance tuning of Intel® Desktop Board DZ77GA-70K 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 DZ77GA-70K. 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 while protecting the user from overheating or damaging board components. 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.
- Processor voltage regulator heat sinks — these provide increased cooling capability to the voltage regulation system components.
- Six-phase processor voltage regulator — component stress is reduced since overall electrical load is distributed among six 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® Z77 Express Chipsets. Additionally, the Intel Extreme Tuning Utility is a great tool for monitoring most Intel desktop board-based systems and is available for download at
http://www.intel.com/design/motherbd/software/xtu/

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

2 3rd Generation Intel® Core™ Processor Family and Intel® Z77 Express Chipset General Concepts

2.1 Architecture

Intel Desktop Board DZ77GA-70K consists of the 3rd generation Intel Core processor family and the Intel Z77 Express Chipset (the Platform Controller Hub (Intel Z77 PCH)). The 3rd generation Intel Core processor family integrates the system memory controller and the PCI Express x16 interface. DDR3 memory is accessed through two independent memory channels. A system clock that drives all Desktop Board components is integrated into the Intel Z77 PCH. The Intel Z77 PCH provides support for a PCI Express x1 interface, a PCI* bus, SATA, USB, and other system interfaces. The Intel Z77 PCH communicates with the processor via the DMI bus. BIOS performance tuning controls include processor turbo ratios, the system clock, and processor and memory voltages. A simplified system block diagram is shown in Figure 2.1.
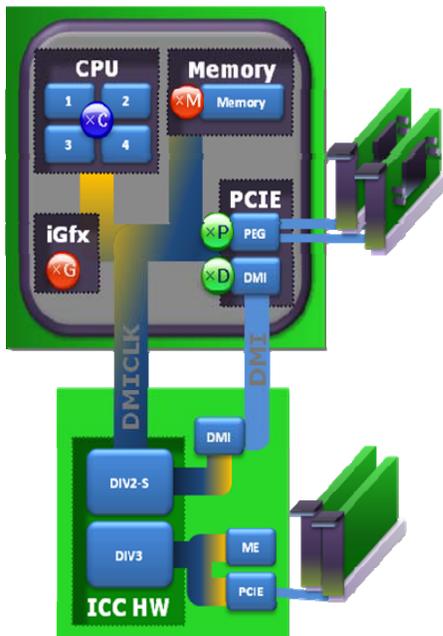
- **Core Frequency**
  - Unlocked turbo limits (100MHz increments)
  - Programmable voltage offset to improve core frequency limits
- **Graphics Frequency**
  - Unlocked graphics turbo limits (50Mhz increments)
  - Unlocked graphics power limit ratios
- **Memory Ratio**
  - Unlocked memory controller (XMP profiles, individual timing parameters)
  - Unlocked memory controller voltage levels
  - Granularity options for 200 and 266MHz
- **DMICLK (aka BCLK)**
  - Unlocked PCH clock controller (1MHz increments)
  - Unlocked CPU PLL voltage levels
- **PEG and DMI Ratios**
  - Fixed ratios

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Figure 2.1. Intel Desktop Board DZ77GA-70K Simplified Block Diagram

3   Intel Desktop Board DZ77GA-70K Performance Tuning Using BIOS Setup

3.1   Hardware Considerations for Performance Tuning

3.1.1   Processor

In addition to Intel Desktop Board DZ77GA-70K, a processor that allows the desired level of performance tuning by the user is required. Performance tuning capability with the 3rd generation Intel Core processor family is dependent on the selected processor. Fully unlocked processor numbers end in the letter "K" and have maximum performance tuning potential using the system clock and turbo ratios. All 3rd generation Intel Core i5 and 3rd generation Core i7 processor numbers that do not end in the letter "K" are partially unlocked. Partially unlocked processors allow system clock and limited turbo ratio increases. 3rd generation Intel Core i3 processors do not have turbo mode capability and therefore allow performance tuning using the system clock only.

3.1.2   Memory

Memory modules with XMP profiles have pre-programmed 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.

3.1.3   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 DZ77GA-70K, the power supply should have at least 150 watts of unused capacity to accommodate the typical needs of performance tuned processor and memory. For more extreme performance, additional capacity beyond the extra 150 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.

3.1.4　　System Cooling

Performance tuning results in additional system heat generation. Increased cooling capability may be required to allow performance tuning and operation of a performance tuned system while maintaining stable operation. 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 DZ77GA-70K BIOS or the Intel Extreme Tuning Utility.

Earlier performance tuning methods where the frequency of the system clock was increased are now not the most effective means of boosting performance with the processors in the 3rd generation Intel Core processor family that support turbo mode. Turbo mode provides "on demand" performance when needed while allowing the processor to run at a lower frequency with reduced heat generation and improved efficiency when demand is low. With Intel Desktop Board DZ77GA-70K, Intel suggests beginning tuning efforts by optimizing turbo mode performance and then utilizing the system clock for secondary adjustments.

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 will be helpful.

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 DZ77GA-70K BIOS supports a single profile. The user may either go into BIOS and change the performance settings as needed or utilize the profile storage capability in the Intel Extreme Tuning Utility. The Extreme Tuning Utility allows various performance profiles to be loaded and implemented as needed.

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 latest BIOS revision 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 'F9' while in BIOS setup mode and then pressing 'F10' to save those settings.
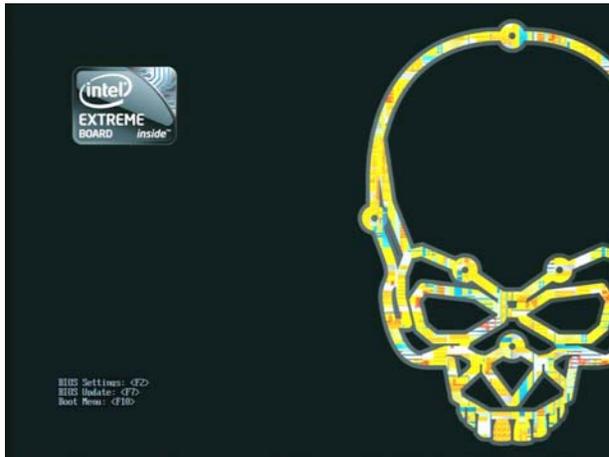
Boot Screen Menu

F2 – to Enter BIOS setup

F7 – to update system BIOS

F10 – Boot options menu

✏ **NOTE**

If you configured your system to boot to RAID or IDE, 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 F10 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 has been 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 the DZ77GA-70K board at the top of the Diagnostic LED bank, a red LED will illuminate when the Watchdog Timer is activiated. 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 most, 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 Sections 3.4.2 through 3.4.4 can be used.

```
BIOS has detected unsuccessful POST attempt(s).
Possible causes include recent changes to BIOS
Performance Options or recent hardware change.
Press 'Y' to enter Setup or '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 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 needing to open the system chassis to access the BIOS jumper. When the Back to BIOS button is depressed, both the button and a red LED located on the DZ77GA-70K board Diagnostic LED bank will illuminate. 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 DZ77GA-70K Product Guide*.

**Figure 3.2. Screen Displayed When 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 that is provided on the
board to allow the user 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 DZ77GA-70K 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 power and
rebooting will allow the system to initiate a reboot. 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 DZ77GA-70K Tuning using Over-Clocking Assistant™

Included in the DZ77GA-70K Visual BIOS™ setup program is an automated method to over clock using pre-tested built in settings. These settings have been extensively developed and tested in Intel's over clocking laboratory and will work with most system configurations.

The Overclocking Assistant can be found on the home screen of the Visual BIOS setup. Note the 'Unlocked' icon which shows that an Intel K-SKU processor is installed and over clocking is unlocked and available. Non Intel K-SKU processors are locked and can not be overclocked.

To increase the processor frequency using the Overclocking Assistant, simply use the mouse to move the slider until the desired frequency is shown on the main display.

3.6 Intel Desktop Board DZ77GA-70K Performance Manual Tuning Process

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.

Performance tuning is an iterative process. The settings made for a parameter may affect which settings will work for another parameter. For example, increasing the system clock frequency may require that previous adjustments to the processor turbo ratios be revised downward to maintain processor stability.

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 3.6.1 through 3.6.9. 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.

1. Configure the BIOS for performance tuning
2. Set processor voltage and turbo ratios
3. Check stability
4. Increase system clock frequency
5. Check stability
6. Tune memory
7. Check stability
8. Reduce voltage, current, and power
9. Check stability
10. Re-enable dynamic and burst mode (if possible)
11. Check stability
12. Reconfigure the BIOS to enable interfaces
13. Check stability
14. Archive performance settings

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3.6.1   Configure the BIOS for Performance Tuning

It is recommended that non-essential interfaces (such as, onboard audio, USB, LAN, external SATA, etc.) be disabled when performance tuning to simplify the process. Once the performance parameters have been optimized, the onboard features can be re-enabled.

Scroll to "Configuration" > "On-Board Devices" and use the submenus to disable these features (refer to Figure 3.3).

NOTE

Do not disable the USB port where the keyboard is connected.
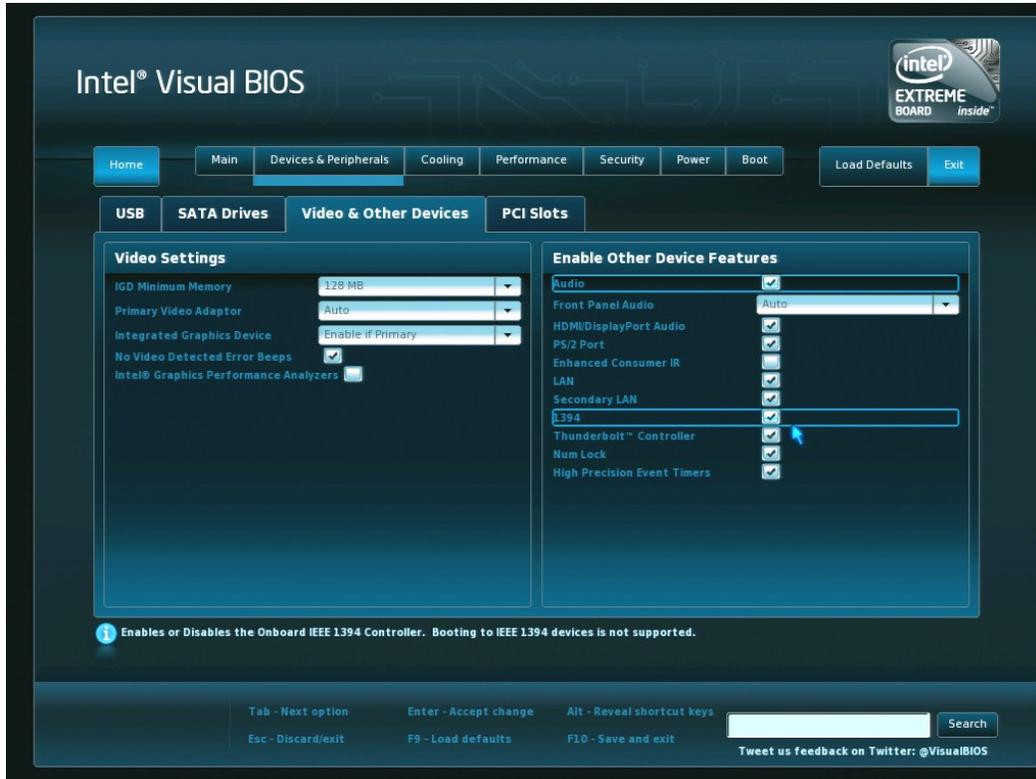
Figure 3.3. System Setup

Performance tuning options are located in the menu section labeled "Performance".

From the Performance page, processor tuning options are under the "Processor Overrides" section shown in Figure 3.4 below. Also see Appendix A for a table summarizing these settings and their effects. Sections 3.6.1.1 through 3.6.1.8 include guidelines for setting the processor override parameters.

Figure 3.4. Processor Overrides Page Showing Defaults

3.6.1.1   CPU Voltage Override Type

Two methods are provided for increasing the processor voltage, Processor Voltage Override and Voltage Offset. Override commands the VR controller to supply a constant voltage to the processor ignoring SVID requests from the processor. Offset tells the VR controller to take the voltage requested by the processor and add extra voltage to it. This way the processor can still control the voltage based on its loading and power factors, resulting in a better thermal profile for over-clocking.

3.6.1.2   CPU Voltage Override

On 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. This is something of a trial and error process and the objective is to provide just enough voltage so the processor can sustain the desired level of performance. Note that high voltage settings may potentially cause processor damage. Later in the tuning process, this voltage will be reduced to the lowest level that provides stability.

3.6.1.3   CPU VReg Droop Control

Set CPU 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.

3.6.1.4   TDC Current Limit Override

Set the TDC Current Limit Override (Amps). The amount of additional processor current needed depends on the amount of frequency increase being attempted and the processor workload. The purpose of the TDC current limit is to thermally protect the processor voltage regulator. If the processor voltage regulator gets too hot, it will throttle (reduce the frequency of the processor) and greatly diminish performance.

3.6.1.5   Intel® Turbo Boost Technology

Ensure that Intel® Turbo Boost Technology is set to Enable.

3.6.1.6   Burst Mode Power Limit

Set Burst Mode to enable. Disabling burst mode will cause the processor to set the burst mode to a specified default power limit of the installed processor. Burst mode is the maximum instantaneous power that the processor is allowed to consume. It is recommended that this limit be set higher than the sustained mode power limit.

3.6.1.7   Sustained Mode Time

Set Sustained Mode Time in seconds. One second is recommended as an initial setting. Setting this time too long will exceed the capability of the processor heat sink and may result in excess processor heating and subsequent throttling (frequency reduction) to reduce the temperature. A longer time interval in sustained mode may

result in a longer time interval out of sustained mode while accumulated processor heat is being dissipated.

3.6.1.8   Sustained Mode Power Limit

Set the Sustained Mode Power Limit (TDP) for turbo mode. If the average power during the sustained mode time exceeds this limit, turbo mode will disengage and the processor will run at the maximum non-turbo ratio. Inadequate cooling may cause the processor to throttle. You can use the Intel Extreme Tuning Utility monitoring features to track processor temperature. If the processor temperature increases steadily while running under load, the processor cooler capability to dissipate heat is being exceeded and you will need to reduce the TDP power limit to prevent throttling.

3.6.2   Set Multipliers (Turbo Ratios)

◁▱ NOTE

Only fully unlocked or partially unlocked processors in the 3rd generation Intel Core processor family allow modifying the multiplier (turbo ratios). See Section 3.1 for additional details on tuning capability with the various processors.

Set the highest ratio to be used by turbo mode for each of the 1, 2, 3, and 4 core ratio limits. 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 3.6.1.2) and/or the TDC Current Limit Override (Amps) (Section 3.6.1.4) can be used to restore processor operation stability.

For the default host clock setting of 100 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)	Multiplier	Resulting CPU Core Frequency (GHz)
35	3.50	50	5.00
36	3.60	51	5.10
37	3.70	52	5.20
38	3.80	53	5.30
39	3.90	54	5.40
40	4.00	55	5.50
41	4.10	56	5.60
42	4.20	57	5.70
43	4.30	58	5.80
44	4.40	59	5.90
45	4.50	60	6.00
46	4.60	61	6.10
47	4.70	62	6.20
48	4.80	63	6.30
49	4.90		

Note: Multiplier values 60 thru 63 are only available with 3rd Generation core i7 processors.

3.6.3   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 sub-systems. 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. For processor stability issues, revising voltage settings, turbo ratios, system clock frequency settings 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 3.5. Being able to stress test sub-systems like the processor and memory with relative independence is helpful. This enables you to determine which sub-system has become unstable so you know which group of performance parameters to revise. Revising processor parameters will not restore stability if memory settings are actually causing the instability.

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

Once system stability has been established with stress testing software, recheck system stability using your normal software applications to ensure stability.
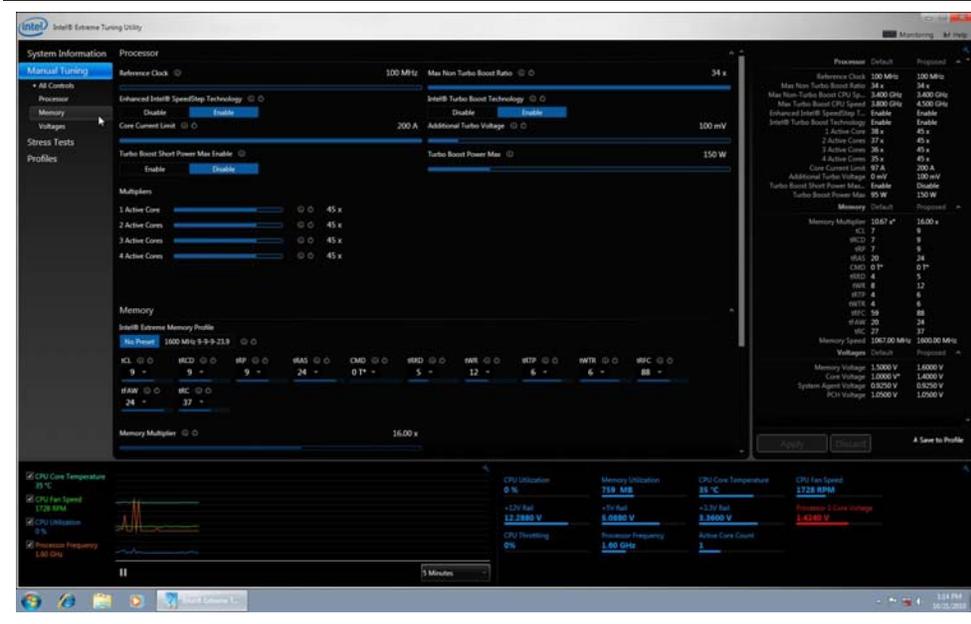
Figure 3.5. Intel Extreme Tuning Utility System Monitoring Screen

3.6.4 Increase System Clock Frequency

With both the 2nd and 3rd generation Intel Core processor families, the system clock frequency is limited to modest increases compared to earlier Intel processors. Limited processor frequency increases can be done by raising the system clock speed and leaving the turbo ratio multipliers unchanged. Performance tuning using the system clock should be done to augment processor performance improvements already obtained using turbo ratios. Note that system clock changes also affect frequency of other systems, such as memory and PCI-Express in addition to the processor.

System (host) clock frequency changes were made using the BIOS screen shown in Figure 3.6. The frequency display shows the results of increasing the system clock setting from 100 MHz to 105 MHz with the resulting processor speed increase from 3.90 GHz to 4.09 GHz (39x105 MHz = 4.09 GHz).

**Figure 3.6. BIOS Screen Showing System Clock Frequency
Increased to 105 MHz**

⊠ **NOTE**

The multipliers for the processor were left unchanged from the default of 39 and only the host clock frequency was increased. Since the speeds of the other board subsystems are derived from the host clock, the memory speed will be increased as well. This increase may require memory setting adjustments to restore stability. Consult Section 3.6.5 for more information on memory settings.

3.6.5 Performance Tuning 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 DZ77GA-70K has two 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 two memory modules will be installed, install the additional memory in the black DIMM connectors.

3.6.5.1 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 pre-programmed by the manufacturer into the memory module itself and can be selected from the XMP profile list as shown in Figure 3.7. 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.

> **Comment [wpm1]:** Isn't it truer to say it WILL affect the life of the CPU and extreme voltage will cause the processor to fail…

Figure 3.7. Selection of XMP 1600 Profile Using the BIOS Menu

3.6.5.2 Memory Performance Options

The Memory Configuration BIOS page 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 3.8. Memory Configuration Screen

3.6.5.3   Determining Memory Frequency

Increasing the host clock frequency will increase the memory speed, in addition to the processor frequency. Note that the memory is not run directly from the host clock. The memory clock frequency is generated by the processor using input from the host clock signal received from the Intel Z77 PCH. The default memory clock frequency runs at 133.3 MHz. Increasing the system clock frequency affects the memory frequency according to the following formula:

Memory frequency = (memory multiplier) * (percent increase in host clock) * (133.3 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 MHz) = 1077 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
18	2400

3.6.5.4   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 iterative adjustments between clock settings that work for memory and processor performance parameter settings will be needed if processor instability occurs.

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.

3.6.6   Reduce Voltage, Current, and Power

Gradually reduce voltage and power settings that were made in the applicable portions of Sections 3.6.1.2 through 3.6.1.8 while checking stability. When instability is encountered, increase the setting(s) as needed to restore stable operation.

3.6.7   Restore Dynamic Voltage

If possible, re-enable dynamic voltage (Section 3.6.1.1). If more than modest performance tuning increases have been made, re-enabling dynamic voltage may result in excess heating and subsequent processor throttling. Leave this setting disabled if processor throttling is occurring.

3.6.8   Reconfigure the BIOS to Re-enable Interfaces

In the BIOS, re-enable interfaces such as, onboard audio, USB, LAN, external SATA, etc., that were disabled earlier in Section 3.6.1.

3.6.9   Archive Performance Settings

The Intel Desktop Board DZ77GA-70K BIOS allows storing one set of parameter settings (profile) at any given time. If several groups of performance settings are needed by the user, the Intel Extreme Tuning Utility allows storing multiple profiles as shown in Figure 3.9. Performance parameter settings can be entered into the Intel

Extreme Tuning Utility using Manual mode. Selecting "Profiles" from the left menu brings up a window that allows the user to enter a profile name where the performance parameter settings will be stored. These profiles can be invoked by starting the Intel Extreme Tuning Utility and loading the desired profile. The most recently loaded profile will remain resident in the BIOS, until changes are made by the user.

Figure 3.9. Using the Intel Extreme Tuning Utility for Storing Performance Profiles

4   Performance Tuning Examples

4.1   4.5 GHz Processor Speed Using Turbo Ratios

Figure 4.1 shows the BIOS settings to achieve a processor speed of 4.5 GHz. The system clock has been left at the default value of 100 MHz. XMP profiles were used to obtain a memory speed of 1600 MHz.

Figure 4.1. 4.5 GHz Processor Speed Using Turbo Ratios

4.2   4.72 GHz Processor Speed Using Turbo Ratios and System Clock Changes

Figure 4.2 shows the BIOS settings to achieve a processor speed of 4.72 GHz. Turbo ratios of 45 were set for all of the processor cores. The system base clock frequency has been increased from the default value of 100 MHz to 105 MHz. XMP profiles were used to obtain a memory speed of 1600 MHz. These settings are shown while running the CPU Stress Test included with the Intel Extreme Tuning Utility shown in Figure 4.3.

Figure 4.2. 4.72 GHz Processor Speed Using Turbo Ratios with a 105 MHz System Clock Setting
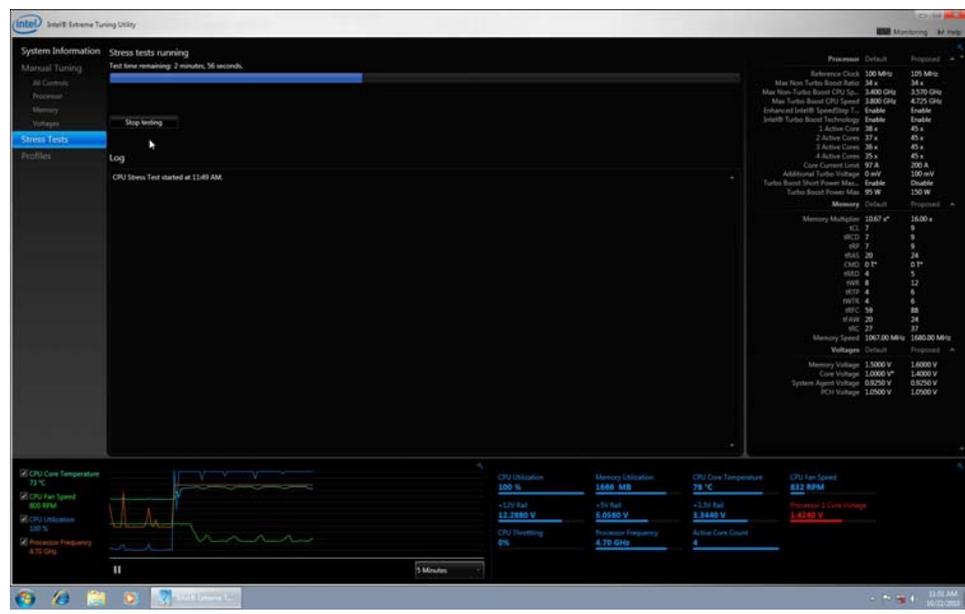
Figure 4.3. Intel Extreme Tuning Utility Screen Showing CPU Stress Test Running with 4.72 GHz Processor Speed

A   Parameter Descriptions for BIOS Performance Settings

Table A-1. BIOS Performance Settings

Setup Option	Description
Static CPU Voltage Override Type	Overrides the voltage requested by the processor and allows a user selected CPU Static Voltage to be applied at all times. This option disables the dynamic voltage control of the processor.
Dynamic CPU Voltage Override Type	Defines an offset that will always be applied to the voltage requested by the CPU. The offset is the difference between the selected voltage and the voltage at power on. For example, if the selected voltage is 1.3V and the CPU powers on at 1.1V, an offset of 0.2V will always be added to the voltage requested by the CPU.
CPU VReg 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.
TDC Current Limit Override	Sets the upper current limit (in amps) that the processor can consume.
Maximum Non-Turbo Ratio	Used to lower the maximum non-turbo CPU speed. The maximum allowed value is set by default and is specific to your processor model.
CPU 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.
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.
Burst Mode	When Intel Turbo Boost Technology is engaged, Burst Mode allows improved instantaneous performance beyond what is already provided by Sustained Mode. It is recommended to leave this enabled for Overclocking as selecting "Disabled" will cause the processor to use a default value.
Burst Mode Power Limit (Watts)	This control is enabled when Burst Mode is enabled. Burst Mode Power Limit is the maximum power (in watts) that can be used by the processor when Turbo Mode is active. It is recommended that this always be set higher than the Sustained Mode Power Limit.
Sustained Mode Time	Defines a window of time (in seconds) the CPU will use to average the power for comparison to the the Sustained Mode Power Limit.
Sustained Mode Power Limit (Watts)	Defines the maximum sustained power (in watts) as averaged over the Sustained Mode Time 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.
CPU Turbo Voltage Offset	Offset CPU Voltage (in mV) that is only applied during Turbo Mode. Note: This setting will be ignored if a Static CPU Voltage Override is selected.
Internal PLL	This is an advanced setting that will slightly increase the internal CPU PLL Voltage for

Setup Option	Description
Voltage Override	more aggressive overclock frequencies. Note: This setting may impact S3 functionality.
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.

B   Parameter Descriptions for Memory Performance Settings

📧 **NOTE**

All multiplier values listed in Table B- are applied to the single 100 MHz (default) host clock.

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 after XMP allows the user to change each of the settings.
Memory Multiplier	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.
Memory Voltage	Changes the voltage applied to the memory.
Command Rate	The amount of time that commands can be issued.
tRC	Determines the minimum number of clock cycles used complete row activation to precharging of the active row.
tFAW	Specifies the time window where four activates are allowed in the same rank.