Coffee Lake Basic Overclocking Guide.

The Coffee-Lake generation of processors represent a welcome (up to) 6-core family of parts with excellent IPC, z270-class memory controller and very good overclocking capability. Many 8700Ks run 5.0GHz and 4000+ ram speeds with little fuss. There is one design aspect that you either fix or live with and that is the TIM used at the die-IHS interfaced. In stock form the 8700K is a great 6 core cpu but can suffer from elevated temperatures. So, if you want to run 5+ GHz on this SKU, you'll want to delid the CPU and replace Intel's stock TIM with a liquid metal. Delided CPUs run 20+C cooler on average and as a result, usually overclock higher. Most delided 8700K can run 5.0GHz at less than 1.4V.

Equipment used:

ASUS Maximus X Apex
Intel 8700K
G.Skill 2x8GB 4400c19 ram kit (excellent B-die kit)
Seasonic Prime 1000W PSU
ASUS GTX 1080 Turbo
Intel 750 SSD
Koolance 380i CPU Water block
Bitpower Full Cover GPU Water block
GPU and CPU are cooled with a custom water loop (1x360 rad, 3 fans), the CPU is delidded with CLP between the die and IHS.

Software:
CPUZ
HWiNFO64
SIV64
CoreTemp
Real Bench

There are two basic modes for overclocking for 24/7 use: Manual Override or fixed Vcore, and dynamically link voltage and frequency (Adaptive or Offset). Of course, each of these can be tuned for a specific user need or application, but let's just get the basics down first. Ideally, we identify the voltages needed for an OC using Manual Override, then if/when desired, use this knowledge to set Adaptive voltage.

A few assumptions:

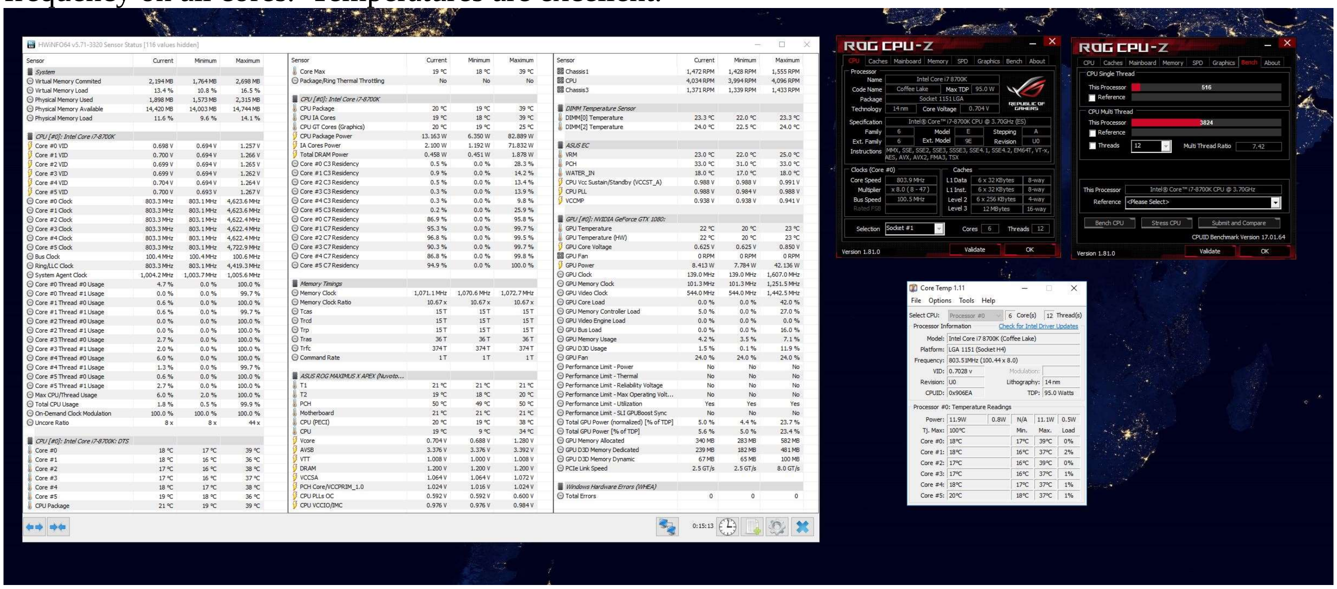
1. The idea is to find the sweetspot for your combination of components.
2. Vdroop is a good thing. Settings shown here allow for a modest amount of droop on the voltage rail LLC is acting upon, which is vcore for Z370.
3. Acceptable load temperature is at least 20C lower than the throttling temperature. We do not want the part slamming into the temperature ceiling, especially when running vcore higher than stock.
4. CPU degradation is cause by many factors, the principal causes are current, voltage and temperature in combination… all the things we do to overclock a CPU
5. Overclocking is always 'at risk".

So… let’s begin by finding a manual override OC on an 8700K which gives us a base to work. System is set up, windows loaded, all drivers are loaded, cooling is in place and the system will boot into windows with all default settings (XMP is not a Default setting). It’s always a good idea at this point to make an Image of your boot drive(s). The built-in Win 7 imager works fine, or use the backup software you prefer. The main thing is to have a good system image to “deploy” should things go horribly wrong (*very* unlikely if you do this with patience).

Step 1

- Clrcmos
- Check your boot priorities, F10 to save and reboot.
- Let the system boot into windows.
- Open two instances of CPUZ and your favorite temperature monitoring software (such as CoreTemp, HWiNFO64, SIV64, AID64, etc)
- In one instance of CPUZ switch to the Bench tab and run the CPUZ Bench. Note (write down) the vcore reported. Note the highest core temperatures reported.

You can see from the picture below, this CPU uses 1.28V at default settings to achieve a 4.6-ish frequency on all cores. Temperatures are excellent.



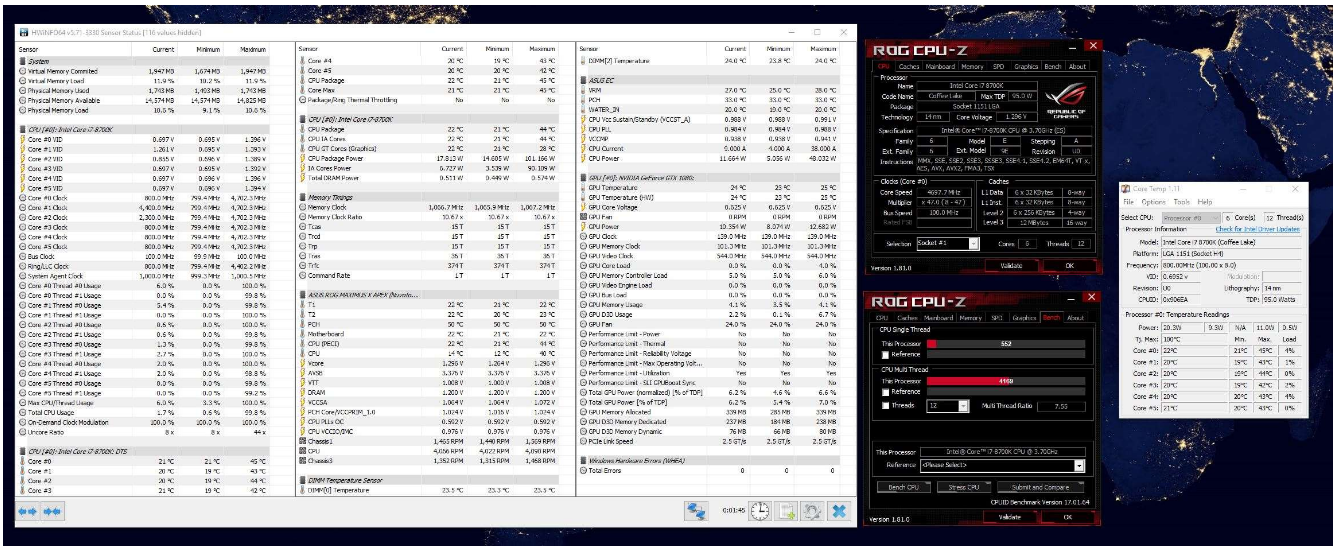
Step 2

Post back into bios:

- Ai Overclock Tuner to “Manual”
- BCLK 100
- AVX neg offset to 0 (we can tune an offset later)
- Synch All Cores
- Multiplier to 4.7
- CPU SVID to Disabled or Auto (since we are using Manual Override)
- Core/Cache Voltage to Manual Mode
- Core Cache Voltage to 1.28V (the vcore you wrote down in step 1)
- Nav to Extreme Tweaker

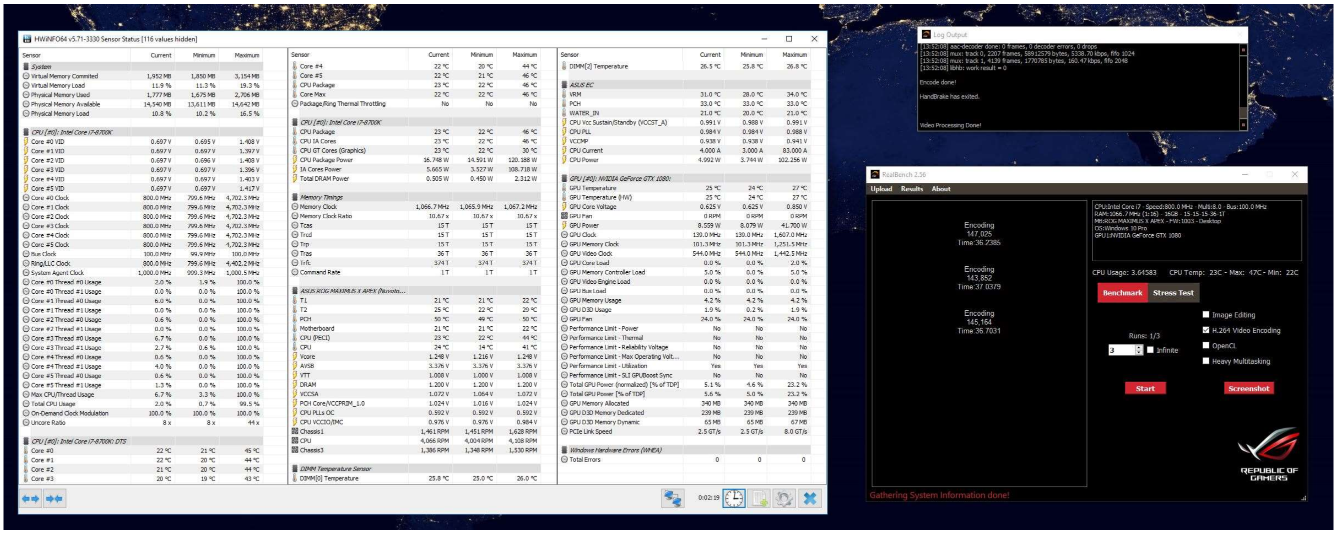
- Cpu Load Line Compensation to Level 5
- Vrm Spread Spectrum to Disabled
- *Leave all other settings unchanged.*
- F10 to save and reboot.

If the system fails to post or can't load windows, enter safe mode (hold down the start button for 3 sec) and increase vcore by 10mV (0.010V) F10 to save and reboot. If it still fails to post and load windows, double check that the bios settings are exactly as shown. Continue to increase vcore 10mV at a time until one of two things happen: it will boot to desktop, or still fails and the voltage is now 1.32V or higher. You can lower the multiplier one notch instead of continuing to raise the vcore. In the picture below, I chose to enter bios and LOWER the vcore from 1.28V until the system failed to load windows then back up 10mV and test stability… eventually finding the lowest vcore 4.7 is stable at. I saved this result to a bios save slot.



All cores hit 4.7GHz, and the min vcore droops to 1.264V during the CPUZ bench test. The above settings pass 3 loops of RealBench 2.56 H.264, as does 1.235V vcore on this Cpu sample. DMM measured vcore off the MB is 1.210V during Realbench H.264 at 1.235V. This was the lowest vcore tested for 4.7 and was stable. Now we know that the core can get by with as little as 1.235V entered into bios.

When tuning a CPU, it is my experience that when you start to see each 100MHz increase in core frequency cost significantly more than 10-12mV per active core, the frequency/voltage response curve becoming very non-linear and the CPU is getting past the sweet spot. Sure, you can juice a chip well beyond this *rule-of-thumb*, some overclockers do, just be aware that the chip is getting out of it's comfort zone.. and is telling you that!



1.235V in bios, vcore droop to 1.216V

At this point we need to “tune” the system in terms of cooling capacity, vcore and multiplier. There are many ways to go about this, You can try setting a “manageable” vcore and increase the multiplier until the system fails, finding the top end of the configuration for 24/7 use. Or you can use the default voltage (in this case, 1.280V) and increase the multiplier (using Synch All Core) to obtain a solid overclock at, essentially stock vcore. Using this simple procedure and setting the vcore at 1.30V in bios, this particular CPU sample tops out at 5.0. 5.1 at 1.3V will fail the RealBench H.264 module.

If you start seeing greater than 2xTDP (180-200W) during stress testing coupled with core temperatures exceeding 80C, I suggest backing down a bit.

Recommended vcore limits for 24/7/365 use:
Air cooled: vcore 1.30V
AIO cooled: vcore 1.3-1.325V
Custom Water: 1.3-1.35V

I’ve heard that running higher voltages than shown above may cause some pretty high transition spikes, so as always, we overclock at our own risk. If you do not delid your CPU, I recommend buying the Intel Tuning Plan for a very uneventful replacement if the part should fail. Delidding voids any warranty – of course.

Once you have tuned the core OC, test the stability with the stress test of your preference, 1 hour of the Realbench stability test is a good start. Save the settings.

The Sequence should be 1) core, 2) ram, 3) cache. This guide is focused on core overclock, “core is king”.

Ram overclocking can be a thesis project, I am not a fan of using XMP, and unless the XMP programming is set for BCLK 100, the subject is far beyond the scope of this quick guide. If your motherboard has preprogrammed dram overclocks (ROG boards for example), you can load the settings closest to where you want to operate (frequency and voltage) as a starting point. Visit the OCN Intel Dram 24/7 Stability thread for help and pointers.

We now established the vcore needed to maintain some level of stability of the system core and cache. I find 20 loops of x264v2 stress test and 10 loops of Intel Burntest sufficient for most any use… and in fact will forego IBT many times, substituting hwbot x265 run in 4K with 4 "parts". Stability is somewhat subjective since it depends on the machine's intended use. A solid gaming rig minimally should pass 2h of RealBench, 2 hours of AID64 cache test, Hci Memtest 1000-2000%. adding GSAT, IBT, or things like p95, OCCT or LinX is up to you. Be aware that power virus application of AVX (like p95 small FFT) simply hammer the FPU with the same instruction set and are not representative of any use, well except running p95 small FFTs. Define the stability regime and adjust voltages or multiplier(s) until the system is stable for what you use it for. In my opinion, locking down a solid ram OC with robust stress testing is critically important: A bad core OC will BSOD, a bad ram OC can silently corrupt an OS install or data files beyond recovery.

AVX OFFSET

AVX Offset will allow you to run a higher frequency for 99% of the CPU's work load, and then lower the operating frequency when AVX is detected in the execution stack.

If the system cooling can't handle an AVX load at 5.0 in the above tests, before bailing out and lowering the multiplier, change AVX offset to 2 and repeat stability testing. Lowering the frequency for AVX is absolutely fine since no regular use (gaming included) will load AVX 100% of the time. Moreover, for some CPUs (like high core count X-class CPUs) it is absolutely necessary. If you use AVX offsets to manage stressors like OCCT small data set, pr p95 small FFTs, AIDA64 CPU (only) stress test does not use the AVX instruction set and allows you to test the stability of the non-AVX clocks. Alternatively, p95 v26 does not use AVX and you can mod the local.txt file to switch off AVX FMA etc; Instructions are in the undoc.txt file in your p95 folder.

Adaptive Voltage Control

The default operating mode for this platform is dynamic voltage and frequency control (adaptive mode) and we have just determined the vcore our system needs to perform to our expectations (clocks, voltage, temperature under load). Moving to Adaptive is quite straight forward, now that we know the vcore needed. From the Manual Override settings we just worked out:

- Enable CPU SVID (adaptive is not available when this is disabled)
- CPU core/cache to 'Adaptive"
- Additional Turbo Mode Voltage to "t*he value you determined using manual override*"

If your Bios has these settings:

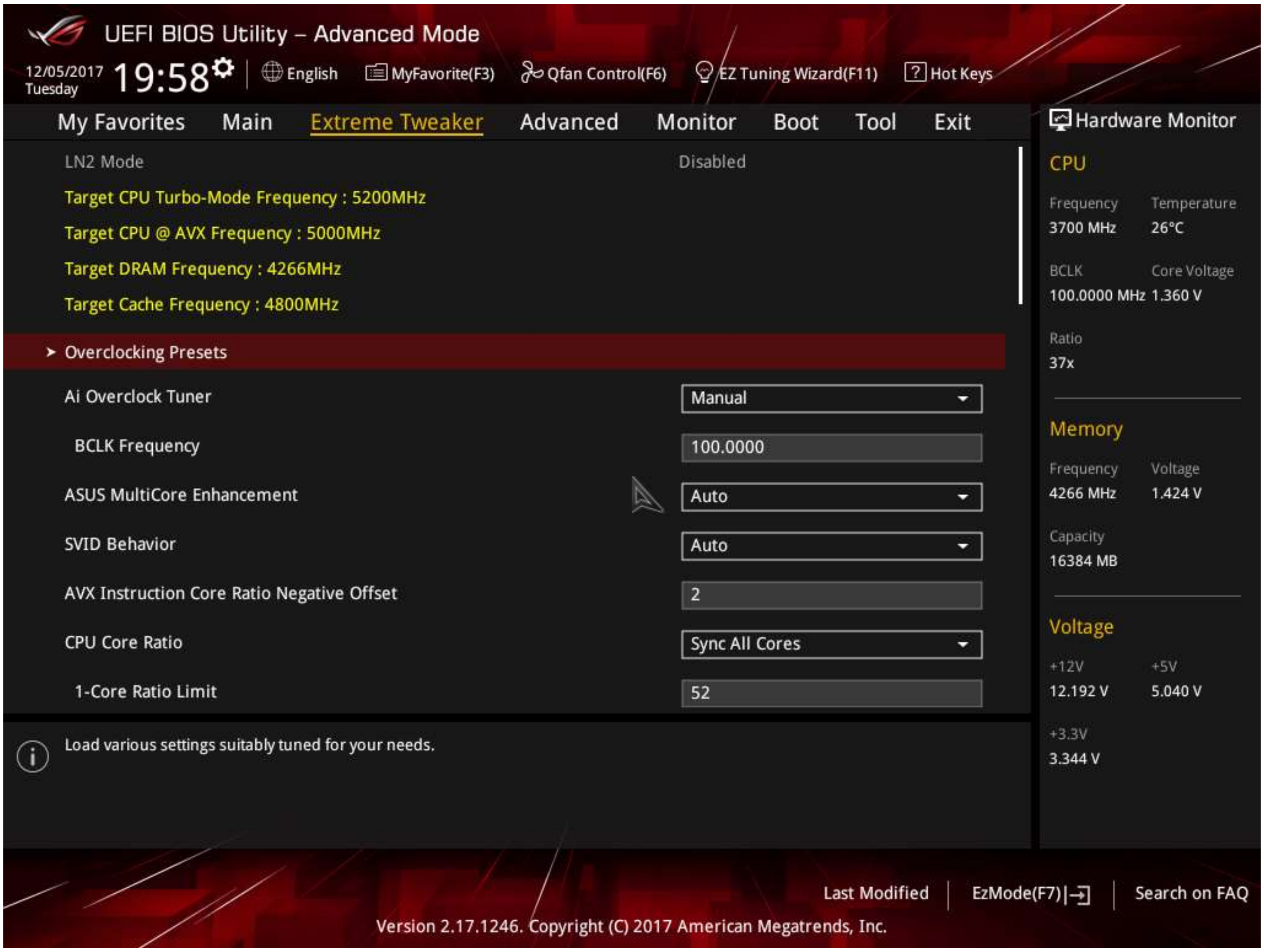
- IA AC Load Line to 0.01
- IA DC Load Line to 0.01
- CPU SVID Behavior to "Best Case Scenario"
- F10 to save and exit.

You now have adaptive voltage control, your system will idle at low voltage (Windows Balanced power plan).

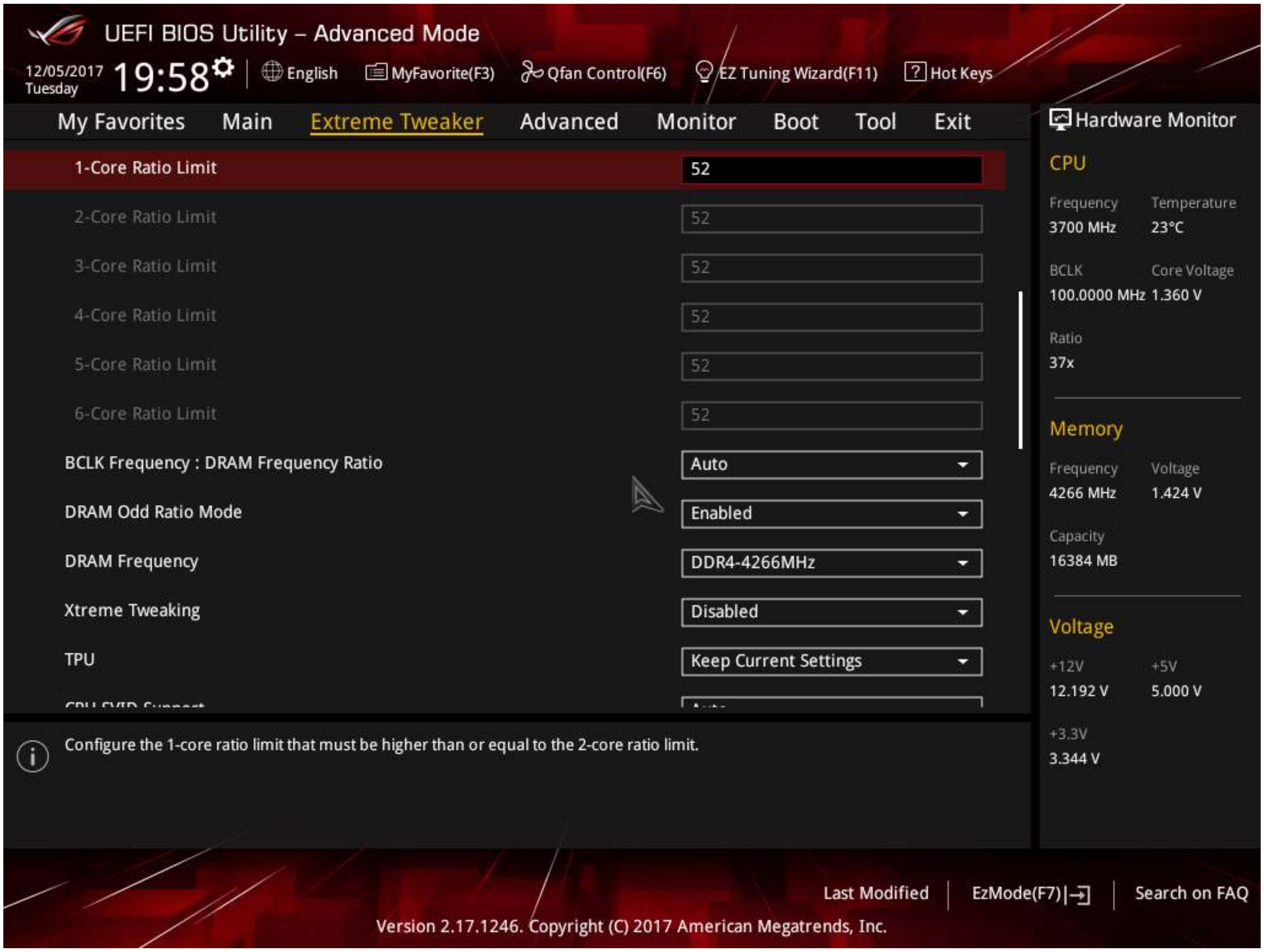
Remember to save your settings to a bios save slot so you do not have to manually re-enter everything in the event you need to do a clrcmos.

Below, I have attached some Bios screenshots of the 24/7 overclock I settled on for this 8700K, Asus Maximus X Apex and G. Skill ram kit. Yes, I am running voltage higher than recommended above – that is a risk I'm okay with for my system. These screenshots are included only as an example and potentially are running the CPU a bit too hard. That said, many of the more obscure settings shown below really do not need to be changed from the default "Auto" setting (for example, power limits).

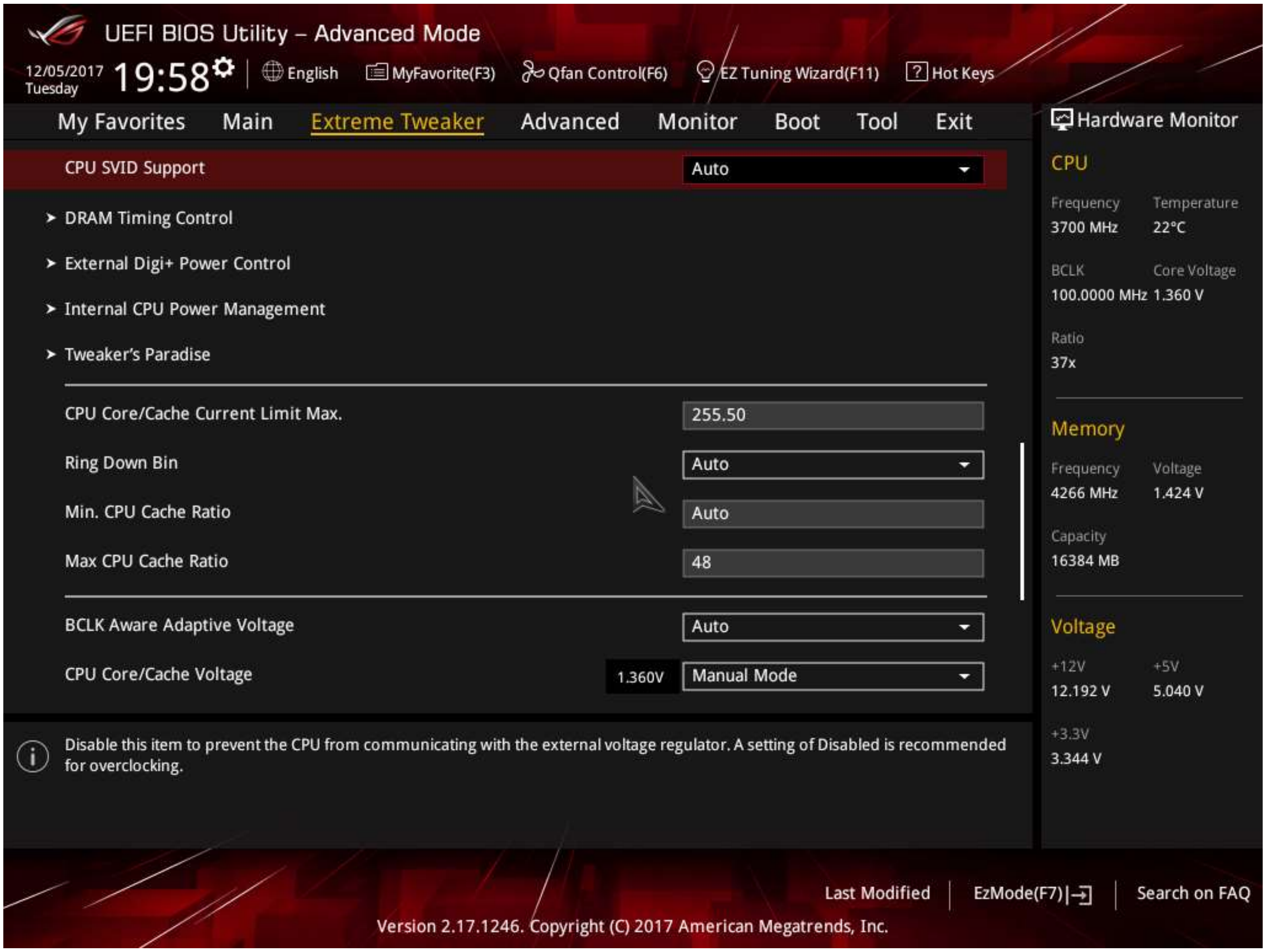
Manual Override Bios Screen Shots



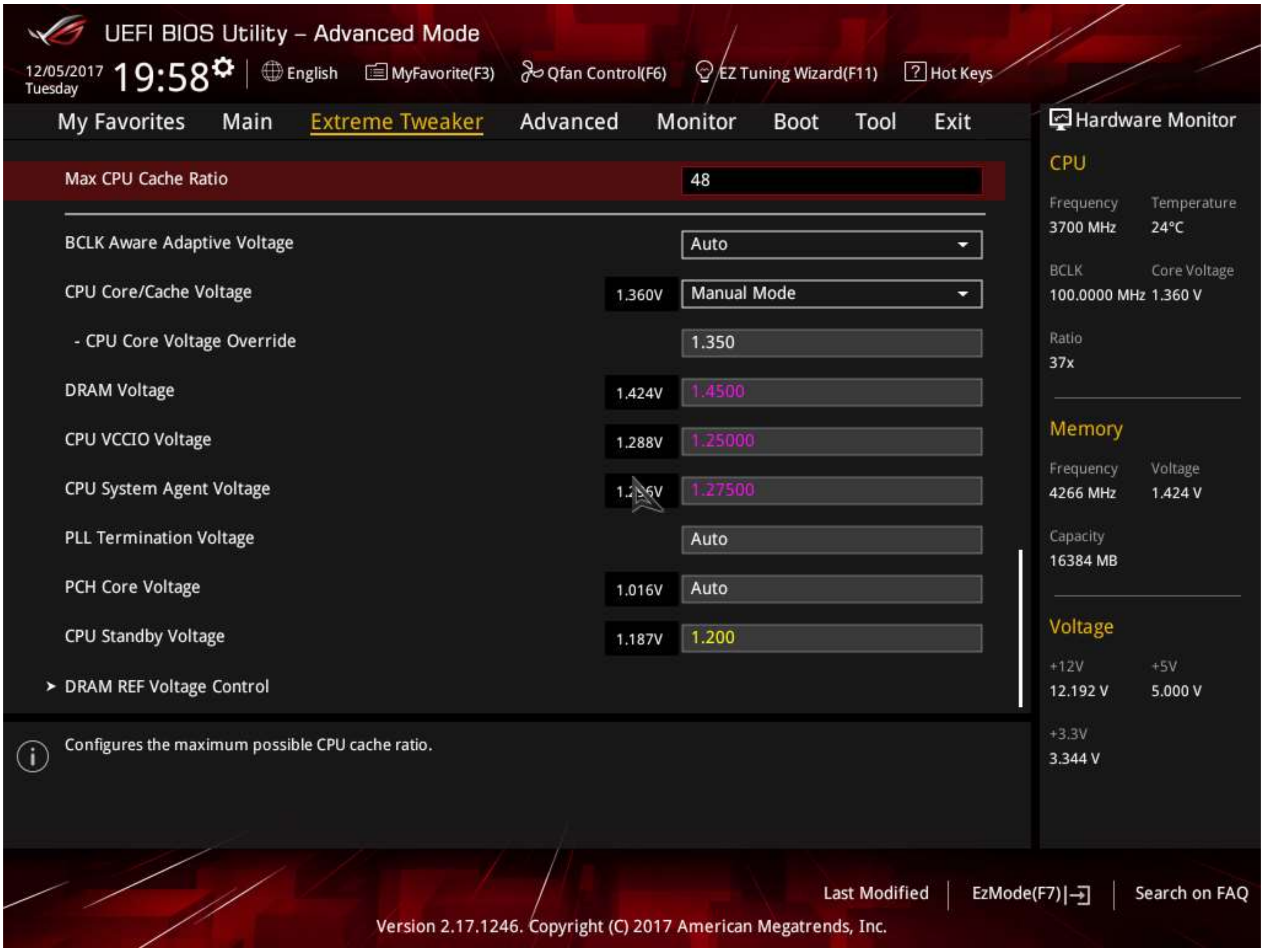
In the above example, this CPU sample benefits from a small AVX offset, but can run 5.2 for everything else, and not get too hot.



The G.Skill 4400c19 ram kit runs 4266c17 at a somewhat reasonable voltage using Raja's 4133 preset for 2x8GB Samsung B-die ram. I then changed the primary timings and voltage as needed for these specific sticks.



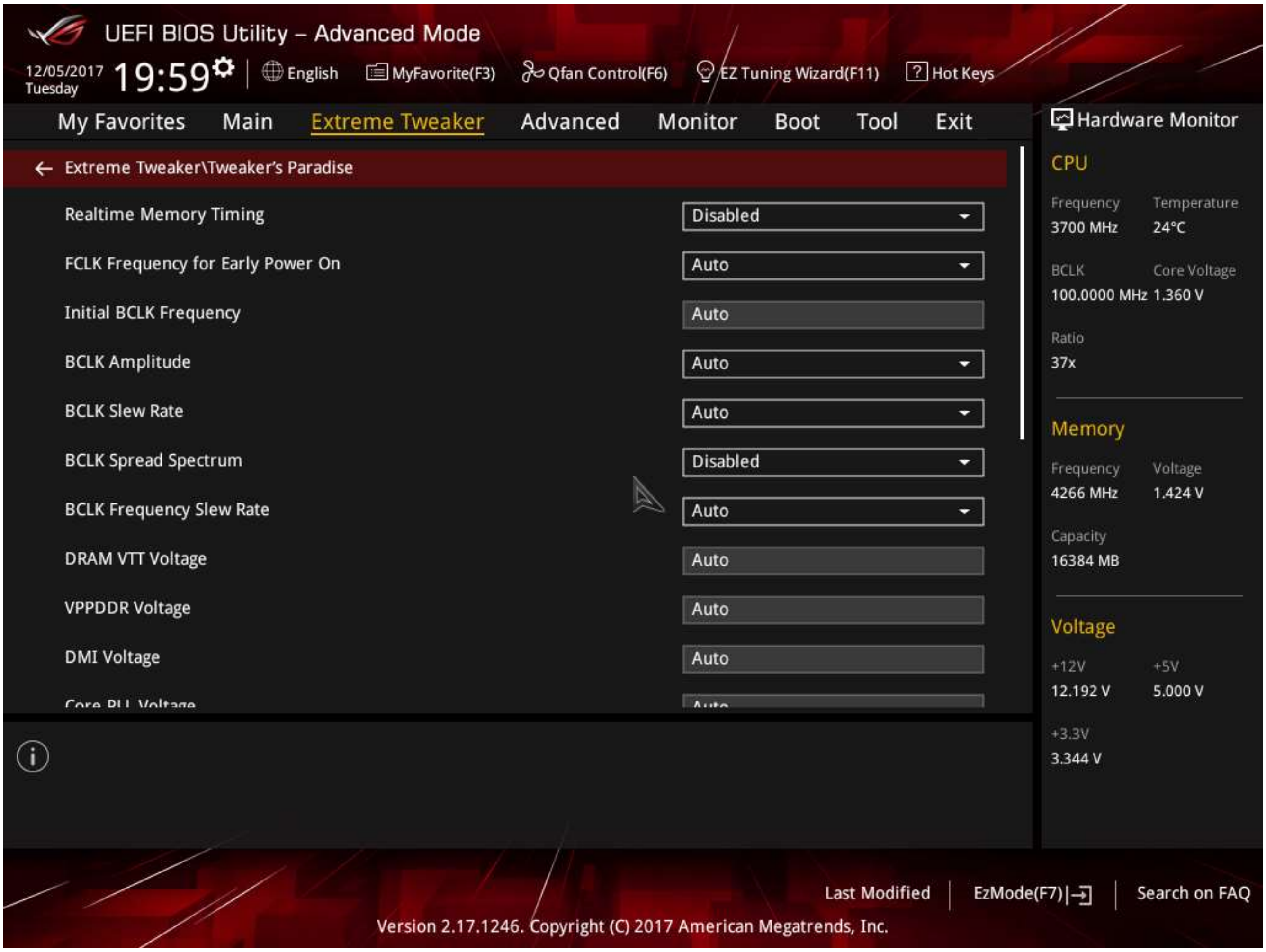
You *should* leave the Current limit on Auto. I have it at the max permitted setting which removes this safety feature. Ring bin down can be left on Auto. See the Notes at the end.



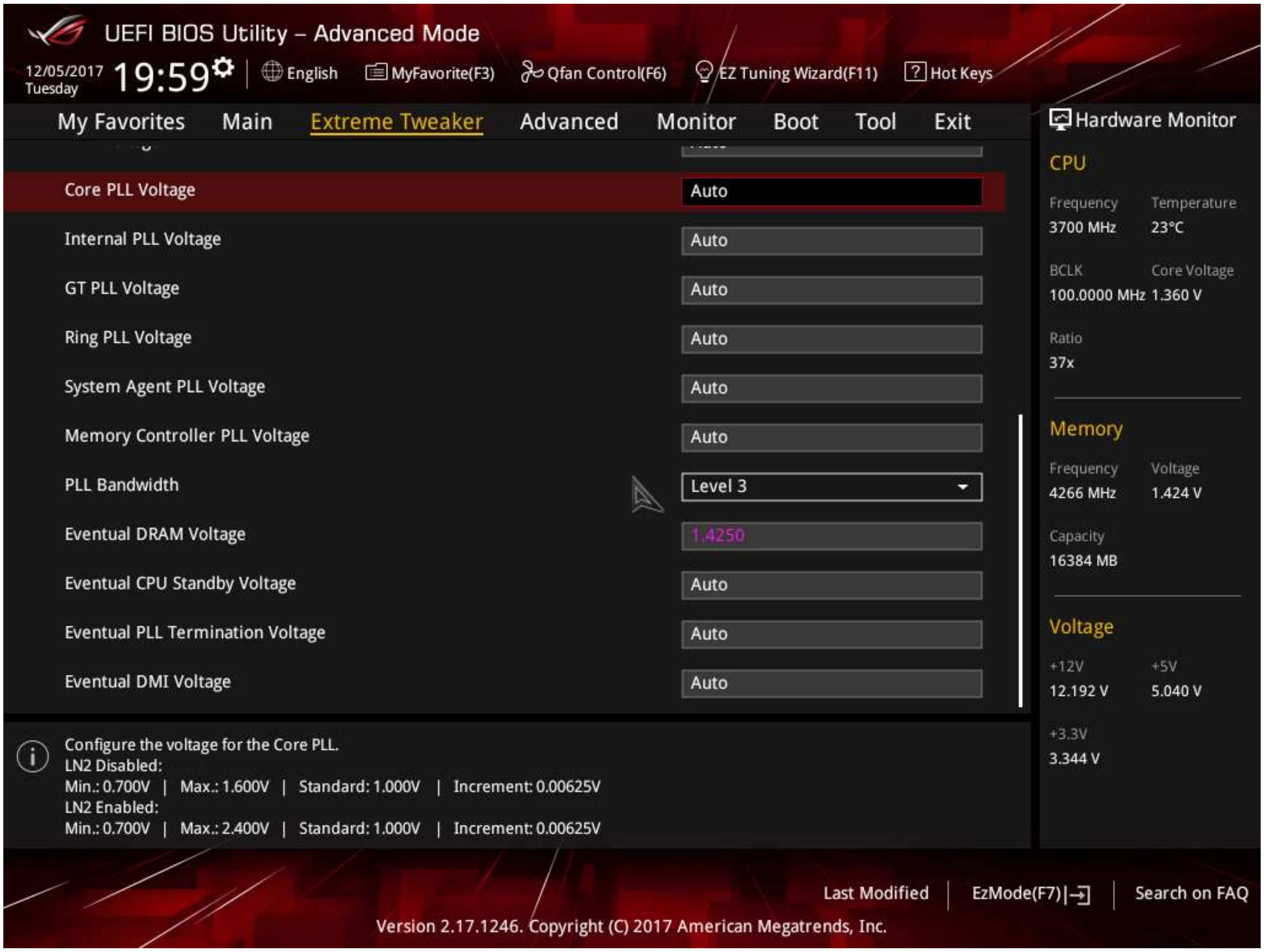
With this CPU Sample, 5.2 GHz needs Core voltage set to 1.35 with LLC 5. This gives a healthy amount of droop under heavy load)to 1.32-ish volts).

Dram voltage, VSA and VCCIO are specific to the memory kit I'm using. Yours will likely be different once you start testing ram stability.

CPU Standby Voltage helps to stabilize high(er) frequencies. This can be left on Auto, however, at certain high multipliers this can run unnecessarily high. This CPU sample is fine with 1.2V standby voltage up to 5.5GHz.



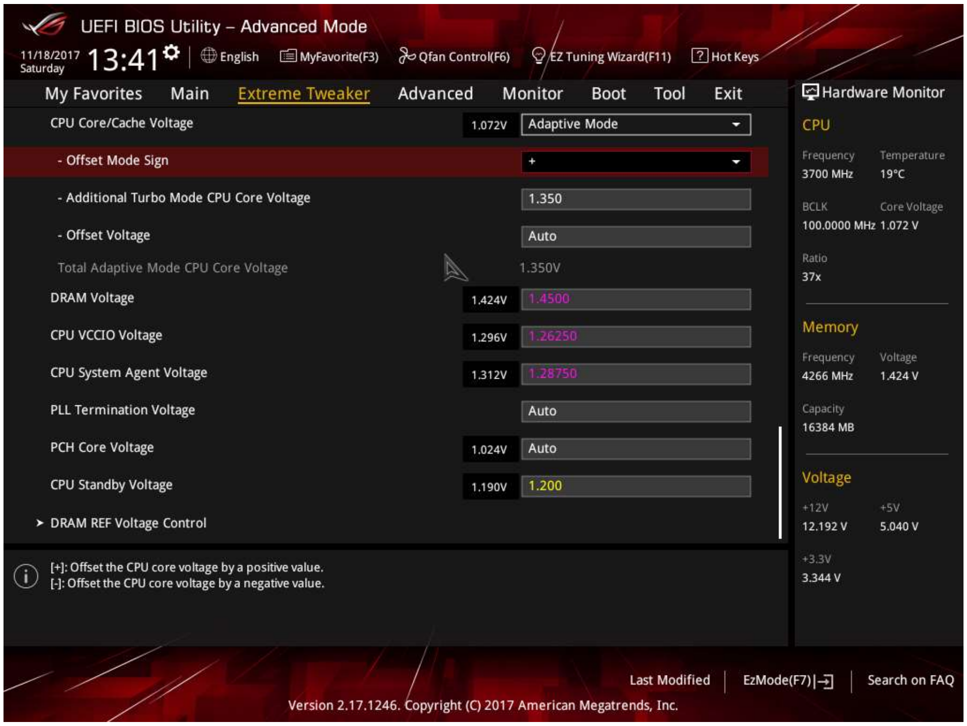
BCLK Spread spectrum Disabled. Everything else is left on Auto



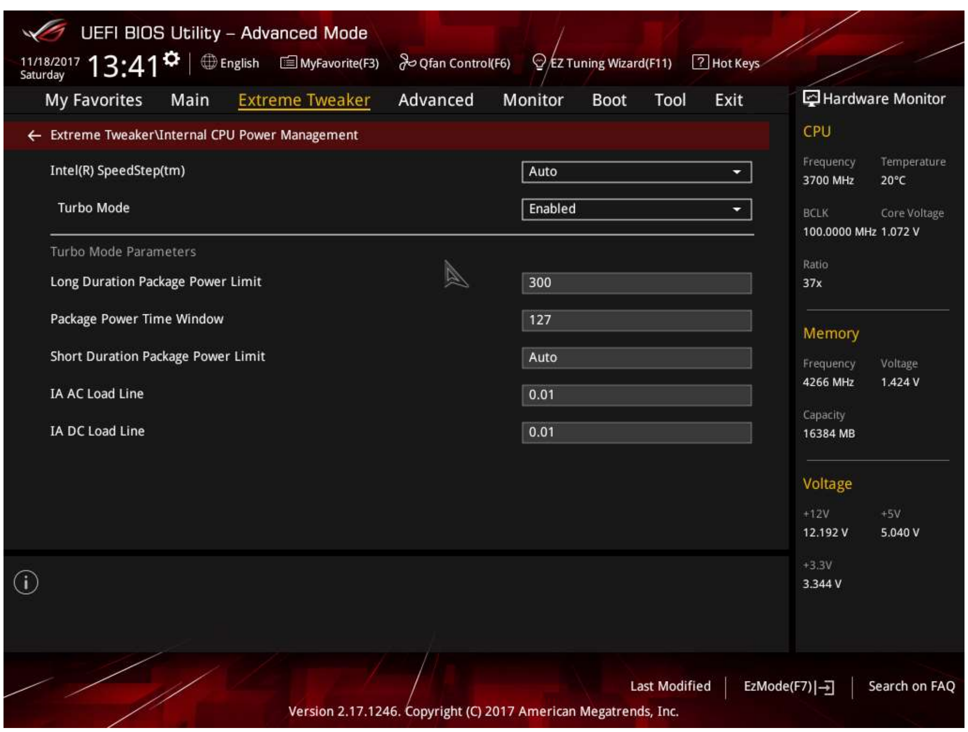
PLL Bandwidth scales with cpu Frequency. This shows up in HWiNFO64 as CPU PLLs OC. Level 3 sets 1.000V on the Apex.

Adaptive Mode Bios Screen Shots

CPU SVID must be set to Auto or Enabled for Adaptive to appear in the drop-down list.



Core/Cache Voltage: select Adaptive from the drop down list
Enter the same voltage into Additional Turbo Mode CPU Core Voltage that you had for Manual override. F10 to save and reboot in Adaptive mode



IA AC and IA DC Load line settings.

Notes:

1. The recommendations in this guide are my own and not authorized by any component or system manufacturer.

2. Once core and ram overclocking is complete, enter bios and increase the Max Cache multiplier one step at a time (from 46) until the system fails to post or fails 1-2 hours of AID64 cache stress test. You can try p95 using a single FFT (1344 say), but I find that the AID64 cache test is pretty good (especially when coupled to Hci Memtest for Ram stability). You can increase Vcore in order to stabilize cache, but the benefits really are nominal once you get in the 4.8 GHz range especially considering the added heat. Remember, Cache frequency can interfere with maximum stable memory frequency.

3. After setting a new cache multiplier, it is advised that you re test ram stability. Programs like Hci Memtest, or RamTest work fine, as does GoogleStressAppTest (GSAT) run under linux using Windows BASH.

4. Ring Bin Down: you can leave this on auto, however if you want the ring to hold a solid frequency when under load and at 4.8 or above, set this to disabled. READ THE WARNING for this setting!!