
Here comes the legal stuff guys and gals...

I do not expect complete novices to overclocking to be reading and working through this outline so at this point I am assuming you have a decent grasp on everything I have outlined and have used the tools or similar tools in the past that we are about to break out below.

If you are a complete novice to overclocking I suggest treading very lightly because if you did not build that tower the right way due to lack of experience this can be a very dangerous area to enter.

I have no responsibility for any tower, CPU, motherboard, memory burn or lack of experience and that includes the smarty pants reading this too.

Those fingers are on your mouse and keyboard. It isn't my fingers making the changes.

In other words: YOU CLICK IT, YOU BOUGHT IT!

OVERCLOCKING AFTER HASWELL

- AND -

HOW **WE DID IT**

For Z490 Chipset and the 10900K

By: Wile E. Coyote (*maximus vulgaris*)

This will be the last overclocking document I produce. I would suggest saddle up and read though this carefully because in order to give proper credit where it is due and also try to educate on this platform and processor there will be a little reading involved here.

KUDOS AND THE HISTORY...

Although I did develop the engineering theory that made this clocking methodology possible **the final success was a group effort** and I do not take the credit for the success because unlike Haswell and the 9700K/z390 I did not have the hardware to scrutinize with scopes and meters on a bench to develop an approach based on empirical data and relay that to a team for verification.

Instead this was the culmination of many months of hacking and reviewing BIOS code, research into the hardware white paper engineering documents, building rendered circuits in my computer and testing them (like Samsung uses to build TV boards or Asus uses to design motherboards) *and then* came the commitment and dedication of those willing to extend their trust in my process to actually apply what is in this document to hardware. In that, we have developed a conclusive consensus the approach is valid, safe **and most important** works perfectly in repetition. We have a successful methodology of clocking this platform and processor from 5.0GHz through 5.2GHz.

It should be noted that this approach was developed with the specific hardware outlined in this document. I can not say what substitutes for the hardware will or will not work the same however lower memory speed product than outlined should not present any issue.

5.3GHz has been done but thus far not *with voltages that would be considered reasonably safe* to run for 3-5 years out. On the other hand that does not mean a processor that has 5.3 golden sample cores incorporated into its manufacture production run may be possible to come across and work the same with this outline, I have simply never come across one yet and quite frankly I doubt I ever will because Intel *is already pushing the envelope* as it is with a single core running default @ 5.3GHz.

Although I was the engineer at the helm here, the credit for the success and the development of this outline goes to everyone that volunteered and worked through the process with me.

HOW IT STARTED AND WHO DESERVES CREDIT:

A forum member here read my z390/9700K outline and used it to try and work their z490/10900K system clock. Of course he was aware I said I did not know if what I outlined would work on later systems and in the process contacted me and made some inquiries which included a few tech reports about his findings that differed from the 9700K outline. I was already diving into this platform on paper and code and the information he provided triggered a light bulb.

He appeared to have a good grasp of computers going back decades and most important did not appear afraid to take some risks. So, with a real pair and a desire to uncover a mystery he agreed to work intensively with me while I went through the process of evaluating his results in compare to the available technical information I had at that point was involved with decompiling.

I had contacted and was somewhat working with a few in my old overclock group who ran with me on Haswell as well as the 9700K z390. These are folks that take my direction, log every test run, note every single change and hiccup and send those reports back in detail for my analysis and direction. As overclockers they too have a huge pair *and huge pocketbooks* but have only one goal; overclock to the highest performance level possible **except under my team terms** they must also adhere to the safety rules for CPU longevity, which, they don't like but that is price of admission **to be on my team**. What they do after that is their business. They can care less about flight simulation.

Between the data sets coming back from the forum member here and applying theory/changes as well as testing with the clock team, we found the answers and they were quite amazing. With the exception of 1 test system, everyone made it to 10 core 5.2GHz with HT. Even better, everyone found the same result right down to the voltage outlines including the system that did not quite make 5.2 safely. That exception required further diagnostics which the person decided not to undergo and accepted 5.1GHz as their clock.

Not long after this another forum member joined in and in that process it was discovered they too had the same apparent 5.1GHz restriction issue and at first appeared content to remain there since it was all stable and safe but then unlike the first person this forum member offered to deep dive into the issue and see if could be overcome.

Not being a trained overclocker I decided it was time for him to go school instead of just parroting settings. Had a feeling it would pay off since he is an engineer and a keen mind.

In that process I put him through hell on purpose (lol he knows that now) with tests that were not exactly necessary during the clock training but that included detailed explanations of what he was seeing which built confidence to look elsewhere without my direct instruction using suggestions during clock training as we went along. That is exactly what he did. He changed the LLC on his own and discovered the overshoot we were missing at the top end due to VRM motherboard differences provided the 52x stable and secure clock. He wasn't an experienced overclocker before, but now *he are-is one. LoL.*

I went back to the first person who failed, asked if they would like to try/verify the change, which they did, and now they too are running 52x.

Put this all together and without scopes, meters and empirical data there are now 12 systems to date that completely agree with each other on this clocking methodology right down to the specific target voltage numbers and although there are a few mild differences, none of them display any oddball change that would suggest inaccuracies as the rules are followed.

This is the first (and last) technical document I have ever released that does not include empirical data derived from scopes and meters to back it up and therefore that is why it took so long in a very painstaking manual method of development to produce with results I now feel confident in placing out to the public.

And so without any further adieu...

The Oscars for this outline go to:

Clocking Team Members:

These folks do not wish to be directly identified through their forum names since they spend a great deal of time in overclocking forums but have agreed to be included in the credits here:

Chris T. (You are lucky you didn't fry a chip with the stunt you pulled)

Eric N. (Excellent work on CSTATE code breakdown and confirmation back)

Selena G. (ay, Chihuahua Columbian momma) AKA: The 10 Core 5.3GHz Queen

Robert W. (Don't quit your day job you need it to pay for those ridiculous tower lighting mods)

Jikai T. (Sialan Kamikaze! Banzai!)

SimForum Members and Special Recognitions:

Donovan16: Who brought the original data sets and questions to my attention and worked extensively to resolve and test the methodology. These results were passed on for confirmation to the overclock team above and verified.

Fly Happy: Who stepped up with a system that did not make it to 5.2GHz originally and then through dedication and assistance with learning, discovered that raising the LLC using the exact same clock methodology and voltage outline netted a successful 5.2 clock.

You won't find this clocking approach anywhere online unless someone finds it here, copies and posts it elsewhere as their own discovery. Quite frankly none of the egghead overclockers out there and not even the person(s) who designed the BIOS for the motherboard itself thought of what is outlined in this document.

In history they said bringing a 180 thousand pound brick glider down to a precise IP and soft land it from orbit was insane too but that was eventually accomplished and repeated.

The clocking approach in this document overall is simplistic as hell compared to clocking in the past for reasons you will soon understand but to describe how to do it and also understand *what you are doing and why* requires a bit more explanation than the 9700K outline I wrote up some months back.

Introduction is concluded... School is now in session:

PLEASE READ CAREFULLY –

This section will help enlighten, educate and provide a clear understanding of the possible outcomes and why before proceeding.

First and foremost unlike the overclocking approaches I have outlined in the past, with the introduction of the z490 motherboards and 10900K processors the overclock process has shifted from a direct manual control of all variables to utilizing the automated VRM (voltage regulator module) control the z490 platform introduces. Unlike Haswell or even the z390 overclocking approach I outlined in other publications the new chipset and processors have undergone a change in the way manufactures are approaching performance enhancement. Some of the new processors such as the 10700K are being internally controlled and therefore internally limited by Intel where the 10900K is not.

In many ways in the now 'new approach' motherboard manufactures are taking in automated control is undesirable because they are over-volting the processors even at default CPU/BIOS in order to try and make one motherboard offering look better to the public than their competitors. The competition between the motherboard manufactures *is ridiculous* because none of them make a processor run better than another under default conditions. The difference is in how they run the voltage to the processor under stress condition in order to hit the Intel marketing 5.3GHz **one-core-wonder** speed. I will also talk about that here too because it is important to understand how Intel accomplished that marketing sales pitch for CPU speed as **it can and will affect how far you may or may not be able to go in a clock.**

LET'S REVIEW FIRST...

This next subject will define why *you may, or may not* be able to get to 5.2 stable using this outline. At this point in time and with the real world computer systems this methodology has thus far been applied, I have seen **no failures** getting to 5.1GHz HT @ DDR4 4000 c15/16/16 (**assuming no defective hardware**) and even the ones that initially failed to get to 5.2 were able to eventually get there using *an alternative* brought to light with assistance from a forum volunteer which I will outline that change in this document if it appears needed.

The next subject defines and explains the reason for how far you may/may not get and why...

HOW CPU/MEMORY/GPU CORE PRODUCTION WORKS:

This is how a golden sample or silicone lottery winning CPU comes about as well.

During the manufacture process the processor cores and physical cache on the wafer go through a process known as SPEED-BINNING. This is the same process memory and GPU manufacturers use to select the memory chips for high speed/low latency memory and different quality GPU card cores.

Intel has to meet truth in advertising laws for their marketing speed of the CPU. In the case of the 10900K that is a SINGLE CORE reaching 5.3GHz under CERTAIN CONDITIONS they control through the chipset on the motherboard. That definitely does not mean that CPU will run that core @ 5.3 all the time as a matter of fact you will probably notice it hardly remains at that speed for time spans and instead PEAKS at that speed but tends to run in a range below that.

In order to meet that in manufacture they speed-bin the cores/cache as the wafers are produced. Those cores that hit 53x and above, go into a bin. Those that do not are separated and sorted out using the same method so they end up with bins of pre-tested cores that pass 52x, 51x, 50x, 49x, 48x, 47x, you get the idea.

That was just the preliminary production, now comes the actual CPU production with the cores/caches and the encasement of the die that acts as a heat transfer device between the cores and the cap.

During that production run the output product MUST meet the advertised spec of 5.3GHz on ONE CORE, that's all. Therefore the speed-bin 53x+ cores are loaded for that **one-core-wonder** on the machine for the run. The rest of the cores are pulled from the other bins and loaded up. Typically they will use the cores in sequence however because they have to load 9 lower + 1 golden core for each CPU *they can run out of certain cores* in the production roll faster than others. This means in order to complete the run they may need to make some alterations:

1. Load the lowest quality tested cores to make up the difference. They only have to guarantee one core 53x and the rest default. This means that processor may not like clocking past a certain point no matter what you do to try and compensate.
2. If they run out of the lowest quality tested cores but have a surplus of the golden cores, load the golden bin cores into the system for a 10 core 53x+ tested core slug. They try NOT to do this but if they have no choice in order to complete that run and make production quota, they will supplement with the better speed-binned product. That would also be the last rows of the run *as they won't burn all their quality cores for a very large number of CPUs*. This would be your grand prize silicone lottery winner and believe me, this is not only going to be **very rare** but anyone online posting they are running 10 core HT 53x 100% stable, PROBABLY *ISN'T* DOING IT 24/7 3-5 year safe.
3. Just because they may use the better speed-binned cores does not mean they are all 53x+ quality. They can be a combination of that and better quality cores mixed in meaning, that slug will probably do 52x HT 45/48 without a single hiccup and on lower voltage. I would also call that winning the lottery. Some may need higher voltage but still hit 52x.

4. Last, there is *cache quality* loaded into the production run the same way with the cores. Just because a 53/52/51x tested core does not mean the cache is of the same quality. HT has a separate physical cache.

So now you see why someone might get a chip that will run 53x on lower voltage and some ***cant hit more than 51x or even 50x on all 10 cores stable...*** Furthermore ***the quality of the cache*** can define how high/stable the cache speed will run with ***HIGHER MEMORY SPEED***. Some caches may max out at 45/46 with a CPU core speed of 52x ***and not*** be able to run the memory @ 4000 requiring the memory speed drop. In that, the CPU cache MAY be able to come up to 45/48 and run 3800/3700 instead @ 52x.

Those who run lower memory speeds will usually find it far easier and faster to hit their top end on the CPU without going through what top end overclockers do to roll with top end memory speed/latency.

It is also important to note than the 10 core processor and z490 does not appear to like memory speed above 4000 in a high/tight CPU clock.

AND NOW FOR SOMETHING COMPLETELY DIFFERENT: THE MOTHERBOARD...

Just like the CPU the motherboards go through production runs whereby they may run out of a certain QC spec component and must load a different one such as VRMs and filtering capacitors. That could also include ICs that control board frequency. In those possible alterations they only have to meet Intel defined specifications for speeds.

When you see motherboard specifications and in the list it says for DDR memory speed: DDR4 3600 (OC), DDR4 3800 (OC), DDR4 4000 (OC), and higher, they DO NOT HAVE TO WARRANTY OR GUARANTEE ANY LISTED ITEM IN THEIR ADVERTISED SPECS AS; (OC) = **overclock**

During development of this outline I came across a few boards that quite clearly could not hit the proper overshoot for the VRMs @ 5.2GHz forcing those boards to run 51x but very stable and safely. In investigation a workaround was found that provided the needed overshoot to accomplish 52x, This was because of lower quality VRMs. Fortunately the workaround provided what was needed in these cases. That does not mean it will in all cases. **A flaky HT physical cache can mean a processor can run 52x without HT but can not run it with HT.**

And last... **The memory QC quality** which follows the same manufacture process as above

LET'S PUT IT ALL TOGETHER:

It is possible your CPU **may simply be manufacture limited** in compare to others from the production run of that CPU as well as the individual motherboard VRM quality control when the board was manufactured, which means you *might not* make to 5.2.

It's not your fault just the luck of the draw on the hardware. It is also NOT THE END OF THE WORLD. Unlike the past we are now *working with 10 cores, HT and the memory latency*. Tell me, when was the last time you were running 10 cores with HT even at 5.0GHz.

Obtain 5.1GHz all core on HT with excellent memory latency, add in a 3x Nvidia high memory (15GB and above) video card and you are running circles around just about any system out there for present and future flight simulation. So don't cry in your beer and stomp your feet if you can't get to 5.2 for god sakes.

IN ADDITION there are those who may be able to get to 5.2GHz but because of the manufacture production run quality of the processor cache **may not be able to maintain** DDR4 4000 c15/16/16. **In these cases** dropping memory speed and applying some latency tweaks the memory is *STILL RUNNING* at just about its default DDR4 4000 speed/latency with a default Intel running CPU. The speed of the CPU in the clock as well as the cache speed increases the memory performance even at lower memory speed.

SO get over not being top dog in these cases. It does not mean you are giving up a huge chunk of performance. AND if that makes you cry in your beer and stomp your feet act like a like the professional clocker who will replace all these parts (*NOT RMA REPAIR*, RMA for new replacement **or buy new**) and try again to win the manufacture run performance game.

If you are getting to 51x 10 cores HT on 45/48 cache and high speed/low latency memory with reasonable voltages/temps with this outline, kiss the tower and count your blessings.

I think anyone who would consider replacing hardware because they want to try for the 52x or 53x lotteries is a bit of a dolt given the cost to roll the dice, but hey, some people just can't live with it. Professional overclockers usually won't settle for less but then they usually burn a system and replace it every 2-3 years max **and have a wallet to match that attitude.**

MOVING FORWARD:

This outline is for a full-on 10 core 5.0, 5.1 and 5.2 overclock as I do not believe 5.3 is safe to go for unless you are working DIRECT TO DIE to the cooling solution with the processor cap completely removed, or, perhaps have a golden sample and can obtain that mark under strict voltage limits ***regardless of if it passes thermal and stress tests.***

Unlike Haswell or other processors of the past removing the cap on a soldered processor **is no simple game** and requires special tools and chemicals as well as a special direct to die mount plate on the motherboard. **There is NO guarantee** delidding *will net any more processor speed* although it will in most cases without question, reduce CPU temps.

Unless you are experienced working with such things, and, very committed and willing to risk the CPU replacement cost ***in a bet*** it may provide a higher clock, I would recommend that thought leave your mind and leave the lid alone on the 10900K.

You should be very aware that in ANY new processor regardless of how well or how bad it runs will burn-in over time and usually over a period of a year or so may require a bump in Vcore from the originally tested stable setup. This is an expected over-time result of overclocking from the natural degeneration process in spite of the silicone lottery so if you think you paid for and got something special today from the lottery, it may eventually pee on you just like any other slug over time.

THE MEAT AND POTATOES

SPECIFIC HARDWARE IN USE FOR THIS OUTLINE:

I have outlined this with a specific motherboard, processor, memory product and cooling solution for duplicated success and engineering reasons.

* ROG MAXIMUS XII HERO (WI-FI)

BIOS 0607 ONLY DO NOT USE ANY OTHER BIOS AND DO NOT UPDATE IT FOR ANY REASON OVER TIME ONCE IT IS FLASHED TO BIOS 0607.

CRITICAL: When the BIOS is first booted on the first BIOS enter screen when prompted be sure to HIT F3 to “UNLOCK LIMITS FOR INCREASED PERFORMANCE”

It was found 0607 was far more stable than BIOS 0707 for DDR 4000 high speed/low latency memory and as the date of this document BIOS 0707 is still the latest release however all test subjects found the same results with respect to memory speed stability and CPU clocking on BIOS 0607. Be sure to hit F3 on first BIOS load to perform the initial setup and prepare for initial setup.

IN THE EVENT a different model motherboard may be used for this, make sure it is a z490 Asus product with the 10900K processor as every manufacture has their own way of designing boards and BIOS systems. I can not say this outline will work exactly the same with different Asus motherboards. Most likely it will not work with a different manufacture motherboard. You will need to extrapolate and work it out yourself using the information here with a different board.

* INTEL 10900K (fully lidded)

* GSKILL DDR4 4000 4x8 32GB c15-16-16)

GSKIL MODEL FROM QVL: **F4-4000C15Q-32GTZR**

NOTE: *A lower memory speed is fine* however always try to obtain the lowest timing possible for that speed. In example, DDR4 3600 c16/16/16 would be lowest speed and highest timing memory I would suggest and usually it is easier to obtain a high stable CPU core/cache clock on lower memory speed but you are also sacrificing some memory latency to obtain that. It is a give and take. 2 sticks of memory are still better than 4 when clocking and ease of stability so if you can find 32GB 16x2 DDR4 3600 @ CL16 16/16 it is not necessary but that could be beneficial to a higher stable clock/cache speed.

ALSO NOTE: With this motherboard the higher speed memory as listed above (DDR4 4000) should be the exact GSKILL model from the ASUS Website QVL for the motherboard. It has been found this board does not like high speed/low latency memory @ DDR4 4000 that is not listed on the QVL for the board.

I can not make memory choices for you but I will say that memory speed lower than 4000 tends to run easier with this board. Not getting the exact model DDR4 4000 memory listed above is a CRAP SHOOT if it will work. Lower speed alternatives may work easier

* ***A PLATINUM CERTIFIED*** 850-860+ watt PSU (in single rail mode)

A 3x video card should roll just fine with the overclock on a platinum certified PSU of 850-860 watts however I would suggest 950w-1000w platinum cert PSU with the 3x series video cards and future proofing. Times have changed.

* CORSAIR H150i Pro **or better** (water pump @ 2100RPM controlled by iCUE software)

NOTE: I DO NOT SUGGEST AIR COOLING FOR THIS. Although a very high end air cooler MAY get you to 5.0 10 core HT, it most likely will NOT get you to 5.1 and certainly not 5.2. Remember, this isn't 4-6-8 cores, its 10 cores and running HT as well with the option to disable HT. I highly suggest a high end AIO liquid cooler today over any air cooler solution. Times have changed.

* A LARGE TOWER (front, side and rear fans controlled by the motherboard)

Large towers are typically quieter and allow more volume of air on lower fan RPM and move heat out more efficiently. Today the trend with case manufactures has been smaller tower sizes and compact use. Quite frankly the more compressed compact the system the more heat retained and the higher the fan velocity required. Also DON'T UNDERESTIMATE the size of a 3x series video card, those cards are NOT small.

I WISH TO MAKE THIS VERY CLEAR:

This outline is a methodology in combined settings. The success depends on a specific series of BIOS and WPP (Windows Power Profile) settings working in concert to deliver the result. Changing or skipping what I outline below **may very well result in failure or undesired outcome.** That being said, if you do not find the settings I outline in your BIOS, or, question because a setting may have a similar but different description, research or ASK, **do not assume.** There are members in the forum running this outline that can assist with questions.

BEFORE CLOCKING WITH NEW HARDWARE:

Always stress test the system with processor manufacture burn software running the default processor BIOS with XMP setup to run the memory at the correct speed/timing and voltage for the memory product. Also run independent memory tests to assure the memory is not defective or there isn't a problem with the memory controller which includes offline memory test boot and use Windows memory testing (MEMTEST OFFLINE and HCI MEMTEST in Windows). It also tests the cooling solution for installation or other issues that can be corrected prior to starting this outline.

IF you don't do this first... ***then go suck rocks on the rest.*** I made this clear years ago.

Once you have all the ducks in a row, you are ready to roll to the next level.

CRITICAL NOTE: FOR THOSE RUNNING DDR4 4000 MEMORY OR VERY TIGHT MEMORY TIMING ON LOWER SPEED...

THIS IS NOT ALWAYS REQUIRED AND ONLY IF DEFAULT SYSTEM MEMORY DEFECT TESTS

FAIL: It was discovered during research that some had to RAISE the VCCIO/VCCSA voltages in order to run higher memory speed/lower to pass offline USB stick boot Memtest and online Windows Memtest and not allow Intel default voltages to run at high VCCIO/VCCSA. In these cases after loading the F3 option on first BIOS boot and setting the basic defaults for the system and XMP in order to reduce the Intel default voltages to a reasonable level they opted to set VCCIO and VCCSA manually. Too low and the memory would not pass the standard tests to confirm the memory was not defective at default CPU speed/control.

In cases like this the suggestion is to set:

CPU VCCIO Voltage: **1.18**

VCCSA (CPU System Agent Voltage): **1.20**

These may or may not be adjusted down later as the CPU core voltage is raised for clocking. If you find your memory is failing basic tests to verify it is not defective set those 2 values in the BIOS manually and retest. If it passes, as outlined those will most likely be reduced but leave them as noted till ready to start the *actual* clocking process if you find you must change those as outlined.

STEP 1:

TOOLS

Past the Intel burn testing and tools used above, for full overclock testing and setup we only need FOUR TOOLS:

1. **HW Monitor x64 (please obtain the latest release)**
2. **OCCT v4.5.1 <--- NO OTHER VERSION!** There is a reason for that!
3. **CPUz (please obtain the latest release)**
4. **HCI Design Memtest** - The paid version is worth the 5 bucks and makes the job easy.

STEP 2:

WINDOWS – CONTROL PANEL – POWER OPTIONS

The profile list may not display the HIGH PERFORMANCE profile. It may be hidden at the bottom of the list, click the small arrow if this is the case and the high performance power profile should appear.

Select the **HIGH PERFORMANCE** profile with a bullet and then click **CHANGE PLAN SETTINGS** and then on the next screen click **CHANGE ADVANCED POWER SETTINGS**

POWER OPTIONS ADVANCED SETTINGS BOX:

You can customize the list any way you like if you know what you are doing however for this outline, scroll down to: **PROCESSOR POWER MANAGEMENT** and expand it and verify or make the following changes:

MINIMUM PROCESSOR STATE = 100%

SYSTEM COOLING POLICY = ACTIVE

MAXIMUM PROCESSOR STATE= 100%

Also make sure **PCI EXPRESS > LINK STATE POWER MANAGEMENT >** is set to **OFF**

CLICK APPLY and then **OK** to close the box. Close the Power settings box and Windows Control Panel.

STEP 3:

THE INITIAL BIOS SETUP: IT IS NOT TO BE USED UNLESS YOU ARE READY TO CLOCK

THIS IS NOT TO BE COMPLETED UNTIL YOU ARE READY TO INPUT STEP 6

WARNING:

THIS WARNING IS FOR THOSE WHO ALREADY HAVE THE HARDWARE BUT ARE NOW TRYING THIS OUTLINE TO CLOCK IT AND DID NOT SET UP AS I OUTLINED ABOVE.

If your BIOS was tampered with for voltage and other such CPU or control settings be it because of a previous clock setup or just messing around, (or if you are not sure or remember) that BIOS needs to be reset CLEAR CMOS and then to default and at the same time you will need to make sure that BIOS is launched with the F3 option I outlined above.

PLEASE DO NOT CHANGE ANYTHING UNDER THE EXTREME TWEAKER MENUS OR THE CPU CONTROL MENUS except where you may need to set the memory XMP memory speed/timing/voltage, nothing else.

Once you know your BIOS is properly setup otherwise begin making the changes outlined here *and do note* some of these are the default settings. Verify each one I list as you drill down the BIOS menus.

**SPECIAL NOTE:
IF I DID NOT LIST IT HERE, PLEASE DO NOT MESS WITH IT!**

EXTREME TWEAKER MENU:

Ai Overclock Tuner [XMP X] – VERIFY XMP PROFILE IS IN USE

BCLK Frequency [100.0000]

ASUS MultiCore Enhancement [Auto – Lets BIOS Optimize]

NOTE: You should see under this setting a readout that displays:

(Grey Info Line) > "Current ASUS MultiCore Enhancement Status Enabled"

If you do not see that as outlined above then you did not hit F3 on first BIOS load after clearing the CMOS. We want *BOTH* let BIOS Optimize AND MultiCore Enhancement ENABLED

SVID Behavior [Best-Case Scenario]

AVX Instruction Core Ratio Negative Offset [0] -

NOTE: WE WILL USE LONG AND SHORT DURATION PACKAGE POWER LIMITS TO CONTROL AVX and MAXIMUM WATT LOAD @ 90-95c. THIS SETTING WILL NOT PROTECT A SYSTEM IF IT IS SET TOO HIGH AND WILL KILL PERFORMANCE IF SET TOO LOW. [0] MEANS THIS IS IGNORED

BCLK Frequency: DRAM Frequency Ratio [Auto] -

NOTE: THIS SETTING WILL NOT APPEAR UNTIL YOU SET A “ALL CORE RATIO LIMIT” (CPU MULTIPLIER FOR ALL CORES) LATER IN THIS DOCUMENT – DO VERIFY IT APPEARS AFTER SETTING THE ALL CORE RATIO LIMIT AND IS SET TO [AUTO]

DRAM Odd Ratio Mode [Enabled]

DRAM Frequency - **<YOUR DRAM FREQUENCY>**

Xtreme Tweaking [Disabled]

CPU SVID Support [Auto]

Ring Down Bin [Auto]

BCLK Aware Adaptive Voltage [Enabled]

DRAM Voltage [X.X]

NOTE: VERIFY THIS IS CORRECT FOR YOUR MEMORY PRODUCT. *THIS MAY* NEED A CHANGE LATER FOR CLOCKING. So far no one has needed to adjust this however that is not always the case.

Please be aware of and remember the voltage limit of your DDR4 memory product.

VCCIO and VCCSA

Some pertinent and important information you should understand:

CRITICAL NOTE: IF you changed VCCIO/VCCSA in order to pass default memory tests then LEAVE THEM AS THEY ARE FOR NOW. Otherwise, if you passed your default memory tests without changing those voltages in the BIOS, then set them as outlined below.

These two are fun. Asus auto BIOS clocking can seriously overdrive these voltages in some cases over 1.3v. These two settings can drive stability, mostly System Agent, and the required value for VCCIO can vary greatly from system to system. A stable long term safe VCCIO in a clock can be anywhere from 1.10v to 1.225v much depending on the PCIe rack and how busy it is.

IF you are starting out here without a 3x video card and pass ALL tests in your clocks and later install a 3x video card you may very well discover **that because of the hard PCIe load change both of these values may need to be retuned.**

Both contribute to temps but System Agent will definitely add heat as it is increased, especially if it is raised in order to maintain Hyperthread in a clock for the memory controller system.

I place a max manual input of 1.225v (each) limit on these two settings in the BIOS.

I PREFER TO SEE THEM SET NO HIGHER THAN 1.20v but they can live a bit higher.

Can they go higher? Yes however I look at longevity verses clock value.

Set this manually as shown.

CPU VCCIO Voltage [1.170]

Can it be lower for your system? Yes, but to find that out after you have established your stable clock you will have to repeat EVERY test (OCCT:Linpack, OCCT:CPU, and HCI Memtest) for every voltage drop change you may make and with a new modern video card this voltage may be too low

Even if you find the VCCIO lowest value through testing it is possible it could be sitting on the edge and still blow out under heavy PCIe loads and needs to come back up a bit to stabilize. That is why I outline the value shown to start.

Set this manually as shown.

CPU System Agent Voltage [1.180]

It is possible System Agent could be lower, or higher for your system. This can vary based on the memory product in use, how many sticks and their latency and of course the clock speed and then there is that pesky clock killer the addition of Hyperthread, or, adding a modern video card later which can change this voltage, again.

PLL Termination Voltage [Auto]

PCH Core Voltage [Auto]

EXTREME TWEAKER – TWEAKERS PARADISE MENU:

FCLK Frequency for Early Power On [Auto]

Realtime Memory Timing [Disabled]

CPU Standby Voltage [Auto] -

EXTREME TWEAKER/DRAM TIMING CONTROL MENU:

Maximus Tweak [Auto] -

MAXIMUS OR NON MAXIMUS BOARDS, LEAVE IT ON AUTO

MRC Fast Boot [Enabled]

DRAM CLK Period [Auto]

Memory Scrambler [Enabled]

Trace Centering [Disabled]

MCH Full Check [Disabled]

Training Profile [Auto]

DLLBwEn [Auto]

DRAM SPD Write Disabled [True]

XTU Setting [Auto]

EXTREME TWEAKER DIGI + VRM MENU:

CPU Load-line Calibration [Level 5] - ****THIS IS CRITICAL TO WORK WITH THE OUTLINE TO START****

NOTE: In the event it is found LLC5 may not be allowing enough overshoot for a higher clock speed, LLC6 will be selected and voltage search reworked. That will be outlined later in this document

Synch ACDC Loadline with VRM Loadline [Disabled]

CPU Current Capability [Auto]

CPU VRM Switching Frequency [Auto]

VRM Spread Spectrum [Disabled]

Active Frequency Mode [Disabled] – ****NOTE THIS MAY NOT APPEAR UNTIL VRM SPREAD SPECTRUM [DISABLED] IS SET****

CPU Power Duty Control [T.Probe]

CPU Power Phase Control [Auto]

DRAM Current Capability [110%] - set it 110%

DRAM Switching Frequency [Auto]

CPU Core/Cache Boot Voltage [Auto]

DMI Boot Voltage [Auto]

CPU System Agent Boot Voltage [Auto]

CPU VCCIO Boot Voltage [Auto]

PLL Termination Boot voltage [Auto]

CPU Standby Boot Voltage [Auto]

EXTREME TWEAKER/INTERNAL CPU POWER MANAGEMENT MENU:

IA AC Load Line [Auto]

IA DC Load Line [Auto]

TVB Voltage Optimizations [Disabled]

CPU Core/Cache Current Limit Max. [255.75]

Maximum CPU Core Temperature [95]

THIS IS NOT THE CPU DEATH THROW TEMP, ***IT IS WHERE THE CPU IS THROTTLED***

I know the 10900K has a higher rating, however I keep things long term safe and therefore this is set to 95c

***WE WILL RETURN TO THIS MENU TO ADJUST THE FOLLOWING WHEN CLOCKING STARTS,
LEAVE IT ALONE FOR NOW:***

Long Duration Package Power Limit [X.X]

Package Power Time Window [X]

Short Duration Package Power Limit [X.X]

THIS IS A CRITICAL SECTION ABOVE

=====

EXTREME TWEAKER/AI TUNING MENU:

Package Temperature Threshold [Auto]

Regulate Frequency by above Threshold [Auto]

Cooler Efficiency Customize [Stop Training]

PLEASE CLICK THE BUTTON TO RESET THE DATA AND SELECT YES WHEN PROMPTED

Cooler Re-evaluation Algorithm [Normal]

Optimism Scale [100]

=====

ADVANCED/PLATFORM MISC CONFIGURATION:

PCI Express Native Power Management [Disabled]

ASPM 0 [Disabled]

L1 Substates [Disabled]

PCI Express Clock Gating [Disabled]

DMI Link ASPM Control [Disabled]

PEG - ASPM [Disabled]

CPU POWER MANAGEMENT CONTROL

Thermal Monitor [Enabled]

PCH-PCI EXPRESS

DMI Link ASPM Control [Disabled]

=====

ADVANCED/CPU CONFIGURATION MENU:

Software Guard Extensions (SGX) [Software Controlled]

Tcc Offset Time Window [Auto]

Hardware Prefetcher [Enabled]

Adjacent Cache Line Prefetch [Enabled]

Intel (VMX) Virtualization Technology [**Disabled**]

NOTE: *If you are running a virtual machine this must be enabled. If you don't know what a virtual machine is, you are not running one.*

INTEL HYPERTHREAD TECHNOLOGY- DISABLED (for now)

NOTE: Some processors do not support HT in which case this setting will not be in the BIOS, but some do. I would NOT run HT for initial clock setup.

Shut it down just for now if the processor supports it, find your stable clock and then revisit this setting and start the process over with voltages that will not overrun your cooling solution.

Active Processor Cores [All]

CPU POWER MANAGEMENT CONTROL

Intel(R) SpeedStep(tm) [Disabled]

Turbo Mode [Enabled]

Boot performance mode [Auto]

Intel(R) SpeedStep(tm) [Disabled]

Intel(R) Speed Shift Technology [Disabled]

CPU C-states [Enabled]

Enhanced C-states [Disabled]

CPU C3 Report [Disabled]

CPU C6 Report [Disabled]

CPU C7 Report [CPU C7s]

CPU C8 Report [Disabled]

CPU C9 Report [Disabled]

CPU C10 Report [Disabled]

Package C State Limit [C7S]

ADVANCED/SYSTEM AGENT (SA) CONFIGURATION:

VT-d [Disabled]

Above 4G Decoding [Enabled]

MEMORY CONFIGURATION

Memory Remap [Enabled]

BOOT CONFIGURATION MENU

Fast Boot [Enabled]

Next Boot after AC Power Loss [Fast Boot]

WARNING: THIS IS WHERE THE SYSTEM IS REBOOTED; GO DIRECTLY BACK INTO THE BIOS AND SETUP FOR 5.0 OVERCLOCK AS OUTLINED BELOW . DO NOT BOOT INTO WINDOWS FROM HERE! F-10 SAVE AND EXIT – BACK INTO THE BIOS, SETUP FOR 5.0 CLOCK, STEP 6, THEN BOOT INTO WINDOWS AND FIND THE VID AS OUTLINED BELOW.

If the outline above was followed correctly, the system is now ready to be both clocked AND thermal tested at the same time.

STEP 4:

BEFORE CLOCKING AND GETTING YOUR MIND ON RIGHT

This is the point where we deal with how stuff can start getting real and hot.

This section can make or break a higher clock speed with AVX and HT support. The following should be reviewed so you may analyze what you are doing and perhaps it can point to ways you may be able to improve the outcome before beginning the clocking process.

Quite simply, we must test to find the highest watt load the cooling solution can control at the absolute highest safe temperature, between 90c-95c and then input that watt load value into the BIOS to establish a control point limit.

It is not difficult to find the numbers we are looking for but you must comprehend what you are doing and why, what affects the outcome which will ultimately define how high you can clock within a safe operation temperatures.

This will also drive you final clock speed, how much AVX instruction that your clocked CPU cores can handle in a full load and HT on top of it all.

Elements that affect the outcome:

1. Your tower and how well designed for ventilation and fan control.
2. The location of your tower and how well it can move air without recirculation of heat.
3. The room your tower is located and its stable (or unstable) ambient temperature.
4. How clean your tower is kept of heavy dust buildup.
5. Your CPU cooling solution, how well it is designed and is properly installed.

All these items add up. Shoving a tower under a desk where it re-circulates its own heat is going to limit your clock as well as placing it next to a warm wall perhaps where the sun hits the outside and warms it or beams in through a window.

Keeping a tower clean is easy and should be done in a schedule based on the environment itself and how dusty it may or may not be. Your component selections and how efficient they are drive the outcome but what can really change fast is the room ambient temperature.

If the room the tower is located in is not climate controlled and a max ambient temperature of 80F (or less which is always better), and, goes through unchecked high temp/humidity changes then you must be very aware of that. If you are testing this during a time of year the room is cooler then when that room warms up it will negatively affect your system.

My tower is in a room with climate control that maintains 78F (slight increases can happen) and a humidity level of 36-46%. It is possible the temp will drop during the winter months; *it will never go higher* unless the climate control system breaks down in which case I would need to be aware and careful till it is repaired, possibly lower my clock temporarily.

The list outlined above are important issues you can address for greater success and now you are aware of the danger to a system that is tested in a cool environment and then run in a higher temp environment down the road.

MY ADVICE: Make sure you are testing for the maximum CPU speed/watt load vs. maximum CPU temp in an environment that will not later (greatly) exceed the room temperature when it was tested and setup in the BIOS. If that is not possible due to the time of year or other factors at this point in time, then be sure to recheck/retest during a time where the tower will run in such warmer conditions.

Now, nothing is going to ‘burn up’ or explode because the BIOS has been previously set to throttle the CPU *should it happen to reach 95c* but for the best case scenario in clocking or higher clocking success the room ambient environment must be kept in mind.

HOW I RUN MY FANS:

My tower fans are all automatically controlled **using only the CPU temp as the reference** to increase or decrease their speeds. That is setup in the Asus AI Suite Fan Xpert software. They are all set to run 100% when the CPU hits 70c or above.

The PSU fan and 3 radiator fans are controlled separately in the Corsair iCUE software. I set the radiator fans to run on a curve that response to the monitored liquid temperature in the iCUE software. For my specific 78F environment the lower limit is set to 26c and the higher to 38c with a water pump speed of 2100RPM. The PSU is set to a lower limit of 29c and the higher limit of 60c.

That is how I run the fans in my system and the tower is cleaned including video card once a year. There are no air filters on my tower as the environment does not demand them, and, I don’t like them as they restrict airflow. Tower is nearly dead silent unless I am horsing on it.

You should be very aware *these newer processors run naturally higher in temp than CPUs of the past and it is neither unusual nor dangerous to see temps in the 70’s under gaming and other loads.*

Now that you have a clear understanding of the air circulation system and what to look for we can now proceed to find the number to be used in the BIOS that will not only allow maximum clocking potential but also automatically **protect the system as time goes by.**

FINDING THE TOWER THERMAL WATT LIMIT AND SETTING IT IN THE BIOS

The reason I say ‘finding the tower thermal watt limit’ and not the CPU is because of the list I presented above. Everything happening in and around that tower is going affect where you stand with clocking and therefore the watt limit value we are looking for. With CPU voltages there is typically a range to work with to get started but because of all the variables with tower builds and their locations there is no way to estimate a range on this as it is nearly a wild card situation until discovery occurs.

Your final watt limit depending on your tower environment and cooling solution could be:

Air Coolers: 160watts, 180watts, 210watts and perhaps 220 if it is a massive monster and you live in a cool environment.

Liquid Coolers: 220watts, 240watts, 250 watts, 260watts or anything in between.

If you are using high end liquid as I outlined in this document and the tower is correctly built and located for proper airflow then with the 10900K you will probably be in the 240-260watt range but I can not define that because I do not live where your computer sits and I did not build it so this is going to be part of discovery as you go along.

We want to take control to assure our investment is secure. Unlike the 9700K where we ran install watt load tests and located the temp vs. the watt load first, with the 10900K we will be doing this ON THE FLY while raising and testing our individual clock speeds at each step slowly and observe the temp and watt load result in readout.

STEP 5:

A SIMPLE SYNOPSIS OF THE PROCESS

Unlike Haswell or the 9700K where we worked with either manual Vcore, or, adaptive Vcore and used the actual Vcore voltage as the setting to work out the clock, with the 10900K and z490 that gets flipped on its ear.

This time we will be setting a locked Vcore voltage of **1.00v** in the adaptive voltage system and will instead be trimming, *in very small increment*, the offset voltage. This is where you need to get your head out of manually setting 1.25-1.32-1.39 Vcore *in the BIOS* and start thinking in terms of offset voltage settings of + or - 0.060v and every tiny increment in-between.

It sounds daunting when one considers all the combinations in such a small voltage range. It would be ***if we had not reverse engineered the BIOS and electronics*** from this platform and found the target VID voltage required to enter the ballpark ***for each clock speed level to start out***. That simplifies the process down greatly because now all you need to do is find the outlined VID voltage that registers in HW Monitor by working the adaptive voltage offset, first. You will do this before you even begin to run load tests and check temps during those load tests.

The VID voltage for your specific system may be slightly too low or slightly too high for your clock levels. Adjusting VID comes with the testing. The lower the VID, typically the cooler the system runs.

The actual Vcore RANGE displayed in HW Monitor is established from the VID voltage. That Vcore visual range in the monitor software runs **AUTOMATICALLY**. – This is the new z490 automated system at work. Your control comes from adjusting VID through the offset voltage.

There is a visual readout range for Vcore I will outline with the each clock level and like anything else along with VID and other voltages they all have their **MAXIMUM LIMITS** that should be adhered to for long term safety.

CPU TEMPS: Absolutely nothing has changed from the past. The CPU temp limits are exactly the same from Haswell through the 10900K. We want to keep our processor under a certain temperature with maximum load test stress. That is done with v4.5.1 OCCT:Linpack 64bit AVX enabled. We have already set a 95c internal BIOS thermal limit as a preliminary safety net and now it is time to see how many watts are required to hit around 90-93c in HW Monitor *as the CPU speed increases*.

Once we find that watt load vs. maximum temperature during the testing process, then another BIOS adjustment is made that will force the CPU speed to REDUCE AUTOMATICALLY *in steps* if the watt load on our individual system that reached the temperature threshold is detected. This allows the system to run AVX instruction *but not neuter the CPU into the ground* simply because the system sees a tiny bit of AVX being applied, which is what the setting **AVX Instruction Core Ratio Negative Offset** level does in the BIOS as soon as any AVX instruction is detected regardless of the AVX level or intensity of load.

AVX comes in different levels. We *are NOT* going to see advanced high load AVX instruction with games and most software. If you are looking to hammer the system into the ground with silly AVX load tests in Prime95 when you do not use such applications then you are effectively removing your systems ability **to run perfectly stable high clocks within reasonable AVX expectations. That in my opinion is a very ignorant egghead move.**

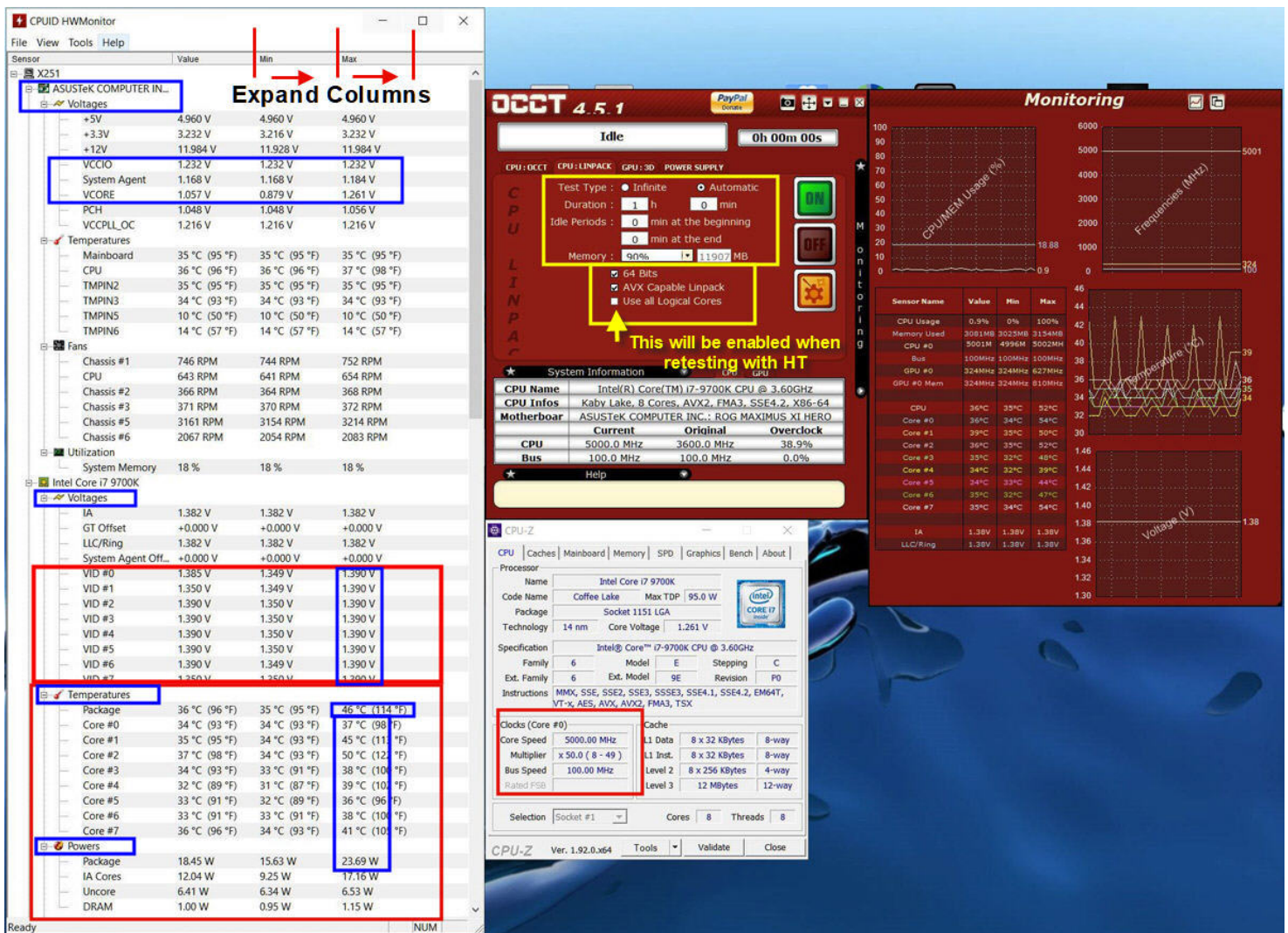
That being said, if your desire in home computer system use is to work on the human genome, design a bionic human heart or calculate the airspeed velocity of an unladen swallow to include all the real time physics of the Aves biological mechanics with respect to atmospheric and meteorological data, DON'T BE A VILLAGE IDIOT AND OVERCLOCK YOUR COMPUTER. Load test it with the whacko AVX2 load test software and every other crazy test out there to be sure it is not unstable for such high end software instruction.

If all the load tests pass then typical system use such a gaming, surfing, downloading, installing and uninstalling software, spreadsheet/accounting, word processing, photo editing, graphics production, driver changes, updating Windows *all these operations are fine while clocked assuming* you have followed the RULES and verified stability, but do not assume you can launch hard hitting higher end engineering program that whacks AVX and HT against the wall unless you have confirmed that the system will in fact run such software stable at both default, and if desired, a defined clock level.

SETTING UP THE DESKTOP TEST SOFTWARE WITH THE SYNOPSIS

We will be using HW Monitorx64 for all testing. If you wish to use HW Info that is your choice however we found no difference between the latest version of HW Monitor x64 and HW Info when it came to the voltage information required to obtain and test clocks. HW Monitor x64 is simplistic and easier to navigate for this exercise.

When HW Monitor is opened, expand it and the columns as shown in the example below and note the sections we must observe. As for the other applications shown in the example below, when ever any load test is being run be it for heat or to test a clock you will always have the applications open as shown so you can monitor everything that is happening. The image below is simply a visual example but will demonstrate where the eyes need to be...



The example above demonstrates the desktop with HW Monitor x64, OCCT:Linpack x64/AVX enabled (without logical core HT testing) and CPUz. This demonstrates all clock testing be it OCCT CPU or Linpack.

The areas in BLUE are the locations the eyes should to be focused on during the tests. The areas outlined in RED in HW Monitor are the primary VID (1st red box) and the temp/watt load sections (2nd red box). As the offset voltage is changed in the BIOS boot into Windows with only HW Monitor x64 launched to locate the outlined MAX column VID voltage based on the clock outlines. RED in CPUz is confirming the CPU speed as the test proceeds and observing a drop in speed that will come later as the system approaches its watt/thermal limit that will be set in the BIOS to protect the system. The YELLOW is the test setup area which at this point, everyone reading this who has overclocked in the past should already understand with no explanation

Once the outlined VID for the individual clock speed is displayed in HW Monitor (MAX Column) from the offset voltage BIOS input, then we move to begin load testing. During the load test the temperature of all cores and the package are monitored and displayed. As these increase during the individual clock tests there will be limits approached and reached. This is where we note the WATT LOAD when the CPU TEMPERATURE approaches and reaches the outlined maximum for the CPU.

We will also take note of the VCCIO/VCCSA and the Vcore range being displayed in both real time (first column) and MAX (last column). The outline below for each clock speed will provide a typical range for these voltage readings as well as the maximums they should not exceed.

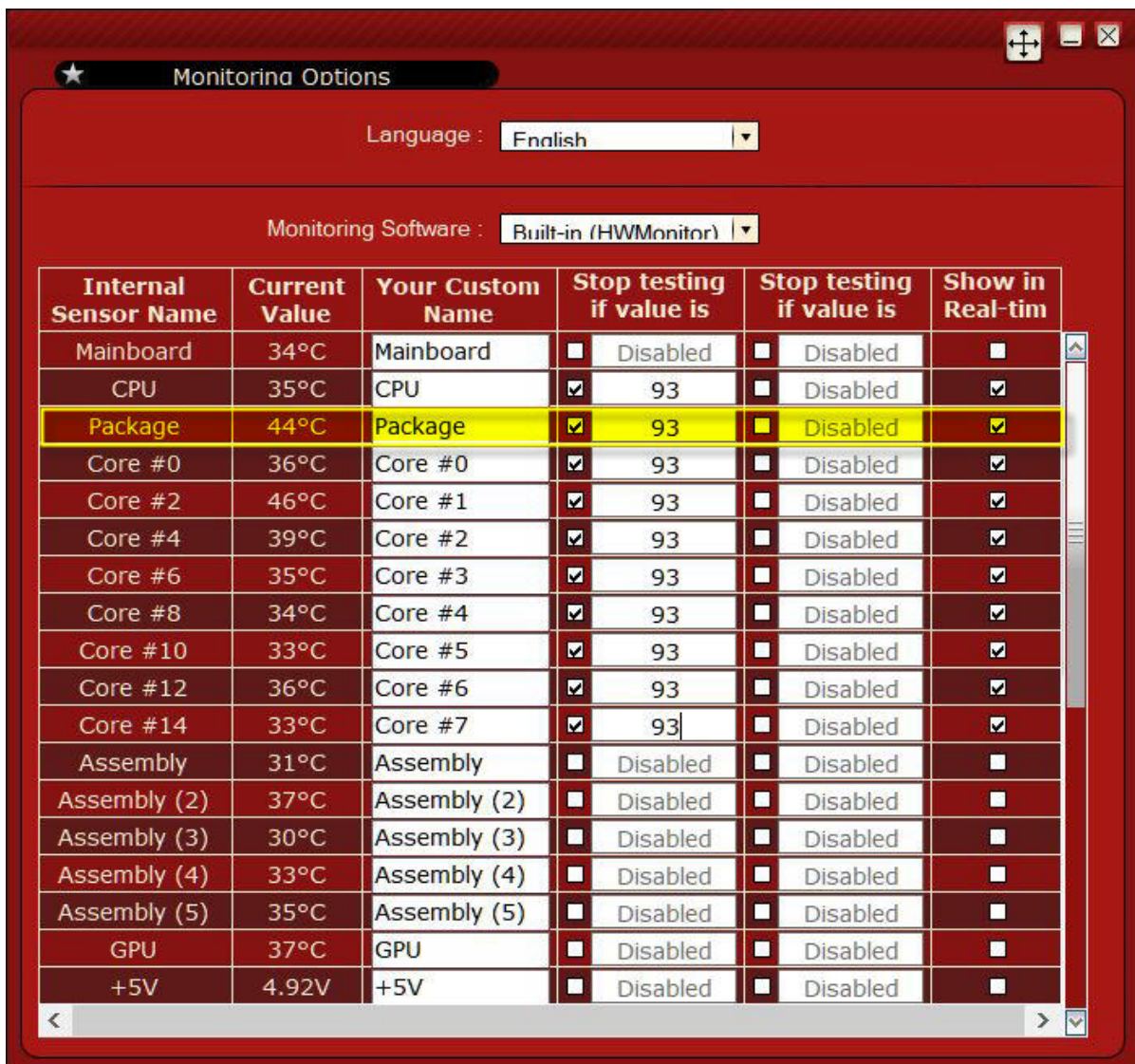
SETUP OCCT TESTING FOR SECOND LAYER OF SAFETY:

PLEASE MAKE SURE THIS IS OCCT: v4.5.1 and NOTHING ELSE! There is a reason why I use this version of the software as it different than the updated version. We don't need 2019 AVX(2) and we want long duration time runs. The newer version run shorter duration times and overloads the CPU for absolutely no value to a gaming or typical system clock.

Set up OCCT for security. Click the ORANGE gear tab (settings) in OCCT. Using the image below please duplicate exactly what you see, setting the limits as shown to 93c and enabling the package to STOP CHECKING IF VALUE IS by checking the box as shown.

NOTE: THE IMAGE BELOW IS FROM OCCT v4.5.1 ON A z390 9700K SYSTEM.

WITH NEWER SYSTEMS OCCT v4.5.1 WILL NOT DISPLAY THE CORE MONITOR LINES AND ONLY THE CPU PACKAGE TEMP. SETUP OCCT AS SHOWN IN THE IMAGE BELOW. HW MONITOR WILL DISPLAY THE INDIVIDUAL CORE TEMPS. THE OCCT TESTS WILL SHUT DOWN IF THE PACKAGE REACHES THE DEFINED SAFETY LIMIT.



The screenshot shows the 'Monitoring Options' window in OCCT. The language is set to 'English' and the monitoring software is 'Built-in (HWMonitor)'. A table lists various sensors with their current values and custom monitoring settings. The 'Package' sensor is highlighted in yellow, indicating it is the primary focus of the safety setup.

Internal Sensor Name	Current Value	Your Custom Name	Stop testing if value is	Stop testing if value is	Show in Real-tim
Mainboard	34°C	Mainboard	<input type="checkbox"/> Disabled	<input type="checkbox"/> Disabled	<input type="checkbox"/>
CPU	35°C	CPU	<input checked="" type="checkbox"/> 93	<input type="checkbox"/> Disabled	<input checked="" type="checkbox"/>
Package	44°C	Package	<input checked="" type="checkbox"/> 93	<input checked="" type="checkbox"/> Disabled	<input checked="" type="checkbox"/>
Core #0	36°C	Core #0	<input checked="" type="checkbox"/> 93	<input type="checkbox"/> Disabled	<input checked="" type="checkbox"/>
Core #2	46°C	Core #1	<input checked="" type="checkbox"/> 93	<input type="checkbox"/> Disabled	<input checked="" type="checkbox"/>
Core #4	39°C	Core #2	<input checked="" type="checkbox"/> 93	<input type="checkbox"/> Disabled	<input checked="" type="checkbox"/>
Core #6	35°C	Core #3	<input checked="" type="checkbox"/> 93	<input type="checkbox"/> Disabled	<input checked="" type="checkbox"/>
Core #8	34°C	Core #4	<input checked="" type="checkbox"/> 93	<input type="checkbox"/> Disabled	<input checked="" type="checkbox"/>
Core #10	33°C	Core #5	<input checked="" type="checkbox"/> 93	<input type="checkbox"/> Disabled	<input checked="" type="checkbox"/>
Core #12	36°C	Core #6	<input checked="" type="checkbox"/> 93	<input type="checkbox"/> Disabled	<input checked="" type="checkbox"/>
Core #14	33°C	Core #7	<input checked="" type="checkbox"/> 93	<input type="checkbox"/> Disabled	<input checked="" type="checkbox"/>
Assembly	31°C	Assembly	<input type="checkbox"/> Disabled	<input type="checkbox"/> Disabled	<input type="checkbox"/>
Assembly (2)	37°C	Assembly (2)	<input type="checkbox"/> Disabled	<input type="checkbox"/> Disabled	<input type="checkbox"/>
Assembly (3)	30°C	Assembly (3)	<input type="checkbox"/> Disabled	<input type="checkbox"/> Disabled	<input type="checkbox"/>
Assembly (4)	33°C	Assembly (4)	<input type="checkbox"/> Disabled	<input type="checkbox"/> Disabled	<input type="checkbox"/>
Assembly (5)	35°C	Assembly (5)	<input type="checkbox"/> Disabled	<input type="checkbox"/> Disabled	<input type="checkbox"/>
GPU	37°C	GPU	<input type="checkbox"/> Disabled	<input type="checkbox"/> Disabled	<input type="checkbox"/>
+5V	4.92V	+5V	<input type="checkbox"/> Disabled	<input type="checkbox"/> Disabled	<input type="checkbox"/>

After the settings changes are made in OCCT you are now ready to begin the process of discovery in how high and how far can you clock the z490 and the 10900K but first a message from reality...

THE LIMITS YOU SHOULD NOT EXCEED ANYTIME DURING THIS EXERCISE

VCCIO and VCCSA – BIOS manual input voltages of above: 1.225v

NOTE: The automated system on z490 will BOOST the manual input voltages in the BIOS automatically. I will outline the TYPICALLY seen VCCIO/VCCSA HW Monitor Maximum readouts for each clock level below. YOURS may be a bit higher, perhaps a bit lower in the end (I doubt it) however, I *personally* prefer these two with the z490 and 10900K set no higher in the BIOS than: **1.20/1.20** but they can roll a bit higher with longevity.

VID – HW Monitor MAXIMUM column readout: 1.47v MAX

Vcore – HW Monitor MAXIMUM column readout: 1.48v MAX

Vcore – HW Monitor REAL TIME (first column): Will not sit above 1.40v for any length of time other than perhaps a second or so at most. You should actually not even notice it reading 1.40v or above in HW Monitor as the voltage will only breach that limit for very short periods of time that the eye and the readout software in real time may not even pickup on the screen.

UNDERSTANDING VOLTAGE CHANGES AND THE CLUES THEY MAY PROVIDE

Understanding the following along the way can clue you in as to what area may need voltage changes as you go. This information should be kept in mind because if instability is found and voltage changes must be made, which one of the areas below can clue you into where the system is lacking or may be unstable and why.

VCCIO – This is the systems NVMe, SATA, PCIE, USB, and a small amount of memory controller I/O to the CPU. Typically the higher the I/O loads the higher the VCCIO.

VCCSA – This is the memory controller as well as a small part of DRAM. This can also stabilize a flakey CPU cache at higher clock speeds.

VCORE – This is the CPU's core stability as well as its stability with the cache

DRAM – This is the DRAM modules themselves. Typically Samsung B die has a voltage range of 1.35v-1.50v. Sometimes modules that are rated and set to 1.35v in XMP must increase in order to run higher core/cache clocks stable. My DDR4 4133 memory modules are rated for 1.40v and I must run 1.45v for a 9700K 5.2GHz 45/48 cache CPU clock. Your mileage may vary and need no change. This is part of discovery as load tests are applied.

If you make 2-3 voltage changes at once you are not going know which one was the culprit causing an issue and forcing more than one voltage change at higher CPU speed/load can increase the testing time because in such cases you then need to begin reducing one or another to find the voltage that locked stability.

Therefore, it is far better to start low and slow and move up one voltage change at a time. If the first change nets a fail return it back to the original setting and make a single change to the next. Sometimes it is best to make a single large change over a very small one when we come across an issue where small increments are not stabilizing the clock. Larger changes if they are either successful or unsuccessful can indicate you are hitting a WALL meaning you may be approaching the maximum stable clock you can obtain. These are the clues that define where your system may max out and for what reason.

STEP 6:

DISCOVERING THE HW MONITOR MAX COLUMN VID AND OVERCLOCKING TO 10 CORE 5.0GHz

Here I will outline **in extreme detail** the 5.0GHz clock process *and then this section is simply duplicated* moving to 5.1 and if possible 5.2. After that, adding in HT is explored and tested by repeating the tests at each clock level. 5.0GHz was found easy to obtain on this platform if the cooling solution is in place and the rules are followed.

This section assumes you have, acquired the software tools outlined in STEP 1 and have in fact verified and edited all the initial Windows and BIOS settings I outlined in STEP 2 and STEP 3 including disabling Hyperthread if your processor supports it (for now).

If you have not, or you question anything now is the time to go back to those sections and review all those settings carefully. I can not say what voltages will run your individual system stable. That is what the next section will define at each clock level.

Reminder: If you are starting out with a certain class of video card and later that card will be upgraded, the entire clock load test routine must be repeated. The increased I/O on the PCIe bus can make an established stable system unstable and require voltage changes or there is a possibility a very high clock speed level can no longer be maintained with that new adapter present. It is also possible due to the increase in graphic load you may find there is a weak CPU core/cache that is not present with your current graphics adapter but is exposed with one of modern specification.

It is possible the system can pass all load and memory tests but under extreme graphic benchmark and rendering the clock may FAIL or there may be no crash/BSOD but still generate **WHEA_UNCORRECTABLE_ERROR** in the Windows Event Viewer and those event viewer errors define *the system is unstable in the clock.* Furthermore, Hyperthread (HT) can introduce another level to the fail when a high end graphics adapter or multiple graphic adapters are present. This will be tested later in the outline in Part 9.

You must remember that although there is no physical CPU core for HT *there is a physical cache attached to the core for HT* and as I described in the beginning of the document in reference to the CPU production run the quality of a core or that HT cache attached to it may affect the success or failure of a higher clock when HT is enabled with or without with a modern graphic adapter.

BASE BIOS VOLTAGE AND SETUP FOR 5.0GHz

Enter the BIOS. Under the **EXTREME TWEAKER MENU** scroll down and make the following changes:

CPU Core Ratio [Sync All Cores]

1-Core Ratio Limit [50] - THIS SETS THE SPEED FOR ALL CORES

A higher cache speed can bring on heat and instability however most found the following to work just fine at all CPU speed levels:

Min CPU Cache Ratio [45]

Max CPU Cache Ratio [48]

The above cache settings are the preferred for performance.

Suggested alternate cache settings should you wish to start lower or if there are stability issues during testing at any clock level (If these are raised later, all load and stability tests must be repeated)

Min. CPU Cache Ratio [45]

Max CPU Cache Ratio [46]

CPU Core/Cache Voltage [Adaptive Mode]

-Offset Mode Sign Set this to [-] (minus) This setting may end up being + (plus)

The final and correct offset mode sign for each clock level will be defined by the required offset voltage to establish the MAXIMUM VID specification defined for each clock level as seen in the HW Monitor x64 readout in Windows.

Additional Turbo Mode CPU Core Voltage [1.00] This voltage setting *will always be* locked at **1.00v**

Offset Voltage [0.060] The discovery process for each clock level should start at offset mode sign [-] offset voltage **0.060v** this may change and end up being a + offset voltage. We must start somewhere and -0.060v is a reasonable starting point that should not overrun the cooling solutions. The starting voltage may or may not be unstable to boot the system in Windows. That discovery is part of the process. The voltage to obtain the correct VID could exist, *in example*, between -0.050v to +0.050v.

VCCIO/VCCSA VOLTAGE:

Earlier in this outline it was defined that a systems running high speed memory may require a boost in VCCIO/VCCSA if manually set in order to pass default memory tests to confirm the memory is not defective. In PART 3 of this document I outlined a base VCCIO/VCCSA voltage setup if the default VCCIO/VCCSA voltage settings did not require such adjustment. Because clocking will raise Vcore which will stabilize CPU and cache differently, **IF** it was required to raise VCCIO/VCCSA during default speed memory testing to pass those tests at this point I suggest lowering those two voltages and see if the system will remain stable. Most found that to be the case.

Set VCCIO to: **1.170v**

Set VCCSA (System Agent) to: **1.180v**

F-10 SAVE AND EXIT – Reboot into Windows

If you have found your VID is 1.32v @ [+] 0.020 then that should be trimmed back down to something like [+] 0.015. Your motherboard VRMs will define how this scale works on your system and how far one way or the other you must go to locate the target voltage. *This area can not be defined in a guide, this is discovery.*

The target VID outlined is the critical voltage to locate for each clock level. Once you have located the target MAX column VID of **1.315v for 5.0GHz** in HW Monitor then the load and stability testing begins.

IMPORTANT NOTE TO KEEP IN MIND: It was discovered during the development of this outline that the z490/10900K can display a FALSE instability with OCCT tests causing the tests to read a red FAIL at the top of the test GUI. This instability occurred in the FIRST MINUTE of the test, usually within the first 30 seconds. Should you experience such a test failure do not reboot, simply start the test over again.

OCCT:LINPACK x64 WITH AVX LOAD TESTING

Nothing has changed from the past. I am not going to explain the clock tests as you should know how those tests are setup and run. Run the 1 hour OCCT:Linpack x64 AVX test. Currently HT is disabled in the BIOS. With a good cooling solution, proper tower design and a reasonable ambient tower environment you should not experience CPU core or package temperatures that approach the 85c-90c level. Most found the maximum temps in the 70's, well below any high stress point.

SPECIAL NOTE: No one experienced CPU temperatures in the 80c range or higher during 5.0GHz 10 core clocking. IF you are seeing temps in this range during 5.0GHz clock testing you should look at:

1. Cooling Solution Itself: If it isn't a good high end liquid system you may already be approaching your limit.
2. Cooling Solution Installation: Is your cooler installed and aligned properly.
3. Tower Airflow or Tower Location: Is your tower able to breathe and is not located near a heat source.
4. Ambient Room Temperature: Is your tower located where the ambient room temp is rolling higher than 80F.

This was discussed earlier in the document. Review the above if you are seeing CPU temperatures in the mid 80c range or even low 80c range or you may not be going much further in CPU speed.

HW MONITOR OBSERVATION OF THE LOAD TEST BEING RUN

During the OCCT:Linpack test you should observe the areas I outlined earlier in this document in HW Monitor.

Your REAL TIME (**first column Vcore**) should run throughout the test somewhere in this voltage range:

Real Time Vcore OCCT:LIN 1.190v - 1.195v could be slightly higher or lower

Your MAX column Vcore should run throughout the test somewhere in this voltage range:

MAX Vcore column 1.255v - 1.289v could be slightly higher or lower

- SHOULD INSTABILITY OR TEST CRASHES OCCUR -

The following is true for ALL tests: OCCT, Memtest and PCIe graphic load instability at ALL clock speeds

IF the crash is a system reboot or BSOD that indicates your voltages are very low – **which one?**

IF the crash is a OCCT test FAIL with no reboot or BSOD that indicates your voltages are CLOSE – **which one?**

As I pointed out earlier in this guide it is always best to change ONE voltage at a time. If that voltage fails, return it to its original clock setting value and change the next. At some point you will see a change in the test, be it that the test finally passes, or, the test runs longer before crashing. That is the clue we use to figure out where we may need to adjust. Making two voltage adjustments can be done, but complicates the discovery time. Moving a voltage too high and too fast may mean longer testing time to locate the lowest stable voltage.

Moving voltages very high first to try and shortcut and then lowering them, we may spend the same amount of time, sometimes more, one way or another. There is no shortcutting to save time so it is best to work your way up one voltage at a time slow until the test passes.

My suggestion is to use the following guide (in the presented numerical order) with ANY test or any crash to locate the lacking voltage

#1 VID - This can increase or decrease real time and MAX Vcore. Move this in **0.010** increments and remember that in some cases a **0.010** increment is a lot. This may only need to be trimmed by **0.005**.

#2 VCCSA - Move this in **0.01** increments.

#3 VCCIO - I will note here *that sometimes* it is in fact best to move both VCCIO and VCCSA at the same time in **0.01** increments together. That is not always the case. Typically VCCSA is more sensitive however with a PCIe rack, drives and I/O rolling VCCIO may indeed need to come *at the same time* with VCCSA. This is trial and error area. **Most found** 1.170/1.180 VCCIO/VCCSA worked for all clock levels.

#4 DRAM VOLTAGE - This area can be tricky. No one in testing found they had to raise DRAM voltage for memory *that was designed to run 1.50v*. Those who may be running lower speed/lower voltage memory may find they need raise DRAM voltage a tad. For memory rated 1.35v, raising it to 1.40v - 1.45v is fine. For memory rated 1.40v, raising it to 1.45v -1.48v is fine. **These changes may also be true** if you are messing around with memory speed/timing *that is not the default speed/timing (XMP BIOS set) of the memory product*.

YOU SHOULD KEEP A RECORD OF MAX CPU TEMP AND WATT LOAD RECORDED WITH OCCT:LINPACK TO BE USED FOR REFERENCE AND A DECISION POINT AS CLOCK TESTING UNFOLDS.

Using the above information, you should be able to get through the OCCT:Linpack test successfully. When that success occurs, reboot the system and move to the OCCT:CPU test. Reboot the system.

OCCT:CPU x64 LARGE DATA SET LOAD TESTING

Run the 1 hour OCCT:CPU load test. It is important to note that if you have passed the OCCT:Linpack test as outlined above and for some reason you may find a voltage must be raised during this test, you do not have to repeat the OCCT:Linpack test. We only need to repeat tests if we LOWER a voltage at some point. Raising a voltage during this process means *the tests run prior will still pass and represent a far more stable environment in previous tests*.

For this test we will use the SAME OUTLINE we did for OCCT:Linpack should the system become unstable or a fail the test. There is no difference in the approach to stabilize this test. You will also note the CPU temperature will be far lower during the OCCT:CPU load test than with OCCT:Linpack with AVX instruction. Most found running 5.0GHz their CPU temps were in the mid 50c to mid 60c range. As mentioned with OCCT:Linpack, if you were seeing higher CPU core and package temps in the AVX test, this test will also reflect higher temps, naturally.

Your REAL TIME (first column Vcore) should run throughout the test somewhere in this voltage range:

Real Time Vcore OCCT:CPU: 1.230v - 1.238v could be slightly higher or lower

Your MAX column Vcore should run throughout the test somewhere in this voltage range:

MAX Vcore Column: 1.255v - 1.289v could be slightly higher or lower

You will note the real time voltage range is higher with OCCT:CPU than with OCCT:Linpack. This is an expected behavior at all clock levels.

- SHOULD INSTABILITY OR TEST CRASHES OCCUR -

Use the same information presented above for the OCCT:Linpack test to find the voltage instability and correct it. When that success occurs and OCCT:CPU x64 passes, reboot the system and move to HCI Design Memtest.

HCI DESIGN MEMTEST

If you acquired the right software and paid the 5 bucks for the pro version, this test is easy to run. After a reboot and time to allow the system to settle, simply run HCI Design Memtest and allow it to continue for MINIMUM of 800% pass. Due to very high system memory amounts (32GB) this test can take quite a while to run and some opt to let it run overnight. 800% is the minimum, 1200% and above is a done deal for stability. If such tests are run overnight make sure the system will not go into any kind of sleep or power down mode.

Once HCI Design Memtest has passed, your 5.0GHz no HT clock is established. What happens with an upgraded PCIe graphics adapter is different subject and all tests above should be re-run to confirm that new card is not overdriving the system.

HYPERTHREAD

Enable HT in the BIOS now and re-run all the tests above for 5.0GHz. Make voltage adjustments as necessary. Most found none were required. Save the new HT enabled profile separately so you have no HT and HT enabled stable profiles saved.

When using the OCCT:Linpack x64 AVX test to RUN HT stability tests, BE SURE to place a check in the box: USE ALL LOGICAL CORES or HT will not be tested.

In ANY CASE be sure to SAVE your current tested stable BIOS clocking profile to both the BIOS and a USB or other drive so you can easily restore your successfully clocked BIOS easily in the event of a disaster or in the event you need a starting point to fine tune your clock voltages. Remember that over time a clock may require a tad more CPU voltage than it needed a year or so from now. Saving profiles and overwriting old ones make the job easier down the road should they be needed.

Reminder; This is not common however all these tests can pass but under high graphic loads instability could appear, or **WHEA_UNCORRECTABLE_ERROR** in the Windows log system may begin to appear. In both cases use the same outline for raising voltages starting with the offset for VID to stabilize in the event that may occur. This will be tested later in the outline in Part 9.

+++++

IMPORTANT: MAXIMUM CPU TEMPERATURES OF HIGH 80's-93c AT 5.0GHZ

SPECIAL NOTE: If you are seeing CPU temperatures in the mid to high 80c range (or higher) with a 5.0GHZ clock for what ever reason be it your choice of CPU cooler or you could not resolve other issues that may be driving the CPU temp that high running 5.0GHZ then I would seriously caution about attempting 5.1. Your system for what ever reason will most likely *not handle* 5.1GHz and it will overheat quickly. You are welcome to test that if you wish however with a temp in the mid to high 80c range at 5.0GHZ I seriously doubt it will allow a higher clock speed from this point.

If that happens to be the case then **you should consider stopping here** and note the highest maximum watt load displayed in HW Monitor x64 when OCCT:Linpack x64 AVX is running and then use the following information to set a WATT LIMIT in the BIOS to prevent your system from overrunning the CPU temperature limit if heavier AVX instruction happens to be detected in use on the system in the future.

If you did not keep records of the temp and watt load as I outlined above under OCCT:Linpack x64 AVX testing then you should rerun the test for at least 30 minutes to define the WATT LOAD at the mid to high 80c (or higher) CPU temperature. Below is an example of how to calculate and set the safety net for this in the system BIOS. IN EXAMPLE:

IF your system is displaying MAXIMUM temps between 85c - 89c during 5.0GHZ OCCT:Linpack testing and lets assume for this exercise the MAXIMUM watt load displayed is 220 watts (or whatever it displays for that CPU temp range). You will ADD 10 watts to that maximum displayed watt value. Enter the BIOS and make the following changes:

NOTE: If the maximum CPU temperature is 90-93c THEN ONLY ADD 4 watts to the Maximum watt load displayed in HW Monitor x64 and input as shown below.

EXTREME TWEAKER/INTERNAL CPU POWER MANAGEMENT MENU:

Long Duration Package Power Limit [230] - This value is always the calculated value.

Package Power Time Window [2] - This value is always '2'

Short Duration Package Power Limit [231] - This value is always 1 watt higher than the calculated value.

F10 – SAVE AND EXIT - You are finished clocking and this will be the best you can run on your system due to cooling solution issues. You may still be able to tweak the memory and you still need to verify PCIe video adapter 3D load stability. (Step 9 and further, below). If you reach this stop point due to temperature and want to go further your will need address your cooling solution and tower.

STEP 7:

DISCOVERING THE HW MONITOR MAX COLUMN VID FOR 5.1GHz

As I said earlier in this document, if you can obtain this level of 10 core HT clocking but can not go further don't fret. You will be running a very serious level of long term safe performance most will never see or experience without major risks and silly bragging rights while they slowly fry their system into the ground.

This is where your cooling solution and tower airflow are going to be put to the test. Moving from 5.0GHz to 5.1GHz on 10 cores with or without HT will generate far more heat. You will need to pay attention to the temp and maximum watt load areas of HW Monitor x64 that were noted earlier in this document. Most found with a good liquid cooling solution and testing with **OCCT:Linpack x64 AVX enabled** (with or without HT) their temps ran in the mid to high 70c to the very low 80c range.

Enter the BIOS and make the following changes:

1-Core Ratio Limit [51] - THIS SETS THE SPEED FOR ALL CORES

A higher cache speed can bring on heat and instability however most found the following to work just fine at all CPU speed levels:

Min CPU Cache Ratio [45]

Max CPU Cache Ratio [48]

The above cache settings are the preferred for performance.

Suggested alternate cache settings should you wish to start lower or if there are stability issues during testing at any clock level (If these are raised later, all load and stability tests must be repeated)

Min. CPU Cache Ratio [45]

Max CPU Cache Ratio [46]

THE TARGET VID VOLTAGE FOR 5.1GHz

1.370v ← FIND THIS MAX COLUMN VID VOLTAGE in Windows with HW Monitor x64 by raising or lowering the BIOS offset voltage. Once this voltage is displayed in the MAX column of the monitor software then the clock load and stability testing in OCCT and Memtest begins.

Locate the max column VID voltage of **1.370v** and load test the system making voltage adjustments as needed. Most found that the offset voltage they used for 5.0GHz was somewhat close to the offset voltage required to locate the defined VID voltage for 5.1GHz however that may not always be the case. You can opt to start at **Offset Mode Sign [-]** and **Offset Voltage [0.060]** if you question this and start over at -0.060, or you can start with what you have for 5.0 and work it from there. **This is the only clock level where it is safe to start with the offset voltage set where 5.0GHz left off. Do not attempt that when moving to 5.2GHz.**

HW MONITOR OBSERVATION OF THE LOAD TEST BEING RUN

During the OCCT:Linpack x64 AVX test you should observe the areas I outlined earlier in this document in HW Monitor.

Your REAL TIME (**first column** Vcore) should run throughout the test somewhere in this voltage range:

Real Time Vcore OCCT:LIN: 1.230v - 1.235v could be slightly higher or lower

Your MAX column Vcore should run throughout the test somewhere in this voltage range:

MAX Vcore Column: 1.330v - 1.345v could be slightly higher or lower

- SHOULD INSTABILITY OR TEST CRASHES OCCUR -

Use the same information provided in the 5.0GHz outline under SHOULD INSTABILITY OR TEST CRASHES OCCUR to locate the voltage needed to stabilize the test and pass it starting with VID (offset adjustment). Also note the maximum CPU temperature and watt load during this test as it eventually passes through the 1 hour mark successfully. Unless you are running a special chiller or direct to die setup we will be setting the BIOS watt load limits after this test to assure that the system is safe, or, to move to the next clock speed level and continue the journey. Reboot to run the next test when complete.

OCCT:CPU x64 LARGE DATA SET LOAD TESTING

Run the 1 hour OCCT:CPU load test. It is important to note that if you have passed the OCCT:Linpack test as outlined above and for some reason you may find a voltage must be raised during this test, you do not have to repeat the OCCT:Linpack test. We only need to repeat tests if we LOWER a voltage at some point. Raising a voltage during this process means *the tests run prior will still pass and represent a far more stable environment in previous tests.*

For this test we will use the SAME OUTLINE for voltage changes we did for OCCT:Linpack should the system become unstable or a fail the test. There is no difference in the approach to stabilize this test. You will also note the CPU temperature will be far lower during the OCCT:CPU load test than with OCCT:Linpack with AVX instruction.

Your REAL TIME (**first column** Vcore) should run throughout the test somewhere in this voltage range:

Real Time Vcore OCCT:CPU: 1.270v - 1.290v could be slightly higher or lower

Your MAX column Vcore should run throughout the test somewhere in this voltage range:

MAX Vcore Column: 1.330v -1.345v could be slightly higher or lower

You will note the real time voltage range is higher with OCCT:CPU than with OCCT:Linpack. This is an expected behavior at all clock levels.

- SHOULD INSTABILITY OR TEST CRASHES OCCUR -

Use the same approach starting with VID (offset voltage) to find the voltage instability and correct it. When that success occurs and OCCT:CPU x64 passes, reboot the system and move to HCI Design Memtest.

HCI DESIGN MEMTEST

After a reboot and time to allow the system to settle, simply run HCI Design Memtest and allow it to continue for MINIMUM of 800% pass. Due to very high system memory amounts (32GB) this test can take quite a while to run and some opt to let it run overnight. 800% is the minimum, 1200% and above is a done deal for stability. If such tests are run overnight make sure the system will not go into any kind of sleep or power down mode.

Once HCI Design Memtest has passed, your 5.1GHz no HT clock is established. What happens with an upgraded PCIe graphics adapter is different subject and all tests above should be re-run to confirm that new card is not overdriving the system.

HYPERTHREAD

Enable HT in the BIOS now and re-run all the tests above for 5.1GHz. Make voltage adjustments as necessary. Most found none were required. Save the new HT enabled profile separately so you have no HT and HT enabled stable profiles saved.

When using the OCCT:Linpack x64 AVX test to RUN HT stability tests, BE SURE to place a check in the box: USE ALL LOGICAL CORES or HT will not be tested.

SETTING THE SYSTEM 5.1GHz MAXIMUM WATT AND CPU TEMP LIMIT SAFTEY NET

At this point you are most likely approaching the higher end of temperature where your system can safely run higher load AVX instruction. Most found with OCCT:Linpack x64 AVX enabled that their CPU temperatures were in the high 70c to low 80c range, however that may not be the case with your system. In either case it is time to evaluate and set a limit in the system BIOS that will assure safe CPU temperature will continue, or, in the case where *you may be reaching the safe CPU temperature limit of the system and must stop further clocking* so AVX can not overrun the CPU temp limits should higher AVX instruction become present.

THE INFORMATION BELOW IS A RECOMMENDATION... *This is an area you may need to evaluate yourself and perhaps make custom adjustments that differ from what is suggested below based on how high your CPU temperature runs and what value the max watt load displays. We don't want to be higher than 93c in the Linpack AVX test and at the same time we want to place a watt limit in the BIOS to keep the temp in check automatically as the system is used or the next CPU speed is tested.*

I will outline below the recommendation for settings and your next steps based on the *maximum temperature and watt load readout* in HW Monitor x64 from the OCCT:Linpack (with or without HT) 5.1GHz tests.

IF you are seeing CPU temperatures in the high 80c range – *You will most likely not be going any further in clocking.* Using the MAXIMUM WATT LOAD reading in HW Monitor during the OCCT:Linpack x64 AVX test and add 10 watts to the value. Let's assume that watt load value is 235. Enter the BIOS and under this menu make the following edits:

NOTE: If the maximum CPU temperature is 90-93c THEN ONLY ADD 4 watts to the Maximum watt load displayed in HW Monitor x64 and input as shown below.

EXTREME TWEAKER/INTERNAL CPU POWER MANAGEMENT MENU:

Long Duration Package Power Limit [245] - This value is always the calculated value.

Package Power Time Window [2] - This value is always '2'

Short Duration Package Power Limit [246] – This value is always 1 watt higher than the calculated value.

F10 – SAVE AND EXIT - You are finished clocking and this will be the best you can run on your system due to cooling solution issues. If you wish to try the next level that is up to you but I would be very cautious at this point. **If the temp is in the 90-93c range I would not attempt the next level at all.** You may still be able to tweak the memory and you still need to verify PCIe video adapter 3D load stability. (Step 9 and further, below).

If you are seeing CPU temperatures in the high 70c to low 80c range – Using the MAXIMUM WATT LOAD reading in HW Monitor during the OCCT:Linpack x64 AVX test and add 15 watts to the value. Let's assume that watt load value is **245**. Enter the BIOS and under the same menu header outlined above, make the following edits:

Long Duration Package Power Limit [259]

Package Power Time Window [2] - This value is always '2'

Short Duration Package Power Limit [260] - This is the calculated value minus a buffer I outline below.

F10 – SAVE AND EXIT

SPECIAL NOTE: I am placing a maximum watt limit of 260 watts on the system even if the watt load with +15 watts is higher than 260 watts. The watt limit can go a bit higher if the maximum CPU temp is running in the high 70c to low 80c range however you should never see that load under typical conditions and the watt load I outline should keep you secure for years to come. If you want to push it higher, (265-270), that is on you. That may be OK if you know what you are doing however I am outlining 260 watts as the max.

WHAT THE BIOS WATT LOAD LIMIT PROVIDES FOR OUR SYSTEMS

What we are doing is setting a limit in the BIOS that if/when heavy AVX load is applied or by some other dynamic the system reaches this watt limit based on temperature, the CPU SPEED will DROP in steps based on the limit set. It may drop 100MHz, 300MHz or reduce the CPU speed to the default if necessary depending on the load being applied however this allows the system to run AVX or other loads and not overrun safety limits for temperature.

Be sure to save your 5.1GHz BIOS profiles to both the BIOS and an external source in case they are needed in the future.

STEP 8:

DISCOVERING THE HW MONITOR MAX COLUMN VID FOR 5.2GHz

SPECIAL NOTE: When moving from 5.1 to 5.2 we *MUST* reset to Offset Mode Sign [-] and **Offset Voltage [0.060]** or risk very high voltage and temps. A shift takes place in the BIOS programming going from 5.1 to 5.2 and therefore *leaving the offset voltage for the 5.1 VID to locate the VID for 5.2GHz is NOT recommended.*

This is where the rats are and have been hard at work. Intel and the motherboard manufactures make a behind the scenes shift in over-volting the system in order to hit that Intel **one-core-wonder** 5.3 speed that is hardly used or shows up under heavy load running the default automated BIOS. Running a partial manual control of the system exposes this going from 5.1 to 5.2 in the background BIOS code. If you have made it this far and your temps look good, then there is a good chance you may be able to work out a long term safe 10 core 5.2GHz clock with or without HT enabled.

This assumes the system has passed all the clock test levels above and is not running close to 90c in the 5.1 Linpack AVX test and you have at this point set the watt limit in the BIOS as defined in the last section. It is possible the watt limit you set in the last step may still have room for adjustment as that is an area you will need to evaluate during 5.2GHz clock level testing and use the defined limits outlined to make such adjustments. Enter the BIOS and set the following..

1-Core Ratio Limit [52] - THIS SETS THE SPEED FOR ALL CORES

A higher cache speed can bring on heat and instability however most found the following to work just fine at all CPU speed levels:

Min CPU Cache Ratio [45]

Max CPU Cache Ratio [48]

The above cache settings are the preferred for performance.

Suggested alternate cache settings should you wish to start lower or if there are stability issues during testing at any clock level (If these are raised later, all load and stability tests must be repeated)

Min. CPU Cache Ratio [45]

Max CPU Cache Ratio [46]

THE TARGET VID VOLTAGE FOR 5.2GHz

1.470v ← BY STARTING AT OFFSET SIGN [-] AND OFFSET VOLTAGE 0.060 FIND THIS MAX COLUMN VID VOLTAGE in Windows with HW Monitor x64 by raising or lowering the BIOS offset voltage. Once this voltage is displayed in the MAX column of the monitor software then the clock load and stability testing in OCCT and Memtest begins.

Repeating the outline for 5.0GHz above with HT disabled in the BIOS, locate the max column VID voltage of **1.470v** and load test the system making voltage adjustments as needed. This is the MAXIMUM *RECOMMENDED* VID LEVEL THE SYSTEM SHOULD RUN. Slightly higher can be OK however you will be approaching a limit that may not be worth it. **1.480v is the HARD MAXIMUM.**

HW MONITOR OBSERVATION OF THE LOAD TEST BEING RUN

During the OCCT:Linpack x64 AVX test you should observe the areas I outlined earlier in this document in HW Monitor. **You should also note the CPU speed in CPUz as this test is being run because the system now has a watt load limit that will begin to reduce and then fluctuate the CPU speed as that limit is approached. This behavior is NORMAL and expected. NOTE the maximum temp and watt load readouts.**

Your REAL TIME (first column Vcore) should run throughout the test somewhere in this voltage range:

Real Time Vcore OCCT:LIN: 1.240 - 1.290 could be slightly higher or lower

Your MAX column Vcore should run throughout the test somewhere in this voltage range:

MAX Vcore Column: 1.425 - 1.448v could be slightly higher or lower

- SHOULD INSTABILITY OR TEST CRASHES OCCUR -

Use the same information provided in the 5.0GHz outline under SHOULD INSTABILITY OR TEST CRASHES OCCUR to locate the voltage needed to stabilize the test and pass it starting with VID (offset adjustment). *Also note the maximum CPU temperature and watt load during this test as it eventually passes through the 1 hour mark successfully.*

AFTER PASSING THIS TEST

It is possible you may be able to make some minor adjustments to the watt load set in the BIOS when running the 5.1 Linpack AVX test which can reduce the amount of CPU speed fluctuation observed while the Linpack AVX test was run. **Should you alter the watt load limits in the BIOS (not voltage, watt load) it is recommended to rerun the Linpack AVX test for at 30 minutes to verify the CPU temp is still within the defined limit of 93c or below.**

OCCT:CPU x64 LARGE DATA SET LOAD TESTING

Run the 1 hour OCCT:CPU load test. It is important to note that if you have passed the OCCT:Linpack test as outlined above and for some reason you may find a voltage must be raised during this test, you do not have to repeat the OCCT:Linpack test. We only need to repeat tests if we LOWER a voltage at some point. Raising a voltage during this process means *the tests run prior will still pass and represent a far more stable environment in previous tests.*

For this test we will use the SAME OUTLINE for voltage changes we did for OCCT:Linpack should the system become unstable or a fail the test. There is no difference in the approach to stabilize this test. You will also note the CPU temperature will be far lower during the OCCT:CPU load test than with OCCT:Linpack with AVX instruction.

NOTE: Because of the reduced maximum watt and temperature running OCCT:CPU x64 the system *should NOT* display CPUz CPU speed drops and fluctuation. That is only typically seen in during the OCCT:Linpack x64 AVX testing.

Your REAL TIME (**first column** Vcore) should run throughout the test somewhere in this voltage range:

Real Time Vcore OCCT:CPU: 1.365v - 1.380v could be slightly higher or lower

Your MAX column Vcore should run throughout the test somewhere in this voltage range:

MAX Vcore Column: 1.425v - 1.448v could be slightly higher or lower

You will note the real time voltage range is higher with OCCT:CPU than with OCCT:Linpack. This is an expected behavior at all clock levels.

- SHOULD INSTABILITY OR TEST CRASHES OCCUR -

Use the same approach starting with VID (offset voltage) to find the voltage instability and correct it. When that success occurs and OCCT:CPU x64 passes, reboot the system and move to HCI Design Memtest.

HCI DESIGN MEMTEST

After a reboot and time to allow the system to settle, simply run HCI Design Memtest and allow it to continue for MINIMUM of 800% pass. Due to very high system memory amounts (32GB) this test can take quite a while to run and some opt to let it run overnight. 800% is the minimum, 1200% and above is a done deal for stability. If such tests are run overnight make sure the system will not go into any kind of sleep or power down mode.

Once HCI Design Memtest has passed, your 5.2GHz no HT clock is established.

HYPERTHREAD

Enable HT in the BIOS now and re-run all the tests above for 5.2GHz. Make voltage adjustments as necessary. Most found none were required. Save the new HT enabled profile separately so you have no HT and HT enabled stable profiles saved.

When using the OCCT:Linpack x64 AVX test to RUN HT stability tests, BE SURE to place a check in the box: USE ALL LOGICAL CORES or HT will not be tested.

At this level it is possible you may experience stability and voltage issues enabling HT. Be aware it is possible you may be able to run within temperature specification but a weak cache or core may not allow hyperthread at 5.2GHz. It comes down to voltage and production run component quality.

FINE TUNING THE SYSTEM MAXIMUM WATT AND CPU TEMP LIMIT SAFTEY NET

At this point you may or may not be able to make fine tune adjustments on the watt load safety limit. In example, if after 5.1GHz testing the system BIOS watt load restriction was set to 254/255 and after running 5.2GHz tests your noted maximum CPU temperatures during the OCCT: Linpack AVX tests were in the mid to high 80c range, there is room to allow a higher watt load at this clock level. Use the following recommendations to make that call and setting adjustment:

IF MAX TEMP is mid to high 80c – add 5 to 10 watts to the value currently established in the BIOS and edit those values as such

EXTREME TWEAKER/INTERNAL CPU POWER MANAGEMENT MENU:

Long Duration Package Power Limit [xx] – Add 5 to 10 watts to the value already inputted.

Short Duration Package Power Limit [xx] – Add 5 to 10 watts to the value already inputted.

As outlined, I recommend these not sit higher than **259/260** however a bit over that is OK as long as you are not hitting **89-93c** in the OCCT:Linpack AVX load test.

I found no one needed more than 259/260 on any of the test systems as some were actually running 249/250 at 5.2GHz with and without HT. This comes down to the cooling solution and tower and is a wild card you must define as you go.

IF MAX CPU TEMP is in the 90-93c range – **leave the values established in the BIOS for 5.1GHz as-is.**

IF YOU FAIL 5.2GHz DUE TO TOPPING OUT ON VID OR 3D RENDER INSTABILITY

There is an alternative you can try in order to raise the offshoot on Vcore and stabilize a 5.2GHz clock. Go into the BIOS and change this setting from 5 to 6:

EXTREME TWEAKER DIGI + VRM MENU:

CPU Load-line Calibration [Level 6]

We will be switching the LLC in the BIOS from Level 5 to Level 6 and starting over at **Offset Mode [-]** and **offset voltage 0.060**, finding the max column VID min HW Monitor of **1.470v** (perhaps a touch higher if needed) and following the 5.2GHz outline starting at the top and moving through to enabling hyperthread.

You may be hitting a wall at this point that perhaps you can pass with HT disabled and not with HT enabled. As mentioned that all comes down to the CPU production and system.

NOTE: IF you have a stable 5.1 with hyperthread enabled clock profile but can not enable HT with 5.2 and still manage a stable 5.2 no HT clocking profile, switching between those two may net different performance results. That will come down the application in use itself! You may find in some cases higher performance is found @ 5.1 HT enabled and in other cases 5.2 no HT runs better.

Benchmark programs typically favor HT enabled but that *does NOT MEAN THE REAL WORLD APPLICATION WILL DISPLAY THE SAME BEHAVIOR*. You have that option now to work with.

Once it has been determined if 5.2 can be achieved using LLC6 then refer back to the section above about fine tuning the watt load system.

If for some reason all attempt to run 5.2GHz @ LLC6 FAIL, then the system will be restricted to 5.1.GHz. **Take it like a man and move on. Your system is still smoking hot.**

STEP 9:

3D LOAD BENCHMARK TESTING TO VERIFY STABILITY

-with the current or later added new video adapter-

At this point the system must be tested under heavy 3D load to assure the bus is stable with the established overclock at the final highest level achieved. This test must also be rerun should a new video adapter be installed into the system at a later date.

3DMark06 can no longer be used to evaluate newer hardware. It has to be the latest 3DMark with Fire Storm and Time Spy. There appears to be timing and divider issues with 3DM06 that possibly go back to the 20 series video cards on newer platforms but **are definite** with the newer 3x cards. Download and install the latest 3DMark which includes the two tests required to check the graphic load on the clock.

The website for 3DMark tries to force a STEAM install of the tests. There are stand alone installers available on the net that do not require steam. One I have linked below:

Stand Alone 3DMark Latest Release: (Time Spy/Fire Strike included)

<https://www.techpowerup.com/download/futuremark-3dmark-timespy-raytracing>

Install then start the application to see if any updates are offered. If so update the application now. Once complete or if no update is offered close the application and reboot.

Fire Strike is a DX11 benchmark and would be similar to P3Dv4 and current as of the date of this document MSFS 2020. **Time Spy** is a DX12 benchmark and would be similar to P3Dv5 and possibly future MSFS 2020.

FOR THIS CHECK WE DO NOT NEED TO TEST EVERY CLOCK PROFILE ESTABLISHED

Instead you will select the highest speed clock profile your system passed muster on. Be it 52x with HT, 52x without HT or 51x with HT. If not already running it, load that BIOS profile and boot into Windows10.

Each test comes with a lousy commercial beginning segment and with the free version there is no way to bypass it so allow the intro to run and then the test will start. Run **Fire Strike** first, note the score and then reboot. Then run **Time Spy** note the score and reboot.

IF you do not experience CTD's, BSOD's or system automatic reboots and the Windows log system has not recorded any behind the scenes: **WHEA_UNCORRECTABLE_ERRORS after the test completes** in the Windows log file list when either of the tests are being run then you can assume at that point your system is stable with 3D graphics loads and the current graphics adapter at your highest clock speed. This completes the check. You can review the score numbers I posted below for 3x series video adapters and then move to Step 10.

IF you do experience any of the listed crashes or errors outlined above then note the test the crash or error occurred. Sometimes Fire Strike may run just fine but Time Spy may reveal graphic load issues. In these cases you must find out if this can be overcome by return to section 6, the 5.0GHz outline and use - SHOULD INSTABILITY OR TEST CRASHES OCCUR – located under OCCT:Linpack test that outlines voltages.

NOTE: None of the clock tests need be repeated. You are simply going to work the voltages just as you would to stabilize a clock using the list provided and rerun the graphic test(s) that previously failed.

It is possible you may have a CPU with a flakey HT cache, meaning in example, **you can pass** the 3D load tests with the 52x CPU speed *hyperthread disabled* profile but **can not pass one or the other tests** with the 52x HT enabled profile. It is also possible you simply can not overcome that issue even with voltage changes. This goes back to the quality of the components in CPU production.

You may pass these 3D load tests with, in example, a 2080 video adapter, but with the introduction of the 3x series video adapter the clock is now unstable for one reason or another. **That is why this test must be repeated should you update the video card at a later date.**

You may have to face that issue at this point and may have to abandon the use of HT at the highest CPU speed and perhaps fall back to 51x HT enabled for applications that prefer HT use.

Try to resolve your crash or error log issue and pass the 3D load tests if you can.

One last suggestion if all else fails and you wish to try another angle...

If you are at LLC level 5 @ 52x you could try moving to LLC level 6 as outlined in the last section however if you do that you must start over to locate the VID and then subsequently go through all the clocking tests before attempting to run the 3D load tests. If it fails there that is the last option and you will have to take what you can get.

EXPECTED 3D MARK SCORES FOR CLOCKS AND 3080/3090 SERIES VIDEO CARDS

Do note that memory speed and latency (timing) can have an affect on these scores. Those who may be running lower memory speed and higher timing may see lower average scores than posted below. The lower the latency to the CPU communication, the faster the CPU and memory communicate and therefore the faster the system. Scores below reflect a system running memory latency in the 42-45ns range @ DDR 4000 as tested with AIDA 64 Cache and Memory Benchmark.

I can not estimate exact score evaluations as there is simply not enough information available with this system and different video cards however I can relay this:

Fire Strike DX11 – 3x series cards *should see* around **33,000-34,000pts** when the system is fully clocked up (51x HT -52x HT safe).

Time Spy DX12 - 3x series cards *should see* around **18,000-19,000pts** when the system is fully clocked up (51x HT -52x HT safe).

That's a heck of a ride when you take into consideration some of those idiot 3DMark drag racers are jacking their GPU clocks up past safe as well as tapping 54x-56x CPU speeds to beat that score **and they are not** doing any of that safely so be careful what you see at that website and assuming as your system not performing. Those people cheat and are willing to burn system components and run dry ice or LN2 in order to sit at or anywhere near the top side of that score list.

The 3080 and 3090 will perform exactly the same. The 3080 will have a *very slight* advantage on default GPU clocks but the difference is the 3090 with the 24GB of Vram isn't going anywhere for many years to come.

STEP 10:

(OPTIONAL) TWEAKING DDR4 MEMORY LATENCY

This section will not be exploring direct memory overclocking and tuning. That is a very complicated subject to deal with on top of clocking a CPU. The primary reason when purchasing the memory product for the system we look for the highest stable speed and lowest CAS Latency- tREF- tRP- tRAS timing memory, *also known as the Fab-4 timing specs you see advertised with the memory speed*, is so that type of intense memory tuning is not required. Understanding this area and how to calculate latency requires far more than I will get into here other than the recommendations I have in the beginning of the document about careful purchase of DDR4 memory speed/timing.

It is possible to find DDR4 memory that may overclock easily. **This is not a norm** and far easier when running 2 sticks of memory instead of 4 or more. In example, DDR4 1600 32GB (2x16GB) CL16-16-16 may clock up to DDR4 3800 or 4000 and allow CL in either case to drop to CL15 with a few other timing adjustments. In doing so the latency of that memory has dropped which means the speed/efficiency of the CPU core/cache communication with the memory bus has increased significantly, further improving performance past CPU clocking.

In the process of tuning memory **DRAM Voltage** may need to be raised as well as other voltages such as System Agent slightly tweaked in order to stabilize such tuning. Results, which can take a good deal of time to work out, can range anywhere from 'not possible' to 'totally awesome' and in between there may or may not be discovery that shows the voltage changes made to accomplish the tuning may be pushing things a bit too far for the amount of tested stable gain obtained.

I am sure there are those reading this document that understand what I said above and do try to tweak memory product the best they can with their overclock. That must be done AFTER all of the above in CPU clocking complete, and, each overclock/memory and then 3D stress test must be repeated to ensure the stability of the tuning.

In this section I am going suggest another area of memory tuning that can net results and not require the same technical knowledge and time invested and usually it comes with no voltage tweaks once the CPU clock is found/locked, but that is NOT always the case as it may require some tuning in that area but usually very little. This suggestion could be included with the intensive memory tuning discussed above, or, can be used without and directly with the memory manufacture default speed and timing.

For this we will be looking at: **tRFC (Row Refresh Cycle Time** in CPUz) and usually known in the BIOS under the setting:

EXTREME TWEAKER/DRAM TIMING CONTROL MENU: DRAM REF Cycle Time [AUTO]

Most DDR4 1600 through 4000 memory will be running anywhere in the 580-780 range by default. Typically the higher the memory speed and tighter the timing, the higher the memory manufacture may run that value. Most have found it is possible to trim that value down to somewhere between **305** and **395** (305, 315, 325, 335 and so on)

It is also important to point out that the real world performance difference between say 305 and 345 **is NOT** going to be significant. What we are doing is looking for where in that range the memory and system will run stable with the clock. Starting at 305 may be too aggressive, other times the memory may run 305 just fine as-is. This is an area of discovery.

The following is how I would approach this in order to shorten the process some. As with any other change this must be completely tested and running **HCI Design Memtest** on 32GB of system memory can be time consuming.

You can opt to start by slamming it down to **305** or start out around the middle at **345** In either or any case, the stability tests should be run in this order:

1. HCI Design Memtest

2. OCCT:Linpack x64 AVX (use all logical cores checked with HT enabled)

3. OCCT:CPU x64 Large Data Set

4. 3D DX11 and DX12 Benchmark runs

Usually Memtest will find issues with this memory tweak change before the other tests in the list. That is why we start with Memtest first this round.

If you pass Memtest with the edit in the BIOS, move to the other test in the ordered list.

If you see a fail with Memtest, or the others, first try a boost in DRAM Voltage. Then try VCCSA and last, VCCIO. VID (offset) may play a role however remember raising that voltage could change your temps.

If fails do not seem to clear, you may simply be running **DRAM REF Cycle Time** too low. If you started out at **305**, move to **345**. If you started out at **345**, move to **395**. It is possible to move higher into the **445** range if all seems to fail and not remain stable as your clocks were set to **DRAM REF Cycle Time [AUTO]** however anything above 445 and this tweak really isn't worth going any further. Set it back it [AUTO] and call it a clock.

More than likely after passing every CPU load test and getting this far, instability will be in the DRAM Voltage however you must remember any additional load on the memory controller and memory while clocked could expose a weak cache or other issue another voltage is better suited to help stabilize.

Your Memory Latency can be reviewed using the free version of AIDA64 > Tools > Cache and Memory Benchmark. I have discussed in the past in very specific detail how memory and CPU cache latency improves system performance. I am not going to get into it all again here. I typically run in the 41-42ns range. If you are running 32GB on a good CPU core/cache and memory speed and timing you should be in the 42-45ns range as displayed at the end of the top GUI readout of the AIDA64 Cache and Memory Benchmark test. You can also see (with the free version) some of your CPU cache latency drop there as well but it is far harder to drop the CPU cache latency than memory latency. 1ns lower in each CPU cache readout is awesome!

Every nanosecond counts. Don't fall for any horse manure you may read online at Flightsim sites about how 2-3-5ns lower in that memory test under condition: *When a system is properly clocked up with cache and memory timing in concert, provides nothing*. That may be true for the people who write things like that, but to your now properly clocked and tweaked computer, that is false.

It also is true for hard drive communication to the system which is why I defined nearly 2 decades ago to use **COMPLETE NAME DEFRAGMENTATION** (alphanumerical file placement on the physical platter on the fastest spinning part of the surface) with such devices in order to lower the read latency from the storage device by significantly optimizing the file reads to the system off the disk because the mechanical disk/head and SATA communication was locked.

That same approach and mindset of lowering latency in other areas provides system performance increases at many other levels with the CPU core/cache communication and the memory bus communication.

Just ask yourself why typical home computers became so much faster *even with the same memory and processor* when the mechanical hard drive was ditched for SSD, *and then again later!*~ when the SATA SSD was ditched for the NVMe SSD (PCIe bus). Lower storage system latency and higher communication rate.

Why would that same reduction in communication latency be different for any other part of the system? No brainer there!

STEP 11:

(OPTIONAL) HOW LOW CAN YOU GO ON VOLTAGE

This section only need be reviewed if during the clocking phase you may not have taken the time to test lower VID (offset voltage). The VID voltages outlined were the targets to start and it may be possible to reduce the outlined VID using small increments in offset.

If you did not work out the lowest VID for each clock level at this point but have established stable clocking profiles for each clock level, both HT enabled and disabled, and are stable with the current video card adapter then there is an option to test how low you can go on VID and ultimately Vcore which could lower CPU temps for each clock level.

This is not required however if it is possible to reduce the VID and remain completely stable, including OCCT LIN, CPU and Memtest with 3D load benchmark tests then drops in CPU temp will follow.

You will ONLY be working with VID (offset voltage) at this point.

The downside is, it all has to be tested again if VID is lowered. That is how sensitive the offset voltage can be to VID, Vcore and CPU temperature. So you can decide if you would like to try to work the VID lower at this point, or not. Should you decide to give it a go, follow the simple directions below.

For each clock level you wish to try lowering voltage, Enter the BIOS with that clock profile loaded and subtract from the currently entered: **Offset Voltage 0.003v** **You must not get confused between the -/+ scales.**

EXAMPLES USING [-] and [+] OFFSET SCALES

IF the currently entered **Offset Sign is [-]** and the **Offset Voltage is 0.054v** you would then **ADD 0.003** in order to **SUBTRACT** on the **[-]** scale. That would mean the new Offset voltage for testing is: **0.057**

IF the currently entered **Offset Sign is [+]** and the **Offset Voltage is 0.027v** you would then **SUBTRACT 0.003** in order to **SUBTRACT** on the **[+]** scale. That would mean the new Offset voltage for testing is: **0.024**

It is as simple as that. Just be sure to look at what side of the scale you are using and apply what is outlined above to it. All load tests must now be repeated.

IF you pass all tests, then it may be possible to step down in voltage again.

IF you fail any test at a reduction of 0.003v I would call it quits right there, re-input the original stable clock voltage or reload the profile. You can try other clock profiles at that point if you wish and repeat the process.

This is another area of discovery. Some found they were able to reduce one or more of their clock profiles by as much as **0.009v** or as little as **0.003v**. Some found they could make no stable voltage reductions at all.

If you pass the first round as outlined above how far can go past that is a matter of continuing the process of discovery.

TO SUM IT ALL UP

Typically what I outline below is what I would send experienced overclockers and skip over most of the 46 page novel that was written above. (That's right; you are now on page 46!) I could have simply posted this next section without the defined outline however you would not have learned anything in the process and most likely have made a lot of mistakes by now and possibly created a real pickle for yourself.

You may use the following information after you have reviewed and applied all of the above and simply need a quick cheat-sheet to reestablish clocks for some reason.

THE Z490 10900K CLOCKING QUICK CHART GUIDE (ALL CLOCKS)

VOLTAGE LIMITS:

VCCIO and VCCSA – **BIOS manual input** voltages of above: **1.225v**

I personally prefer these two with the z490 and 10900K set no higher in the BIOS than: 1.20/1.20 but they can roll a bit higher with longevity but try to keep them at 1.20 or under if possible.

VID – HW Monitor **MAXIMUM column** readout: **1.47v** MAX
Can run a touch higher, *stay with 1.47 if possible.*

Vcore – HW Monitor **MAXIMUM column** readout: **1.48v** MAX

Vcore – HW Monitor **REAL TIME (first column): Will not sit above 1.40v for any length of time** other than perhaps a second or so at most. You should actually not even notice it reading 1.40v or above in HW Monitor as the voltage will only breach that limit for very short periods of time that the eye and the readout software in real time may not even pickup on the screen.

Use latest software tools outlined in Part 1

Setup Windows Power Profile as outlined in Part 2

Save default test BIOS first, then apply BIOS settings outlined in Part 3

BIOS CHANGES FOR CLOCKING EACH STAGE

CPU Core Ratio [Sync All Cores]

1-Core Ratio Limit [X] - THIS SETS THE RATIO FOR ALL CORES

A higher cache speed can bring on heat and instability however most found the following to work just fine at all CPU speed levels. These cache settings are the preferred for performance:

Min CPU Cache Ratio [45]

Max CPU Cache Ratio [48]

Alternate cache settings for stability issues during testing at any clock level (If these are raised later, all load and stability tests must be repeated)

Min. CPU Cache Ratio [45]

Max CPU Cache Ratio [46]

Unless otherwise found to require different, start out with:

Set VCCIO to: **1.170v**

Set VCCSA (System Agent) to: **1.180v**

CPU Core/Cache Voltage [Adaptive Mode]

Additional Turbo Mode CPU Core Voltage [1.00] This voltage setting *will always be* locked at **1.00v**

Find the offset voltage that displays the MAX column VID value in HW Monitor x64 using a minus offset (-) 0.060 to begin the search at each clock level. You may be able to use the 5.0 level offset to start with 5.1 but **do not** use that offset voltage to find the VID for 5.2, start with -0.060 for 5.2.

Final offset voltage may be in the - (MINUS) or + (PLUS) range of the offset scale.

Goal is to locate the defined VID voltage shown below, FIRST.

HW Monitor Readouts:

50x

CPU CACHE 45 MIN 48 MAX for highest performance

MAX column VID **1.315** <----- FIND THIS VOLTAGE and NOTE: THIS MAY BE FINE TUNED LATER

There can be slight variations to these:

MAX Vcore column 1.255-1.289

Real Time Vcore OCCT:LIN 1.190 - 1.195

Real Time Vcore OCCT:CPU 1.230 - 1.238

51x

CPU CACHE 45 MIN 48 MAX for highest performance

MAX column VID **1.370** <----- FIND THIS VOLTAGE and NOTE: THIS MAY BE FINE TUNED LATER

MAX Vcore column 1.330-1.345

Real Time Vcore OCCT:LIN 1.230 - 1.235

Real Time Vcore OCCT:CPU 1.270 - 1.290

52x

CPU CACHE 45 MIN 48 MAX for highest performance

MAX column VID **1.470** <----- FIND THIS VOLTAGE and NOTE: THIS MAY BE FINE TUNED LATER

MAX Vcore column 1.425-1.448

Real Time Vcore OCCT:LIN 1.240 - 1.290

Real Time Vcore OCCT:CPU 1.365 - 1.380

IF the VID displayed does not obtain the real time Vcore range displayed OR the system is unstable in load tests, raising the offset SLIGHTLY (add 0.002v or 0.003v) may secure the correct range.

It may also be possible to run a lower offset (cooler CPU temp) once VID is obtained (subtract 0.002v or 0.003v) and load tests pass. Move to VCCSA and VCCIO or DRAM after.

Lowering offset *even slightly* can also result in a lower watt load under OCCT:CPU LINPACK AVX 64bit load tests especially at higher CPU clock speeds.

IMPORTANT INFORMATION ABOUT CPU TEMP AND WATT LOAD WITH AVX

Monitor CPU Temperature – 93c to 95c as in the past is the max. As this temperature is approached or seen the BIOS watt load safety net is set to avoid excessive AVX instruction overrunning the CPU temperature. Typically this is set after the 51x OCCT:Linpack x64 AVX test to assure 52x does not overrun however on a poorly designed cooling solution it could come up at 50x and stop clocking at that point.

Note the MAX column watt load in HW Monitor when the temp approaches or hits these targets and set that as follows. DO NOTE: These can be fine tuned and should not be set too LOW. The MAX suggested WATT LOAD VALUE is **260** but can run slightly higher:

CPU temperatures in the high 90-93c range – add 4 watts to the MAX watt load value

CPU temperatures in the high 80c range – add 10 watts to the MAX watt load value

CPU temperatures in the high 70 to low 80c range – add 15 watts to the MAX watt load value

BASIC EXAMPLE BIOS ENTRY ASSUMING WATT READOUT IS 240 AND TEMP IS AROUND 80c

EXTREME TWEAKER/INTERNAL CPU POWER MANAGEMENT MENU:

Long Duration Package Power Limit [255] - This value is always the calculated value.

Package Power Time Window [2] - This value is always '2'

Short Duration Package Power Limit [256] – This value is always 1 watt higher than the calculated value.

These can be trimmed and adjusted as observed.

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