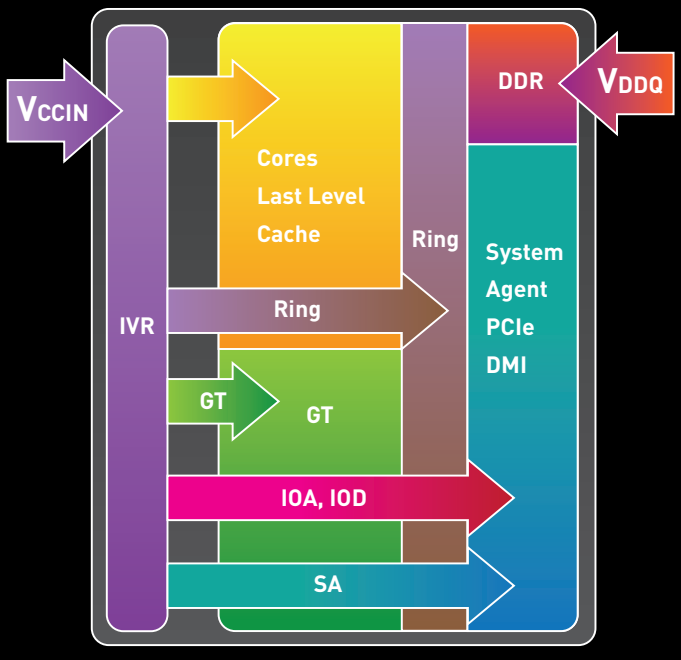
INTEL 9-SERIES CHIP OVERCLOCKING SYSTEM

The Intel 9-Series Chipset is Intel's main product for 2014. Strictly speaking, the structure of the chips is a slightly modified version of the 8-Series chips with the support for PCI-e M.2 interface added. In terms of overclocking, they are identical to the 8-Series chips in their structure as well as limitations. Therefore, the Z97 chip is the main chip for overclocking. Coupled with the K-Series processors, it comes with a complete set of overclocking options, such as CPU Ratio, BCLK and Memory Ratio. As the H97 is not capable of being overclocked, the Z97 platform is thus the preferred platform for overclockers.

Please note that although the Z97 is an all-new product, Intel has yet to release any new processors in the lineup concurrently. So, for now, gamers still have to rely on the Haswell CPUs for overclocking, such as the currently available 4770K and 4670K. The new CPU Codename is designated as Haswell Refresh and it is predicted to be a slightly modified version of Haswell.

Z97 Platform Block Diagram



CPU Ratio

Using the same grading of the Haswell, the Z97 CPUs fall into the K-SKU and non-K SKU grades. The K-SKU are equipped with the maximum multiplier up to 80x; while the non-K SKU will be restricted by the Intel Turbo Ratio Limit. Therefore, if you want OC, choose the K-SKU CPUs.

CPU Base Clock

Same with the Z87 Platform. Intel has included the “ratio” concept in the base clock of the Z97 this time, as the architecture of the Haswell is “CPU Base Clock=DMI/PEG Clock X BCLK Ratio”. Although this allows users to adjust the CPU with greater flexibility, the whole thing becomes more complex and complicated overall. In order to make OC easier for most users, MSI 9 series platform BIOS can automatically integrate DMI/PEG Clock and BCLK Ratio. This way, overclockers only need to adjust the CPU Base Clock for the BIOS to automatically tune the DMI/PEG Clock and BCLK Ratio. This makes CPU Base Clock OC simpler on the Intel Z97 platform.

Memory Ratio

Same with the Z87, the Z97 has added the Memory Ratio to the memory system, with the highest at DDR3-3200(MSI Spec). Along with the flexible base clock combination, it is easier to configure different memory frequencies on the Z97 than the Z87 platform.

Intel 9 Series chip OC Ability Comparison

Intel 9 Series Platform OC Ability Comparison			
	Z97	H97 / H81	B85
CPU Ratio	O	Δ	Δ
Base Clock	O	Δ	Δ
RAM	O	Δ	Δ
GPU	O	O	O

O=Use K-SKU CPU Δ= Adjustable at limited range.

Intel 9 Series system Frequency Formula

CPU Frequency = CPU Base Clock X CPU Ratio
CPU Base Clock = DMI/PEG Clock X BCLK Ratio
GPU Frequency= BCLK /2 x GT Ratio
RAM Frequency = CPU Base Clock x 100/133MHz x DDR Ratio

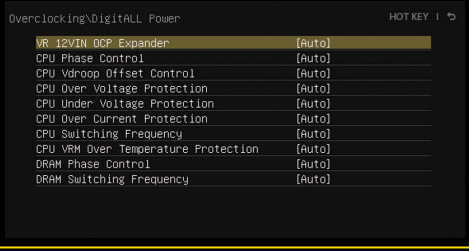
INTRODUCTION TO BIOS OVERCLOCKING KEY ITEMS

The MSI Z97 mainboard OC items are accessible from the OC (Overclocking Setting) icon on the left column. By clicking the icon, the OC Setting Menu will pop up.
Basically, the menu falls into two sections. The upper section provides options for frequency OC, and the lower section contains options for voltage OC. The following will point out the major options related to OC.



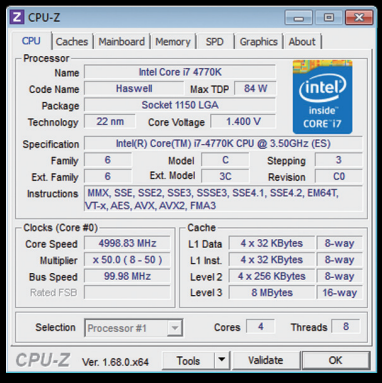
Simple/ Advanced Mode	Simple Mode offers a simple BIOS menu for general overclockers. The Advanced Mode offers a comprehensive set of BIOS overclocking options, allowing overclockers to have full control over their overclocking to achieve the most optimal results.
Extreme OC Config	This feature enables the automatic shutdown of unnecessary peripherals during LN2 overclocking, preventing other peripherals from becoming unstable due to low temperatures, affecting the stability of the overclocking.
Enhanced Turbo	After enabling this feature, the operating frequency of each core in the CPU will tuned and fixed to the highest value of the Intel Turbo Boost for better efficiency.
CPU Base Clock	Manual adjusts CPU base clock. The BIOS will automatically tune the related settings with reference to CPU base clock ratio, in order to make base clock adjustment easier for users. After adjusting the CPU base clock, the memory frequency will be changed automatically. As a result, when the Base Clock increases, the CPU Core Voltage and DRAM Voltage will have to be concurrently increased slightly, or the DRAM Ratio adjusted to lower the DRAM speed to avoid scenarios where the effects between these 2 elements causing the overclocking to fail.

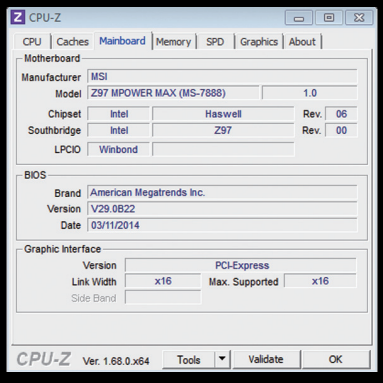
CPU Base Clock Strap	Manually adjusts base clock ratio strap. Users who do not like automatic tuning for the CPU base clock can manually tune individual items from this option. After adjusting the CPU base ratio, the memory frequency will be changed automatically. It is not recommended to adjust this option. MSI BIOS will optimize the setting automatically. 
CPU Ratio	Manual adjusts CPU ratio. Large range adjustments are available only on the K CPUs. This option will not change memory frequency. Adjusting the CPU Ratio is the fastest way of overclocking the CPU frequency. Generally, it can be accomplished simply by increasing the CPU Core Voltage. In cases where the system becomes unstable due to overheating, users may consider increasing the VCCIN Voltage.
Ring Ratio	Ring, the CPU Cache called by Intel XTU, is an interface connecting to each circuit inside the Haswell CPU. To adjust Ring Ratio would have changed the ability and performance of CPU. MSI recommend you not to adjust Ring Ratio higher than CPU Ratio.
GT Ratio	It is for adjusting the frequency of the CPU built-in graphic chipset (iGPU). Increasing the setting value will help improve the game fluency. Each increment in GT increases frequency by 50MHz. Please remember to increase GT voltage as the frequency increases.
CPU PCIE PLL & Filter PLL	These features are PLL related settings that may affect the overclocking potential of the CPU core. However, MSI has already helped overclockers by automatically selecting the most optimal settings; therefore these 2 settings should not be necessary in normal overclocking. 

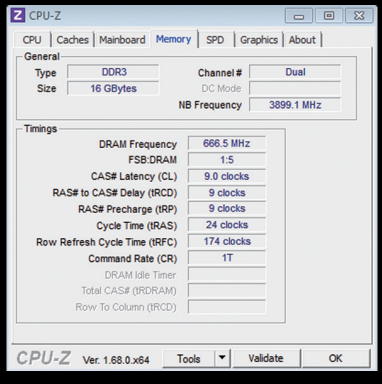
DRAM Frequency	Manual adjusts memory frequency. This is the memory ratio setup option, with the maximum limit up to DDR3-3200(MSI Spec. Depend on CPU quality). Although this option will not change the CPU base clock, users can change memory frequency by adjusting the CPU base clock. 
Extreme Memory Profile (X.M.P.)	Quickly activates the Intel's XMP automatic memory OC function with suitable SPD timing value. However, users must use memory modules supporting XMP.
Advanced DRAM Configuration	Manually adjusts the SPD timing of memory. When memory OC has exceeded the XMP's upper limit, users will need to adjust the SPD timing manually to successfully start the system.Generally, the smaller the DRAM timing value, the faster the speed. Also, users may select the Unlink Mode of individual memory or simultaneously changing the DRAM timing value (Link Mode)
DigitALL Power	The feature contains overclocking options relating to PWM IC power controls, which are comprised of Voltage Frequency and Power Protection. MSI has practically helped overclockers by automatically selecting the most optimal settings, but the CPU Switch Frequency can be slightly increased to generally not more than 500 KHz to help in overclocking. For the overclocking LN2, the frequency can be increased depending on the situation. But please take note that increasing frequencies will increase the power consumption of temperature of the PWM at the same time. 
CPU Core Voltage	Adjust the CPU core voltage. When CPU frequency increases in an OC operation, it is necessary to increase voltage to ensure stable CPU operations. In general overclocking, 1.3V is sufficient. If the user plans to set to higher voltages, please take note of the heat dissipation of the CPU's heat sink.

CPU Ring Voltage	Adjust CPU Ring voltage. When overclocking Ring Ratio, it is necessary to increase the Ring voltage to ensure CPU OC stability.
System Agent Voltage	Adjust the voltage of the internal memory controller (IMC) in the CPU. Therefore, adjusting System Agent voltage may improve memory OC stability.
CPU I/O Voltage	It is also called the CPU VTT voltage. It is another IMC voltage. It may also improve OC performance when memory is running at high frequency in an OC operation. The I/O Voltage in the BIOS is divided into Analog and Digital. Adjusting these 2 sets of voltages may help with the overclocking for some memory modules.
DRAM Voltage	Adjust memory core voltage. When overclocking memory, it is necessary to increase the DRAM voltage to ensure memory stability.
Eventual DRAM Voltage	This value denotes the actual effective voltage of the DRAM after the BIOS Code. Unlike the actual effective voltage of the DRAM after booting up, this feature only needs to be adjusted depending on the overclocking characteristics of ICs on each memory module. 
PCH 1.05 Voltage	When the overclocking of BCLK becomes unstable or failed, users may try to adjust this voltage to increase the chances of a successful boot. It is recommended that the maximum voltage adjustment not go beyond 1.35V, or else the PCH chip may overheat and become unstable.

CPU CORE SPEED OVERCLOCKING





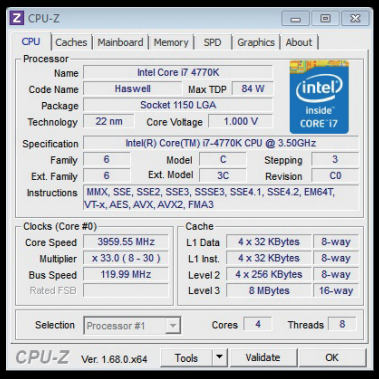


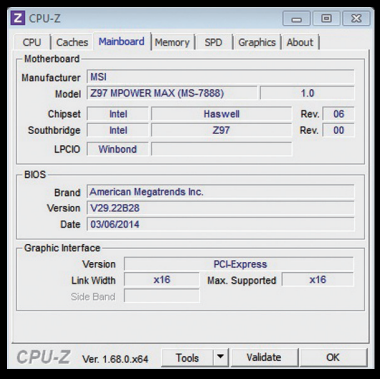
Reference Setting ~ CPU Core 5GHz
Adjust CPU Ratio : 50X
CPU Core Voltage : 1.4V
VCCIN Voltage : 2.2V

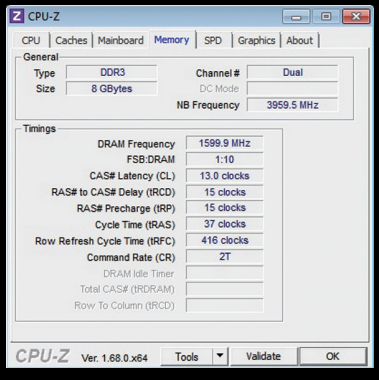
As the CPU adopted the FiVR structure, the CPU die will generate a large amount of heat easily during overclocking. Even with a very efficient heat sink, the dissipation of heat from the CPU proved difficult. This undoubtedly presents a huge challenge for overclockers. Therefore, the Haswell K-SKU CPU is capable of enduring continued loading stably even when overclocked. To attempt to survive the Prime95 heat test, the frequency has to be set at around 4.2 – 4.3 GHz. The voltage must also not be too high at around 1.2V for Core Voltage. An advanced water cooled may also be needed.

If a burn-in test is not necessary, the frequency of an advanced water-cooled CPU may overclocked up to around 4.8 – 4.9 GHz. This time, besides increasing the Core Voltage, users may also try increasing the VCCIN and Ring Voltage to increase stability during overclocking. Maximum overclocking of LN2 may allow it to go beyond 7GHz depending on CPU quality.

MEMORY SPEED OVERCLOCKING





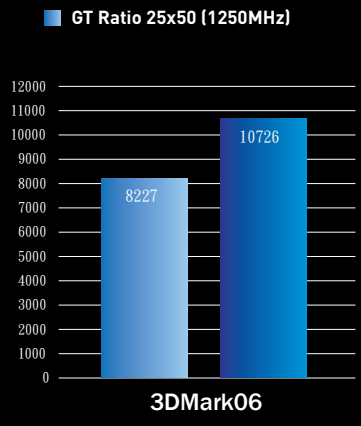


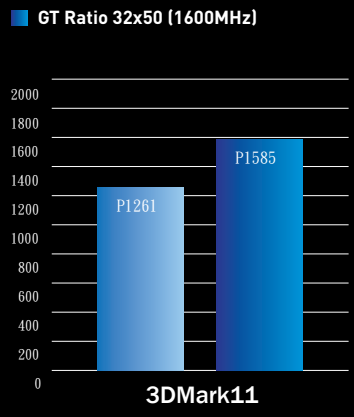
Reference Setting ~ DDR3-3200MHz
DRAM Frequency : DDR3-2666
CPU Base Clock : 120MHz
SA Voltage : 1.1V
I/O Analog Voltage : 1.1V
I/O Digital Voltage : 1.1V
DRAM Voltage : 1.68V

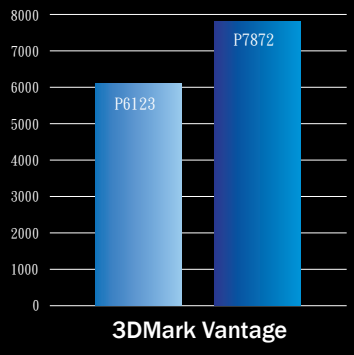
The Z87 platform is best at overclocking memorys. The same, if not better, applies to the Z97 as well. In general, the overclocking of memorys relies on the X.M.P function, but overclocking products beyond DDR3-3200 with X.M.P is a rare and expensive option. But in fact, with the use of certain techniques, it is still possible to let good quality memorys operate at a higher frequency. Users should therefore make use of memory overclocking features such as Load Memory Presets and Eventual DRAM Voltage.

Quoting the abovementioned example, we had taken a set of X.M.P DDR3-2666 memory and subject it to CPU Base Clock and other related voltage adjustments, resulting in it operating on par with a DDR3-3200 effortlessly. Please take note that for a higher rate of success, besides the I/O voltage making, slight adjustments are needed depending on the characteristics of the memorys onboard ICs.

IGPU SPEED OVERCLOCKING







Reference Setting ~ IGPU 1600MHz
Adjust GT Ratio : 32X
CPU GT Voltage : 1.2V

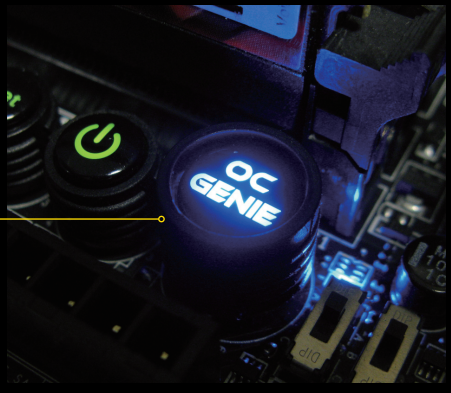
The built-in Intel HD Graphics 4600 display chipset, support DirectX 11, can improve 3D graphics performance by adjusting the GT Ratio.

Take the K SKU CPU as an example, GPU frequency is 1250MHz (calculated as 25x50=1250), and the clock will be up by 50MHz when Ratio value added 1x. Along with the performance increasing, GPU voltage also has to be increased a certain ratio to keep the system stabilization.
Please note that when the GPU is overclocked, it is only effective when the loading frequency of 3D Graphic is present.

EXCLUSIVE MSI OC FUNCTIONS

OC Genie

MSI also equips the Z97 mainboards with the OC Genie function to facilitate users without much OC experience to overclock the CPU, iGPU and memory more easily. In addition, MSI implements OC Genie Mode2 switch to several models for power users to have OC performance enhanced. A strong thermal solution must be needed and the system might have OC failed by using improper system devices. For OCers equipping better heat dissipation fan such as liquid cooling or customized one



Direct OC Button (Option)

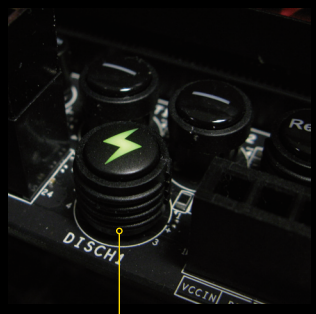
The acclaimed Direct OC Button on the MSI old mainboards has revived in the MSI Z97 mainboards. With the Direct OC Button, users can immediately overclock or reduce the CPU base clock frequency after entering the OS. For example, users can overclock the CPU base clock when playing games to enhance system performance. OC experts can enter the OS at a lower base clock frequency and overclock the base clock with the Direct OC Button to shorten the system loading time when entering the OS.

In addition, Direct OC Button Software comes coupled with the OS, enabling dynamic and instant overclocking options.



Discharge (Option)

In cases where overclocking becomes unstable or fails, pressing this button will allow the mainboard to shut down, discharge electricity, and subsequently Clear CMOS. Unlike the normal Clear CMOS function, the Discharge Button is equivalent to clearing CMOS after removing the buttery, and may prevent occasional situations where CMOS is not fully cleared.



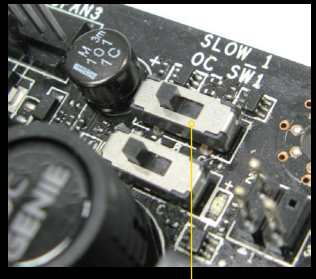
V-check Point (Option)

"V-Check Points" detects voltage for core components during overclocking activities. There are five measure points at the edge of this mainboard, allowing enthusiasts to check relevant voltage values through a multimeter.



Slow Mode Switch (Option)

After activating the Slow Mode Switch, the CPU will boot into the OS at a lowered frequency. Only when the Switch is off that the system instantly returns to its overclocked state. This function is also available under LN2 environment. After executing Benchmark to obtain various results, it can be verified with CPU-Z to break records in an instant.



Load Memory Presets

This BIOS feature comes inbuilt with the frequently used parameters when overclocking memorys to their maximum capacity. These memorys are mostly unique in terms of their onboard ICs and characteristics, requiring special adjustments and often exceeding XMP standards. Before using the Load Memory Presets function, please find out more on the type of ICs used on the memory so that the correct options are selected.



Memory Try It !

This feature is for beginners who wished to overclock their memory but still do not know how to, or gamers simply wanting better compatibility and performance from their memory. Though these parameters may not 100% guarantee success, they provide beginners more opportunities for overclocking their memory.

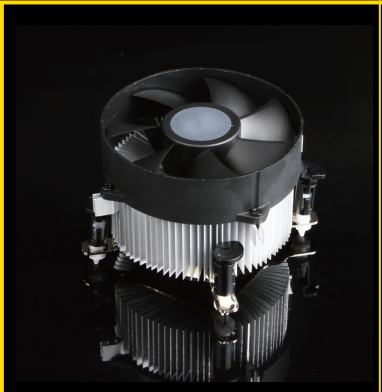


MSI Z97 PLATFORM OC SETTING REFERENCE TABLE

Tuning Item	Default	Increment	Basic	Advanced	High Segment	Extreme LN2
CPU Ratio	35	1	35~40	40~45	45~50	>50
CPU Vcore Voltage (V)	0.8~1	0.001	~Auto	1~1.3	1.3~1.5	>1.6
Memory Frequency (MHz)	DDR3-1333/1600	Depends on DRAM Ratio & BCLK	DDR3-1333~2400	DDR3-400~2666	DDR3-2666~3000	> DDR3-3000
RAM Voltage (V)	1.500	0.01	1.5~1.65	1.65	1.65	>1.65 / <2.0
CPU SA Voltage (V)	0.85	0.001	Auto	1.0~1.1	1.1~1.25	1.20~1.4
I/O Analog Voltage (V)	0.8	0.001	Auto	1.0~1.1	1.1~1.25	1.20~1.4
I/O Digital Voltage (V)	1.0	0.001	Auto	1.0~1.1	1.1~1.25	1.20~1.4
GT Frequency(MHz)	1250	50	1250~1400	1400~1500	1500~1650	>1750
GT Voltage (V)	0.001	0.001	Auto~0.8	0.8~1.1	1.1~1.2	>1.3

Note:
The reference value above is for Core i7-4770K ES Processor.
Increasing voltage may raise the success rate of overclocking as the risk of damage the CPU; thus,we suggest use the special design CPU cooler set to prevent the CPU from overheating.
Below voltage value would cause the damage of component while under air cooling.
* CPU Voltage:1.6V
* CPU Ring Voltage: < Vcore Voltage
* DRAM Voltage:1.9V
We suggest disable some item in BIOS,such as Phase Control and OverSpeed Protection , but EIST、Turbo Boost
If you disable OVP、OCP Function, motherboard or CPU might be damaged.

Cooler Configuration Warning



Standard



Better

Due to the thermal design power specification of Intel Haswell processor is around 90W, so basically the CPU temperature would be higher while overclocking status. Therefore, please try to collocation with heat sink that capable to withstand more than 180W thermal consumption to avoid burning damage on CPU and motherboard.

Note :
The function ,specification ,data and pictures provided by this guidebook is only for reference. Please refer to the actual content through the official launched product or MSI official web site: http://www.msi.com

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