==========

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 compete novice to overclocking I suggest you tread 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 for you 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!

==========

There are 5 Primary Steps

OVERCLOCKING AFTER HASWELL

- AND -

HOW I DO IT

By Wile E. Coyote *(maximus vulgaris)*

I was able to simplify this down considerably from the original BIOS setup I ran. It works exactly the same except removes many voltage inputs and subsequent required tests for them and invokes the Asus automated system.

BE VERY AWARE:

I do not know if this will work for other modern processors (9000 series and up, possibly 8000 series too) with Asus motherboards as there is nothing flat out dangerous about the approach as outlined HOWEVER I would strongly suggest starting out at the 5GHz mark and work up, testing each step very carefully as outlined for temperature and stability.

Starting at the low end should tell you this is working and you can try/proceed to the next level.

This outline is for a full-on 8 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.***

The outline can be used for lower than 5.0 all-core overclocking simply reduce the Vcore from the outline for 5.0 till the lowest stable voltage is found.

AS FOR GOLDEN SAMPLES (OR SILICONE LOTTERY):

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 will 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, it will eventually piss on you just like any other slug over time.

HARDWARE IN USE FOR THIS OUTLINE:

ROG MAXIMUS XI HERO (WI-FI) BIOS 1502 (latest as of this date)

INTEL 9700K (fully lidded)

GSKILL DDR4 4133 16GB (secondary/tertiary timing tuned *after* processor clocking)

CORSAIR AX860i PSU (in single rail mode controlled by iCUE software)

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

NOTE: *Doesn't mean a really good air cooler and well designed tower wont work.*

COOLERMASTER HAF 932 (front, side and rear fans controlled by motherboard)

I WISH TO MAKE THIS VERY CLEAR:

This outline is a methodology in 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 outcomes.*** 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.

ABOUT ASKING:

I will only go so far with responses. I will not diagnose or walk folks through a entire clock or clocking issues. Please read it carefully and follow any special notes I will make.

I have placed a stop point in this outline whereby if you do not see the system behavior that should be expected after making the settings changes and before the load tests, it defines you should stop there and not use this outline.

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. 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.

==========

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** (latest release)

2. **OCCT v4.5.1** <--- **NO OTHER VERSION!** There is a reason for that!

3. **CPUz (latest release)**

4. **HCI Design Memtest** - The paid version is worth the money and makes the job easy

STEP 2:

WINDOWS – CONTROL PANEL – POWER OPTIONS

Select the **HIGH PERFORMANCE** profile 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%

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

STEP 3:

THE INITIAL BIOS SETUP – THIS IS NOT CLOCKING!

==========

WARNING:

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 to default

ENTER BIOS - EXIT MENU – LOAD SETUP DEFAULTS <REBOOT>

On reboot you will have to set XMP, verify correct memory speed/timing/voltage and make all other custom changes such as boot drive, fan/speed sensors, special USB settings, anything that has to do with your custom setup OTHER THAN ANY CPU settings. Make sure those are left at their DEFAULT then F-10 SAVE AND EXIT the BIOS.

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 DON'T LIST IT – DON'T 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]

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 @ 93-95c. THIS SETTING WILL NOT PROTECT A SYSTEM IF IT IS SET TOO HIGH. [0] MEANS THIS IS IGNORED*

BCLK Frequency : DRAM Frequency Ratio [Auto]

DRAM Odd Ratio Mode [Enabled]

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

Xtreme Tweaking [Disabled]

CPU SVID Support [Auto]

CPU Core/Cache Current Limit Max. [255.75]

Ring Down Bin [Auto]

BCLK Aware Adaptive Voltage [Enabled]

DRAM Voltage [X.X] VERIFY THIS IS CORRECT FOR YOUR MEMORY PRODUCT. NOTE THAT ***THIS MAY*** NEED A CHANGE LATER FOR CLOCKING THE PROCESSOR

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:

These two are fun. Asus auto BIOS clocking can seriously overdrive these voltages in some cases over 1.3v In switching over to using the Asus automated system and eliminating many manual inputs I retuned these values for the 9700K which eliminated a lot of BIOS inputs.

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 1.25v much depending on the PCie rack and how busy it is.

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 1.25v (each) limit on these two settings in the BIOS. You may do as you please.

Can they go higher? Yes however I look at longevity verses clock value and also look at what will give the user the best chance of finding their clock core voltage without spending days flipping different numbers and seeing glitches that need to be tuned out.

Set this manually as shown and lock it for now.

CPU VCCIO Voltage **[1.21250]**

There is nothing wrong with this value for VCCIO and 24/7 use. It covers the bases. 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.

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. It may save you some heat, but no where near as much heat as changes in the next voltage, VCCSA.

Set this manually as shown and lock it for now.

CPU System Agent Voltage **[1.16875]**

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, their latency and of course the clock speed, then there is that pesky clock killer the addition of Hyperthread.

We will start with these voltages. I estimate that VCCIO will not need to be touched at all but System Agent may need to be increased on your system. I will note in the outline when to look at that.

So you are aware, the voltages outlined above tested perfect for a 5.0, 5.1, 5.2, and, a 5.3 temporary test run completely stable requiring nothing but CPU core voltage to be located/changed on my system.

PLL Termination Voltage [Auto]

PCH Core Voltage [Auto]

CPU Standby Voltage [Auto] -

NOTE: *ON REBOOT SHOULD READOUT 1.168 (can vary +/- slightly 1.18 is not a problem, never above 1.20) AUTO appears to work just fine with this outline.*

==========

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]

XTU Setting [Auto]

EXTREME TWEAKER/EXTERNAL DIGI + POWER CONTROL MENU:

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

Synch ACDC Loadline with VRM Loadline [Disabled]

CPU Current Capability [Auto]

CPU VRM Switching Frequency [Auto]

VRM Spread Spectrum [Disabled]

Active Frequency Mode [Disabled]

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]

Core PLL 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:

Intel(R) SpeedStep(tm) [Disabled]

Turbo Mode [Enabled]

IA AC Load Line [Auto]

IA DC Load Line [Auto]

TVB Voltage Optimizations [Disabled]

Realtime Memory Timing [Disabled]

FCLK Frequency for Early Power On [Auto]

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 I WILL ADDRESS WHEN CLOCKING STARTS

==========

EXTREME TWEAKER/AI TUNING MENU:

Package Temperature Threshold [Auto]

Regulate Frequency by above Threshold [Auto]

Cooler Efficiency Customize [Stop Training]

Cooler Re-evaluation Algorithm [Normal]

Optimism Scale [100]

==========

ADVANCED/PLATFORM MISC CONFIGURATION:

PCI Express Native Power Management [Disabled]

PCH DMI ASPM [Disabled]

ASPM 0 [Disabled]

L1 Substates [Disabled]

PCI Express Clock Gating [Disabled]

DMI Link ASPM Control [Disabled]

PEG - ASPM [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

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. Can it be done?

Yes, but it will limit your clock, had little influence in Flight Simulator products of the past and I have found it creates more issues with FS than its worth.

So, my advice is to shut it down if the processor supports it, find your stable clock and if you decide you want this enabled later then revisit this setting and start the process over with voltages that will not overrun your cooling solution. HT CREATES HEAT AND MAY REQUIRE HIGHER VOLTAGE.

THE INITIAL VOLTAGES IN THE OVERCLOCK OUTLINE I WILL PROVIDED IN ANOTHER STEP IS DESIGNED **FOR HT DISABLED**

If you run this for Flight Simulator you may also be playing the Affinity Mask Wheel of Fortune game too! Have fun with that instead of taking the all-physical-core clock speed.

Applications that make **true use** of HT, that's different. YMMV

Maximum CPU Core Temperature [95]

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

Active Processor Cores [All]

Thermal Monitor [Enabled]

CPU POWER MANAGEMENT CONTROL

Boot performance mode [Auto]

Intel(R) SpeedStep(tm) [Disabled]

Intel(R) Speed Shift Technology [Disabled]

Turbo Mode [Enabled]

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]

CFG Lock [Disabled]

==========

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]

F-10 SAVE AND EXIT

If the outline above was followed correctly, the system **is now ready to be thermal tested.**

STEP 4

BEFORE THE JUMP TO LIGHTSPEED

This is the point where stuff starts getting real and hot.

I considered simply posting the test process and what number to change then it occurred to me that this section should include the items that will make or break a higher clock speed. So 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.

Quite simply, **we must test to find the highest watt load the cooling solution can control at the absolute highest safe temperature, between 92c-95c and then input that watt load value into the BIOS to establish a control point limit.**

It is not difficult to find the number 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 parameters.

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 though 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 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 75c 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.**

**** PLEASE NOTE THE FOLLOWING ****

What I preset in images and values from this point forward is <u>FOR EXAMPLE ONLY</u>. I will be using my system to demonstrate this. My system is not your system and this variable must be defined <u>SPECIFICALLY FOR YOUR SYSTEM</u>. You can NOT simply copy what I show and input it into your BIOS.

FINDING THE TOWER THERMAL WATT LIMIT

I set this up so you should know this is working as defined before applying any load tests.

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 limit could be: 160watts, 180watts, 210watts, 220watts, 250watts or anything in between.

One of items we are going to discover fast is we can even clock 8 cores full-on at 5Ghz securely and not have to worry about AVX instructions being applied in applications over time.

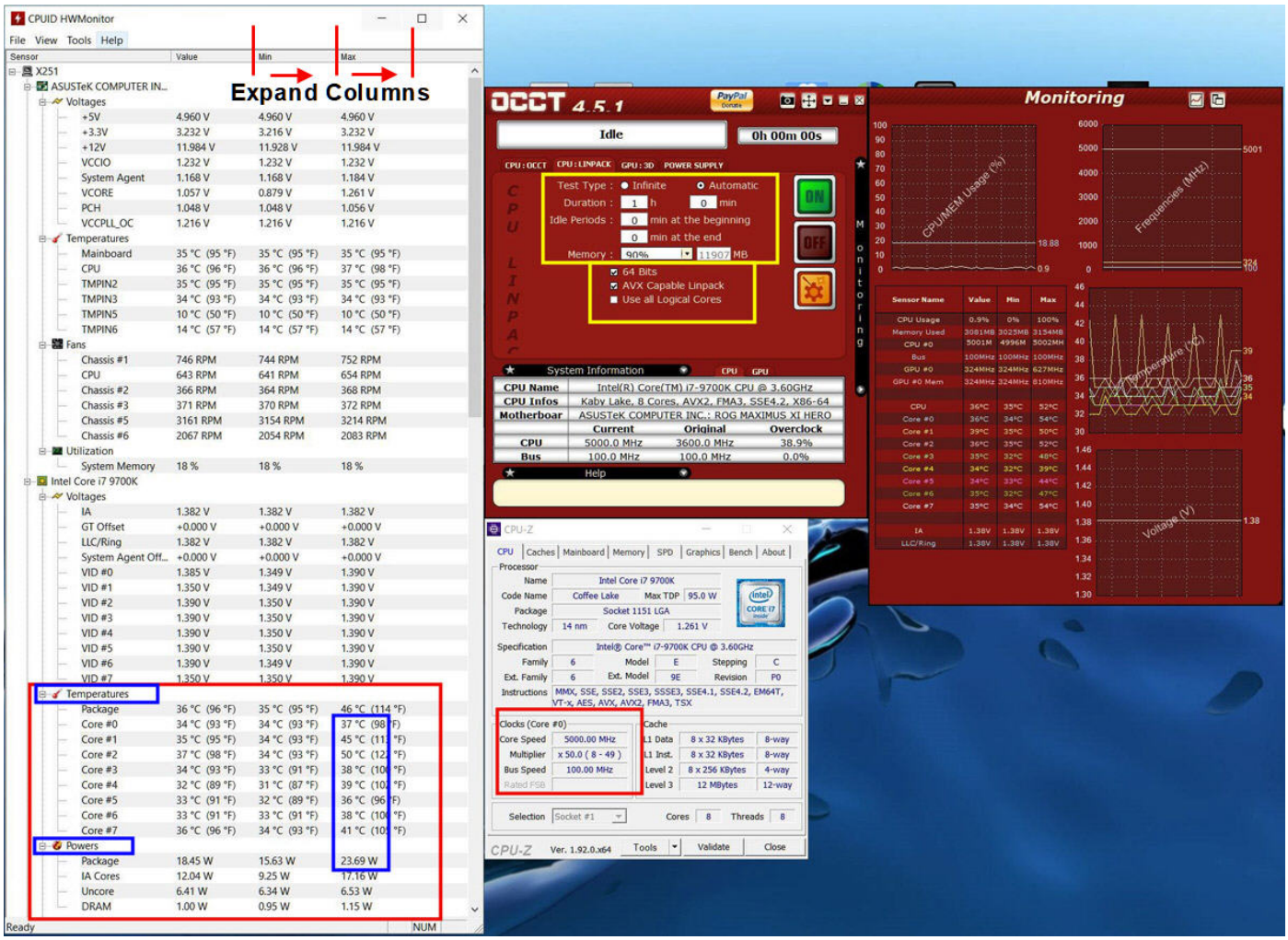
Most modern high end processors will run 5Ghz. Even Intel markets them with a limited core 'up to' 5.0 - 5.1 turbo speed but what we want is 'all cores' and we also want take control to assure our investment is secure. I have found the automated clocking system in the BIOS to run many of the voltages ridiculously high for a one or two core peak.

There's more than one way to accomplish this next step but I am going demonstrate how I do it and from there if you want to get creative and/or make smaller or less aggressive changes to the approach, nothing wrong with that as long as we end up with the same result I demonstrate in the end, then it is all good.

IF IT FEELS GOOD, DO IT
LETS ROLL:

We will be using HW Monitorx64 for all testing. When the application is open expand it and the columns as shown in the example below and note the sections we must observe. OCCT:Linpack and CPUz is also shown with highlighted areas.

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.



You notice at the bottom of HW Monitor the large red box outlines the location of the CPU core temperatures and just below that, the powers (watt loads). The large blue box inside that area is what we are looking for. In the powers section the MAX watt load is displayed just under the CPU core temps.

That's our target for this exercise. How high does that MAX watt readout go before OCCT:Linpack 64bit with AVX enabled automatically stops with a safety cutoff setting of 93c.

SETUP OCCT:

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 our clock.

WHAT WE ARE DOING WITH THIS OCCT v4.5.1 APPROACH:

In the end what we are about to do will ALLOW AVX (all versions) to be applied and the system will automatically down-clock in small steps as is needed till the CPU reaches its lowest default clock speed should hard AVX instruction become present in a application.

APPLICATIONS DO NOT APPLY THE LEVEL OF AVX INSTRUCTION THE SOFTWARE STRESS AND LOAD TESTS APPLY. Therefore if and when AVX may be coded in a software that you might happen to run, this methodology allows it to roll with AVX and keeps the system in check instead of instantly neutering the CPU to nothing or instantly overheating it as AVX can do.

Furthermore, if no AVX application is in use this finds the highest stable heat stress point for our clock and restricts the CPU to run under that limit even with NO AVX applied. So we are setting up a DOUBLE PROTECTION layer here along with the BIOS CPU throttle temperature point of 95c.

For some reason adding Hyperthread back in later to test it with a clock is another very good reason for setting the system up this way because that will definitely raise your temps and watt load!

Set up OCCT for security. Click the ORANGE gear tab (settings) in OCCT. Using the image on the following page please duplicate exactly what you see, setting the limits as shown to 93c and enabling them to STOP CHECKING IF VALUE IS by checking the box as shown. Also, skip the PACKAGE readout as shown. I would then scroll down and DISABLE everything else in that list other than what is highlighted in YELLOW.

We are ready to go now. Close all the applications shown and reboot the system into the BIOS. We must now jack the system into gear to get the temp up and find out where we stand.

THE BIOS CHANGES:

I am going to use a 5.0GHz overclock setup to check my max watt load. **I am not looking for a final tuned overclock; I am looking for that high watt load and max temperature with this.**

I will show you below what you can leave out for right now if you feel you may be pushing things too hard or too fast.

This assumes you have reviewed this document 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.

If you have not, or you question anything **NOW is the time to back to those sections and review all those settings carefully.** If they are not as I outlined this may get nasty, fast.

I can NOT say what voltages will run your individual system stable however I have found the range I am working with below to be in the very close ballpark for the 9000 series processors

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
NOTE: You can opt to run 49 instead of 50 if you wish to take this slower.

You may leave the CPU Cache Ratio's on AUTO for right now if you wish to take this a bit slower. A higher cache speed can bring on heat and instability.
Min. CPU Cache Ratio [46]
Max CPU Cache Ratio [46]

CPU Core/Cache Voltage [Adaptive Mode]

- Offset Mode Sign [+] Always +

- Additional Turbo Mode CPU Core Voltage [1.260]
NOTE: If you leave the CPU cache on AUTO you can probably drop CPU Core Voltage to **1.250** for now. If you are running a Core RATIO Limit of 49 instead of 50 you can probably drop this voltage to **1.220**.

In any case you will probably know if this voltage is too low if the OCCT test fails **due to a core** ERROR **instead of** a temperature fail. We raise this value **.010** volts at a time if it fails with an error and then retest till we hit the temp cutoff.

- Offset Voltage [0.090] - THIS SETTING WILL ALWAYS BE **0.090** regardless of the CPU core voltage being ANY lower, or, ANY higher.

We are not running our CPU flat out @ 1.35v. You are giving the system the ability to fluctuate the voltage as needed **in duration time** and your CPU should idle voltage and watt load.

ONE LAST ITEM before we continue. This may have absolutely no influence on your system during testing however..

My default SPD XMP DDR4 DRAM VOLTAGE for DDR4 4140 is 1.40v and when tested in a high CPU clock with some tuning that voltage had to be raised to 1.45v.

I do not see a problem with that change however it may be possible your DDR4 if it is high speed/low latency and has a base voltage of 1.35 may need to be bumped to 1.40, possibly 1.45. That I CAN NOT DEFINE. So keep that in mind as you go along.

OCCT:LINPACK loads the memory and the memory controller as well as the CPU. **So if you blow that test with CORE ERRORS and core voltage change increases do not appear to be helping with the core errors, your DDR4 voltage *may* need to be raised .05v if it is 1.35v OR raise VCCSA in .01v increments.**

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

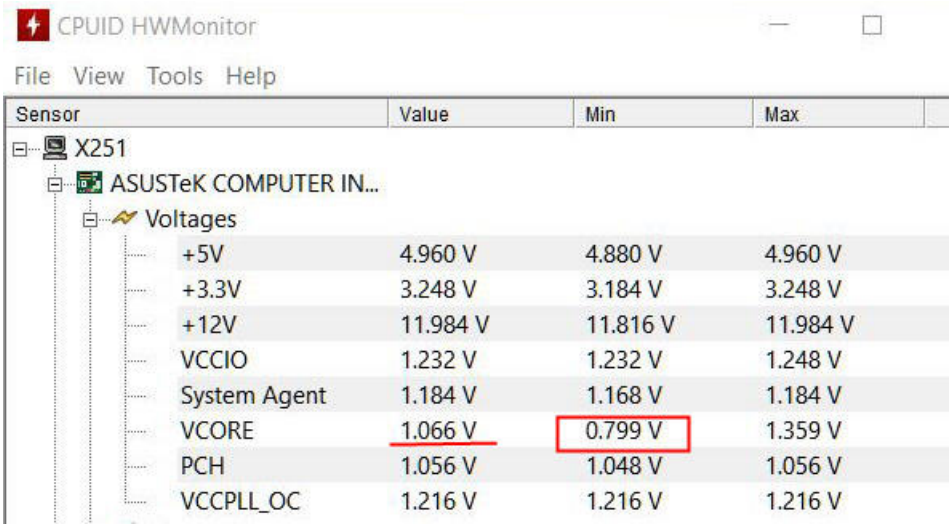
F-10 SAVE AND EXIT – Reboot into Windows

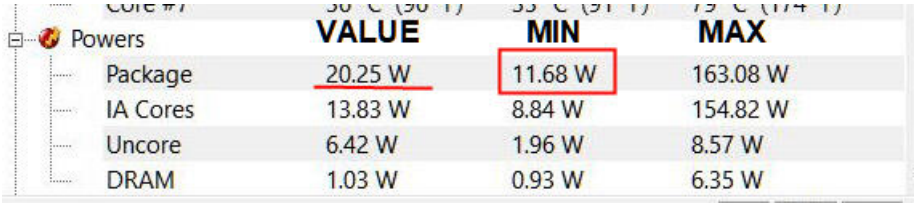
LET THE SYSTEM COMPLETELY BOOT UP (give it a few minutes)

Open your clock test software tools as shown (HW Monitor, CPUz and OCCT:Linpack) just to be sure, verify the OCCT 93c cutoff settings (Orange gear button then close the settings). Make sure OCCT is on the LINPACK tab test, 64bit and AVX is checked.

BEFORE WE START THE TEST the sign to look for **that this is actually working** is in HW Monitor. At the TOP look under VOLTAGES at the VCORE (current value – min – max). Then look at the bottom in the POWERS section (current value – min – max).

Assuming your system is booted and there is nothing hitting the CPU, (check CPU VALUE column under 'Utilization' in HW MONITOR) you should see something like this:





Notice the MIN VCORE and the MIN WATT LOAD as well as the current VALUES.

If these 2 items display LOW idle values as demonstrated above with low CPU utilization then this outline is working as designed. If those 2 values are NOT idling low as demonstrated with low CPU utilization then something isn't working. **This outline must be STOPPED HERE, reset your BIOS and DO NOT USE IT.**

If this is not a 9000 series CPU on the same series chipset motherboard that may be why and at this point until such time as I get more information **you have reached the end of this road for now. Stop here.**

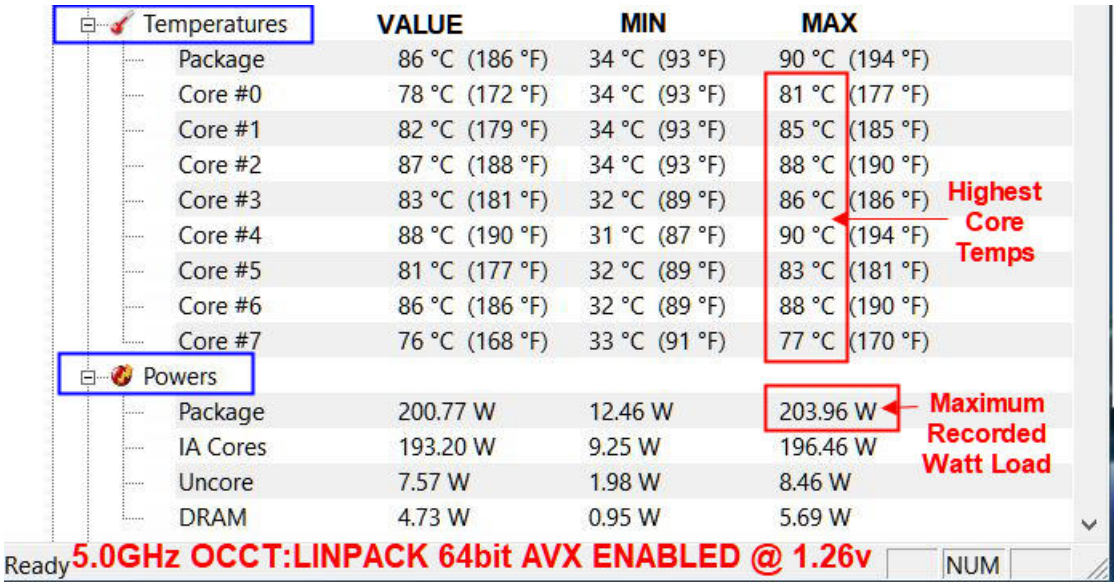
If all is good as shown above in the demo images, you may now proceed to test your setup.

Click the START button on OCCT:Linpack. Let it run. Test will run for 1 hour if no errors and no temperature limits have been reached. IF the test stops with a CORE ERROR and NOT a TEMP ERROR then the **Additional Turbo Mode CPU Core Voltage** is most likely too low. **The DRAM Voltage (.05v if it is 1.35) or VCCSA may need to be raised in .01v increments for your system if CPU core voltage increases do not appear to stabilize the test.**

We want to make small increment changes so we only tap the high end and do not JUMP way over it.

Right now I would raise the **Additional Turbo Mode CPU Core Voltage** 0.01v and try again.

In my case, I ran this test and it completed with no errors and no thermal shutoff. The graphic demonstrates the HW Monitor readout for POWERS.

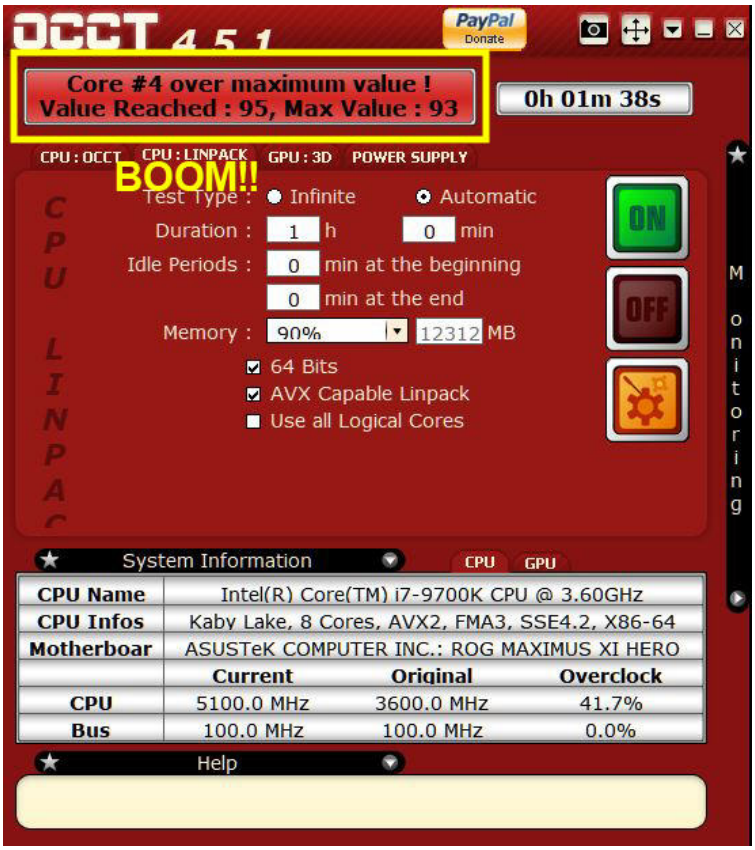


This shows my highest watt load during that 1 hour test was **203.96 watts** however the system did NOT fail on temp therefore I must go higher till the test trips up.

You can simply RAISE the **Additional Turbo Mode CPU Core Voltage** or if you were running some of the lower settings I outlined above, change those to what I posted and repeat the entire process again.

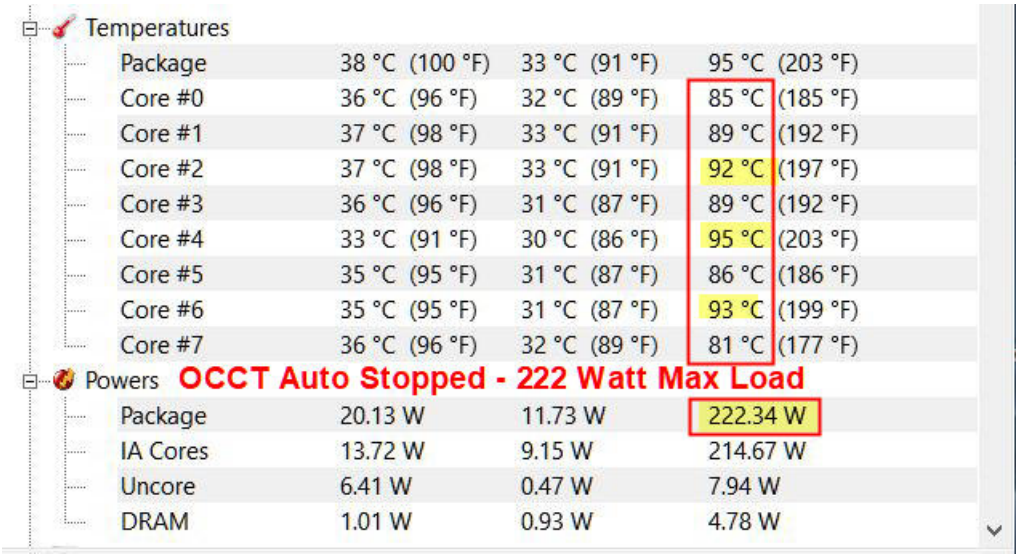
Continue to raise the **Additional Turbo Mode CPU Core Voltage** leaving the current clock alone is fine too. Higher voltage will generate more heat with no affect to the clock other than stabilizing it.

After raising my voltage several times and repeating the test, I finally hit the HOT SPOT and OCCT shut down with a core TEMPERATURE ERROR



(I know BOOM is a bad word to use but no worries)

Looking at HW Monitor I can see the highest watt load recorded right when or just before that happened as shown here:



THAT IS "MY PERSONAL SYSTEM" TOWER WATT LIMIT; 222.34 WATTS
I did not exceed the TEMP LIMIT when that happened; I just tapped it as shown.

That's it, that is the end of the road no matter how high the stable core clock or how much AVX, I will begin to throttle @ 222 (rounded off) watts.

My tower environment is climate controlled. It will always be 78F-80F (or less) and 36-46% humidity so I now have my watt limit for that stable tower environment and will apply it in the BIOS.

I don't want to throttle and I don't want my system to hit that watt value!! Now I know where to stop it automatically and let the system do the work.

INPUTTING THE TOWER WATT LIMIT

Subtract 4 watts from the highest watt load value. In my case that will be **218 watts**

Enter the BIOS –

EXTREME TWEAKER/INTERNAL CPU POWER MANAGEMENT MENU:

Long Duration Package Power Limit [217] - This value will be 1 watt lower than the 2nd.

Package Power Time Window [2] - ALWAYS 2

Short Duration Package Power Limit [218] - This value is MY tested and calculated watt value

F-10 SAVE AND EXIT

TO VERIFY THIS IS NOW WORKING AS OUTLINED:

We leave everything as is when it failed the test **by slowing increasing voltage till that failure occurred.**

Open the tools (HW Monitor, CPUz and OCCT set again for LINPACK/64bit AVX)

This time pay attention to max watt load AND the CPU SPEED readout in CPUz

Start OCCT:Linpack

You should clearly notice that **as the watt load approaches the watt limit** set in the BIOS **the CPU speed will being to DROP and also fluctuate.** You should also notice that the max watt load **never exceeds the limit now applied in the BIOS.**

IF that is true, this is working!

Let OCCT:Linpack run the full hour and see what happens.

REMEMBER THIS IS NOT TUNED OVERCLOCKING AND ALTHOUGH CORE ERRORS ARE A PAIN THAT MAY NEED TO BE ADJUSTED OUT, WE WANT TO SEE OCCT:LINPACK PASS THE TEMPERATURE TEST FOR 1 HOUR WITH OUR NEW WATT LOAD SETTINGS IN THE BIOS.

Let say for some reason it fails on temp again.. go into the BIOS and drop those 2 watt value numbers by **ONE** and try again until it passes.

Once OCCT:LINPACK has passed you are NOW ready for tuned overclocking. You may have discovered during this process where some of your voltages MAY need to be **but lets not assume a lot.**

PART 5

OVERCLOCKING THE SYSTEM

In this outline we have touched on all the elements for individual success in order to clock. If you have followed along and perhaps investigated/corrected issues you may not have been aware of as well as developed a better understanding of the technical then this has served its purpose well.

By this point you should have reviewed your tower build and location, burn test and verify a default system to confirm the components, made the Windows power profile setting changes, input the initial BIOS setup from this outline, discovered your tower thermal watt limit and have applied that limit in the BIOS setup. The stage has been set and now it is time for the show.

ABOUT HYPERTHREAD

I know there will be those who want everything and may be sitting there thinking you can get it now by being a smarty pants and not disabling HT for this section. Please consider this, IF I use software **that actually makes true efficient use** of HT and perhaps some modern AVX in that application at the same time those applications are definitely not games. They are typically **mission critical or productivity applications** and therefore;

I WOULD BE A COMPLETE DOLT TO HIGH OVERCLOCK A SYSTEM AND RUN APPLICATIONS THAT ARE MISSION CRITICAL OR FOR PRODUCTIVITY.

That being said, if you wish to set up a clock with HT enabled, **do yourself a serious favor...** find out how high you can clock securely **without it**, save that profile in the BIOS, then restart the clocking process/testing from bottom end speed with HT enabled and see how far you get stable and then save that BIOS profile.

Having two BIOS profiles (HT ON/OFF) saved will also allow you to switch and load the profiles quickly and discover if that HT clock setup **is really worth the voltage, heat and lower core clock** to your system use.

Please leave HT disabled for now.

What we have in setup right now allows any application AVX use securely.

The next section is pretty much a piece of cake compared to the rest however depending on the individual processor/system it can be as boring as watching paint dry.

Our goal here is to have a system that has the ability to run 24/7 at a full clock speed securely without lowering the clock speed at any time and still idle at a very reasonable voltage and temp.

The two items that will get you in a heap of dinosaur dung from this point forward is being impatient or assuming by cutting tests short or skip them and later, pushing voltages too far even if they pass stress tests.

TOOLS:

Same software tools and setup we use to find the tower thermal watt limit except this time we add in **HCI Design Memtest** - The paid version is worth the money and makes the job easy.

I would highly suggest after successfully running the watt load test **that no one assume the voltages that passed OCCT:Linpack 64bit AVX @ temp/watt load are correct I would start over using the outlines below and work it from there**

VCCIO and VCCSA

Listed in the initial BIOS setup as:

CPU VCCIO Voltage **[1.21250]**

CPU System Agent Voltage **[1.16875]**

I place a max manual input of 1.25v (each) limit on these two settings in the BIOS. You may do as you please.

From my specified values, I would leave VCCIO alone and work VCCSA if you come to find CPU Core voltage changes are not stabilizing the tests.

==========

THE 5.0GHz CLOCK – START HERE

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]

NOTE: you can opt for a lower CPU cache for now which will in fact be more stable and require less voltage. ***Raising this after testing requires repeating ALL the tests again.***

Min. CPU Cache Ratio [46]

Max CPU Cache Ratio [46]

CPU Core/Cache Voltage [Adaptive Mode]

- Offset Mode Sign [+] Always +

- **Additional Turbo Mode CPU Core Voltage [1.260]**

- Offset Voltage [0.090] - THIS SETTING WILL ALWAYS BE **0.090** regardless of the CPU core voltage being ANY lower, or, ANY higher. Do not change it!

F10-SAVE AND EXIT – REBOOT INTO WINDOWS

Please skip down to: THE CLOCK TEST PROCESS

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THE 5.1GHz CLOCK – START HERE

CPU Core Ratio [Sync All Cores]

1-Core Ratio Limit [51]

NOTE: you can opt for a lower CPU cache for now which will in fact be more stable and require less voltage. ***Raising this after testing requires repeating ALL the tests again.***

Min. CPU Cache Ratio [46]

Max CPU Cache Ratio [46]

CPU Core/Cache Voltage [Adaptive Mode]

- Offset Mode Sign [+] Always +

- **Additional Turbo Mode CPU Core Voltage [1.315]**

- Offset Voltage [0.090] - THIS SETTING WILL ALWAYS BE **0.090** regardless of the CPU core voltage being ANY lower, or, ANY higher. Do not change it!

F10-SAVE AND EXIT – REBOOT INTO WINDOWS

Please skip down to: THE CLOCK TEST PROCESS

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THE 5.2 GHz CLOCK – START HERE

CPU Core Ratio [Sync All Cores]

1-Core Ratio Limit [52]

NOTE: you can opt for a lower CPU cache for now which will in fact be more stable and require less voltage. ***Raising this after testing requires repeating ALL the tests again.***

Min. CPU Cache Ratio [46]

Max CPU Cache Ratio [46]

CPU Core/Cache Voltage [Adaptive Mode]

- Offset Mode Sign [+] Always +

- **Additional Turbo Mode CPU Core Voltage [1.355]**

- Offset Voltage [0.090] - THIS SETTING WILL ALWAYS BE **0.090** regardless of the CPU core voltage being ANY lower, or, ANY higher. Do not change it!

F10-SAVE AND EXIT – REBOOT INTO WINDOWS

Please skip down to: THE CLOCK TEST PROCESS

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THE 5.3 GHz CLOCK – YOU WISH

I AM NOT POSTING THIS. The voltage is flat out too dangerous for processor longevity and should only be used for periodic drag racing. Unless you have a golden sample processor that will run this clock speed at or perhaps **.01-.02v** higher than the 5.2GHz outline, **don't do it!**

You have been warned.

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THE CLOCK TEST PROCESS:

Regardless of which clock outline we start out with, the watching paint dry session starts here.

Let Windows boot, give it a few minutes to finish booting.

Launch your clock tools as we did with the watt load test.

The only voltage we will focus on at first is:

- **Additional Turbo Mode CPU Core Voltage [X.xx]**

OCCT:Linpack 64bit AVX enabled, run it again.

IF/THEN

- We raise this value **.010** volts at a time if it fails with an error, and then retest.
- Repeat until the 1 hour test passes.
- We LOWER this value **.010** volts at a time if it passes and repeat the test until it fails, then raise it back **.010** (last successful voltage run)

NOTE: Based on the starting voltage I posted for the clock outline, if raising this voltage continues to FAIL and has been raised more than .02v then look to the possibility of DRAM (.05 higher first) <retest> if FAIL reset DRAM VOLTAGE ***and move to*** VCCSA (raise VCCSA .01-.02v) <retest> and continue.

NOTE: If you are messing around with HT, VCCSA may need to come way up from my original settings. (Possibly in the 1.2-1.25 range)

If you changed DRAM or VCCSA and stabilized, then start dropping **Additional Turbo Mode CPU Core Voltage** .01v until it fails, then raise it back to the last successful pass

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

REBOOT THE SYSTEM

Additional Turbo Mode CPU Core Voltage [X.xx]

- We now switch to **OCCT:CPU 64bit LARGE DATA SET** 1 HOUR test **(first tab)**
- We can NOT lower the voltage because it passed OCCT:Linpack so if it fails, increase voltage **.010** until the 1hour OCCT:CPU test passes.
- Note that if it requires more than .02v increase, look to VCCSA and note the warnings above about this. If you change VCCSA and it passes back off **Additional Turbo Mode CPU Core Voltage** till it fails and raise it back up .01 to the last successful voltage run.

- **When it all passes, we are finished with OCCT**

REBOOT THE SYSTEM

We now focus on memory stability in the clock.

Launch **HCI Design Memtest**

If you are using the 5-7 dollar paid version, simply click to start the process and let it run to 500% on each block section of memory it will test. If you using the free version please read the HCI instructions on how to allocate blocks of your memory manually and run the test.

IF it passes 500%, **congratulations, you *could be* finished!**

IF it does not pass 500% you may be looking at a .05v bump in DRAM VOLTAGE, if not then possibly a .005 boost in CPU Vcore or perhaps a little more VCCSA. Change and retest to 500% HCi Design Memtest.

At the point where you have passed all these tests and know it is stable you can now opt to see if **VCCIO can be dropped from the value in the outline**. If it can, it will save you a little heat (not a lot). If it can't then where it is, is where it stays. Save the current BIOS profile so you do not lose what you have.

In order to test VCCIO voltage drops all three tests OCCT:Linpack, OCCT:CPU and HCI Memtest must be rerun. The voltage drop where a test finally fails, raise the voltage back to the previous that passed all 3 tests and lock it there.

You know the drill now.. Once this test is cleared with all others, you are securely clocked.

And do not forget that over time a new CPU will degenerate and may require a boost in all of the above after a year or so of pounding.

In Conclusion

If you want to try clocking with Intel Hyperthread, save your current stable BIOS profile, then enable HT in the BIOS and start again by first checking your tower watt load limit with HT enabled.

You will most likely be raising VCCSA to accomplish. That means the heat is really on. You may be looking at CPU core voltage bumps too but all tests are performed exactly the same.

If you are going to add a HT BIOS profile I would take the time to verify the original thermal watt limit point is still valid with HT and if not, adjust it as demonstrated in Part 4, then proceed to start the stable clocking process all over again and save the 2nd profile when complete.

I hope this outline has helped you. If not, remember when you're out of Bud,... then tough Schlitz!