

Hello! Over the past few weeks, your reports were instrumental in assisting us to root cause why software monitoring tools were reporting unexpectedly high voltages and clockspeeds at the Windows desktop. We now have a comprehensive update to share with you on this topic. We also have some good news for Destiny 2 players!

ROOT CAUSE ANALYSIS

Our analysis indicates that certain pieces of popular software, which are widely considered to be “low CPU load” applications, frequently make indirect requests for the highest performance and power state from the processor. These everyday applications include popular browsers, chat applications, monitoring tools, mouse/keyboard utilities, fan and AIO controllers, driver background services, and more.

Concurrently, 3rd Gen Ryzen™ Processors include a new capability called Collaborative Power and Performance Control (“UEFI CPPC2”). This puts the processor firmware in charge of its own clockspeed selections at all times, and such selections may be done as rapidly as one millisecond (1ms).

Let’s add it up: If a system is running many of these “low-load-but-not-really” applications at the same time, and the CPU is designed to be more responsive than ever, then the CPU may repeatedly interpret their combined activity as a frequent need for boost. The stage is set for some curious behavior.

Taking a look with an oscilloscope, you can observe the frequencies and voltages rapidly bouncing between low and high conditions hundreds of times per second (Figure 1 below)—far faster than any software monitoring tool can observe. The result: software monitoring tools may report that the processor is “stuck” in a high state.

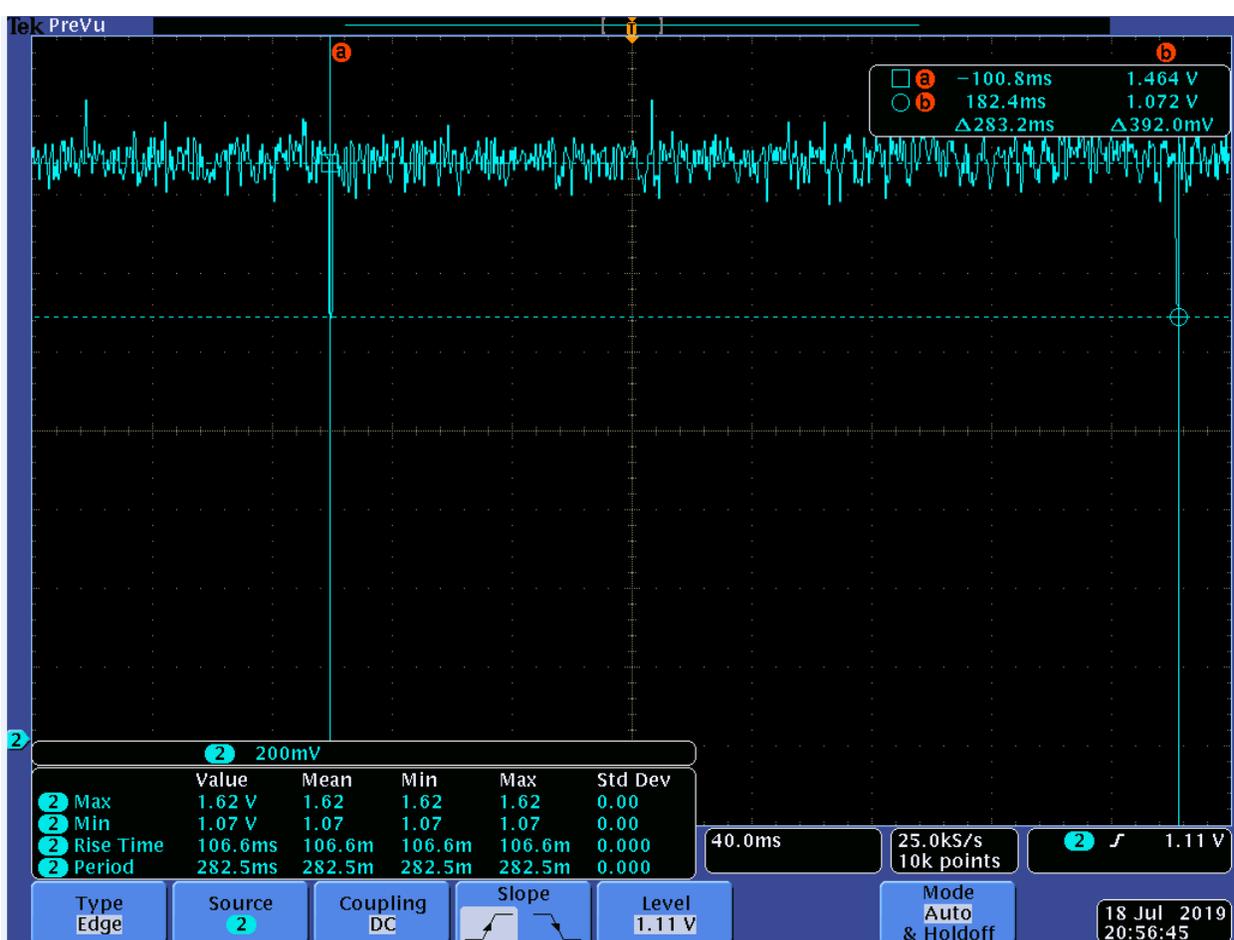


Figure 1: This diagram shows 283ms of time elapsed between orange circles A and B in the chart. You can see the processor (jagged line) voltage rapidly bouncing between 1.072V and 1.464V--dozens of times in just a quarter second. The desktop applications (chat, browser, game launcher) running on this system are collectively making rapid boost and idle requests.

As users add additional background tools and services to the system, this issue can exacerbate. Given that many enthusiasts often keep a monitoring tool, browser, chat app, and peripheral utility open at all times, it becomes relatively easy to encounter the conditions we’re describing.

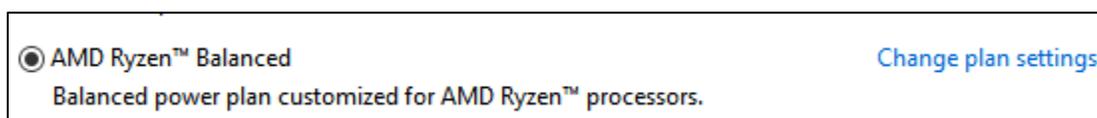
Bottom line: Many tasks—gaming, video, browsing, word processing—deserve high responsiveness from the processor. There are also clear power efficiency benefits to treating workloads with high frequencies ([race-to-idle](#)). But it is also totally fair to say that there can be too much of a good thing.

THE IMMEDIATE SOLUTION

Immediately available for download, a new AMD chipset driver (version **1.07.29.xxx**) is designed to relax the processor's sensitivity level to boost requests while running desktop apps like those described above. It will modify the processor's behavior in two key ways:

- 1) We will be adjusting the sensitivity of CPPC2. If you are running the Windows 10 May 2019 Update, 3rd Gen Ryzen processors will now use traditional 15ms clock selection intervals **when at idle or low load**. This has the effect of filtering many of these short-lived or undesirable boost requests, enabling the processor to be more dormant when the workloads are light.
- 2) We will also be adjusting how the processor behaves in low or idle workloads. If a processor core is not power gated and sleeping, the processor core will sit at 99% of base clock for low or idle workloads. For example: an AMD Ryzen™ 7 3700X base clock is 3600MHz, so you would see "idle" frequencies around 3564MHz \pm 0.08%. This 99% value keeps the active core on a razor's edge so that your non-trivial applications can easily trigger CPU boost. **While boosted, the processor will still control frequency selection in 1ms intervals.**

These changes are implemented in Chipset Driver **1.07.29**, available for download now. The chipset driver installer will automatically install and enable a new AMD Ryzen™ Balanced power plan for all 3rd Gen AMD Ryzen customers. Users of any other Ryzen™ CPU will not receive, and do not need, this plan.



Altogether, this new power plan is designed to make the processor more relaxed when the loads are intermittent or light (Figure 2 below), without taking away from the processor's ability to respond to sustained workloads like games and content creation. It should have the effect of solving the voltage and frequency behaviors you've reported to us over the past few weeks. We truly appreciate your reports and messages, as they were instrumental in diagnosing and resolving this issue.

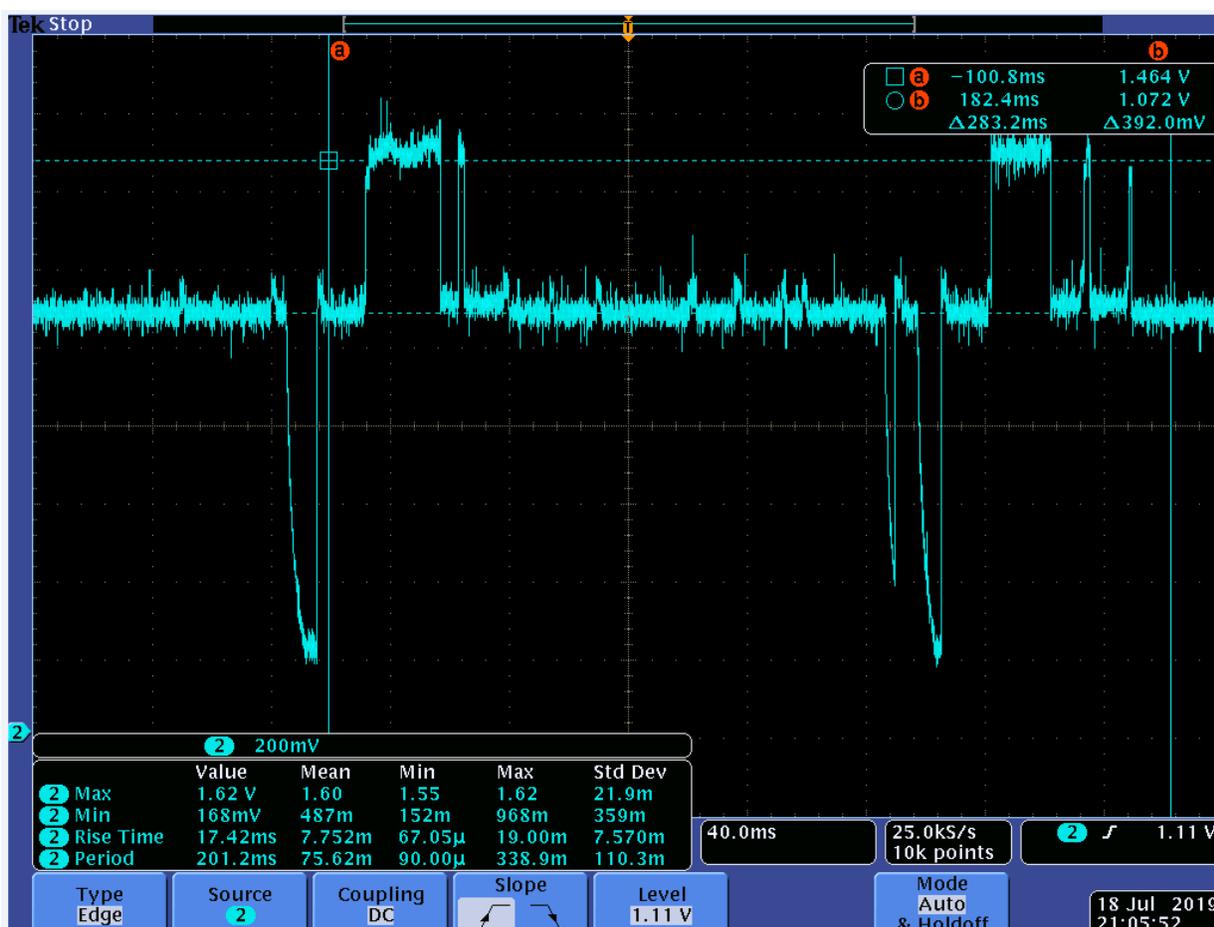


Figure 2: AFTER the new power plan, the same 283ms time window shows a dramatically different behavior for the same application(s). Expected 1.464V peaks now only last for about 25ms, suggesting there was a brief and bursty workload that ended and allowed for idle. You can also see valleys in the chart of 168mV, suggesting the CPU was broadly power gating at these times. And, most importantly, you see general residency around 1.072V suggesting the cores are awake but handling light workloads.

WHAT TO EXPECT FROM YOUR PROCESSOR

Users of 3rd Gen AMD Ryzen™ Processors should expect the following behaviors from their processor after this plan is in place:

1. If a processor core is actively running a low-demand workload, you will see the chip running at approximately 99% of base clock and core voltage up to 1.2V. A properly functioning monitoring tool should always show values clustered around here, *unless...*
2. If a processor core is *truly* running no workload, the processor core will be placed into the “Core C6” (CC6) power-gated sleep state. Presently, AMD Ryzen Master is the only tool that can show this CC6 state (Figure 3 below). This state may be opportunistically engaged hundreds of times per second. Voltages in this condition might be as low as 0.200V, and clockspeeds down to 0MHz/Sleep are also possible.
 - a. Sidenote: It is also possible for all cores to be in CC6. If this happens, the processor can selectively shut down uncore components and enter an even deeper state called Package C6 (PC6).
3. Unless a monitoring tool is capable of probing and reporting CC6 sleep state, the tool may simply report out the last voltage and clockspeed that was observed *before* the processor went to sleep. This may give the illusion that the CPU is “stuck,” which can be interesting if the CPU jumped from high boost to sleep.
 - a. Sidenote: Probing the deeper PC6 state wakes the processor and ruins the power savings. A processor in PC6 will not update your tool(s) until cores are awake.
4. Boost voltages up to ~1.5V should be expected if the processor is truly under some sort of load. We understand that this is quite different from what you may have experienced with other processors, but it is normal behavior for an AMD Ryzen CPU.
5. Frequency boost can and will happen on the desktop. Voltage is required to support boost. OS background tasks, and tasks that *appear* trivial (e.g. websites heavy with Javascript), can be more demanding than you think. Even an idle desktop may have substantial background tasks.
6. If you measure power at the wall (e.g. [Kill-A-Watt device](#)), there should be a small difference between the Windows Balanced and updated AMD Ryzen Balanced power plans. When running the new AMD Ryzen Balanced plan you should expect power usage to be *around* ±5W versus the Windows Balanced plan. Meanwhile, the unique changes to our plan are better suited to exploiting the performance capabilities of 3rd Gen Ryzen™.
7. We know some enthusiasts have been using the Balanced power plan that ships with Windows 10 as a temporary workaround for the frequency/voltage behaviors described in this blog. This workaround is no longer required.
8. As temperature is a function of voltage and frequency, desktop processor temperatures should incrementally decline with the new plan. This is because the processor will spend less time reaching for an unneeded boosted voltage and frequency target. But it goes without saying: *any* processor *will* see transient temperature spikes if boost was applied to handle some sort of workload (a browser with tons of tabs, for example).
9. And on a myth-busting note: users should not try to set a maximum processor state of 99% in a custom power plan. This disables boost by locking the processor to the base clock.



Figure 3: This AMD Ryzen 9 3900X is sitting at an idle desktop with an RC build of the new chipset driver. It has six sleeping cores, an idle temperature of ~38°C. Active cores running lightweight background tasks are running just a few hundred MHz. And, just as we predicted, Ryzen Master is uniquely demonstrating that cores in CC6 can disconnect from the rail to further reduce core voltage down to 0.77V! Even with all cores awake, even [lower core voltages of 0.48V were observed](#), too.

SEE FOR YOURSELF

A new build of AMD Ryzen Master (version 2.0.1.1233) is also available for download today, and it takes all of the above changes into account. If you're new to this utility: Ryzen™ Master is our first-party monitoring and tuning application that can help you observe the behavior of your PC and, if desired, tweak the performance as well.

In addition, the tool has been refined with two critical changes concerning voltage and temperature monitoring.

For temperatures:

- **OLD BEHAVIOR:** Report the highest temp (“instantaneous temperature”) of any sensor in the whole CPU, no matter how isolated or brief. This approach overstated the prevalence and significance of fleeting peaks, which artificially inflated temperature reports by up to 30°C above the true silicon conditions.
- **NEW BEHAVIOR:** Report a short-duration rolling average of all temp sensors in the chip. This model will give you a holistic view of what the processor is doing across cores, cache, bus interfaces, etc. It's the closest any software monitoring tool can come to portraying the true thermal conditions of the chip, and it's the same model our own Precision Boost 2 algorithm uses to make temperature-related boost decisions.

For voltage:

- **OLD BEHAVIOR:** Report the highest transient voltage in the whole CPU, no matter how isolated or brief. This, too, overstated the prevalence and significance of fleeting peaks, which artificially inflated voltage reports by as much as 800mV.
- **NEW BEHAVIOR:** Report the average voltage requested of the regulators, which presents a “whole chip” view that factors in sleeping cores, idle cores, and active cores. This is the closest any software monitoring tool can come to portraying the true electrical conditions of the chip, and it's the same model our own Precision Boost 2 algorithm uses to make electrical-related boost decisions.

Altogether, this version of AMD Ryzen Master will give you an accurate view of what your 3rd Gen AMD Ryzen Processor is doing, using the same sources and methods utilized by our on-chip firmware and internal monitoring tools.

ADDITIONALLY: We also intend to release new developer documentation that enables third-party tools to take the same measurements, so you can continue to rely on your favorite third-party apps after they're updated. We will be contacting utility vendors directly with more details when the documentation is ready.

GOOD NEWS FOR DESTINY™ 2 PLAYERS

Destiny 2 Players with 3rd Gen AMD Ryzen™ systems can also get back into the game! Customers who install chipset driver version **1.07.29** (or later) can once again take the fight to the Red Legion. This driver contains a beta solution for Destiny 2, which resolves an issue where users were unable to launch the game.

A more comprehensive fix will be deployed in BIOS updates for Socket AM4 motherboards in order to address other software affected by the same underlying issue. Motherboard BIOSes based on AGESA 1003ABB will contain this update.

GOING FORWARD

Once again: we genuinely appreciate the time, reports, and collaboration from the enthusiast community on the topics in this blog. You were a critical piece of our effort to understand and develop solutions. But we're not finished! Successive AGESA releases are already in development and, as we near release, we'll continue to use this format to keep you apprised of features and timelines.

And, on a final note, new BIOSes based on the impending AGESA 1003ABB will also resolve the “Event 17, WHEA-Logger” warnings in the Windows Event Log. These warnings indicate that the system successfully corrected a trivial error in a data packet sent between two PCI Express® devices. PCIe devices can transmit thousands of packets per second, and it is typical for a few of them to require a correction or retry. As such, it is customary to suppress these unhelpful/routine messages in the log to limit the error reporting scope to errors that require attention and action. AGESA 1003ABB will make that change.

If you have questions, comments, or concerns about any of the changes described in this blog, please do not hesitate to open an [online service request at AMD.com](#).