



How the latest flash storage technologies can help us adapt to a warming planet

The world is seeing dramatically increasing SSD performance with the recent transition from SATA to PCIe NVMe, with SSD power consumption scaling alongside the increase in performance. In the meantime, the SSD form factor evolution continues toward smaller form factors such as M.2, E1.S and CFexpress – making incredibly powerful compact flash storage products possible.

However, this leap in SSD performance and power consumption alongside ever-smaller form factors gives rise to a different challenge: **thermal dissipation**.

Why do we need thermal control?

Without a corresponding increase in physical size, modern high-performance PCIe SSDs need to address the risk of overheating and thermal runaway in new ways. Otherwise, applications face potentially catastrophic effects on data integrity and even the integrity of hardware components. That is why modern SSDs need thermal control.

How does thermal control work?

Common implementations of thermal control throughout the flash storage industry involves a combination of thermal sensors and Self-Monitoring, Analysis and Reporting Technology (S.M.A.R.T.) to monitor the SSD's operating temperature.



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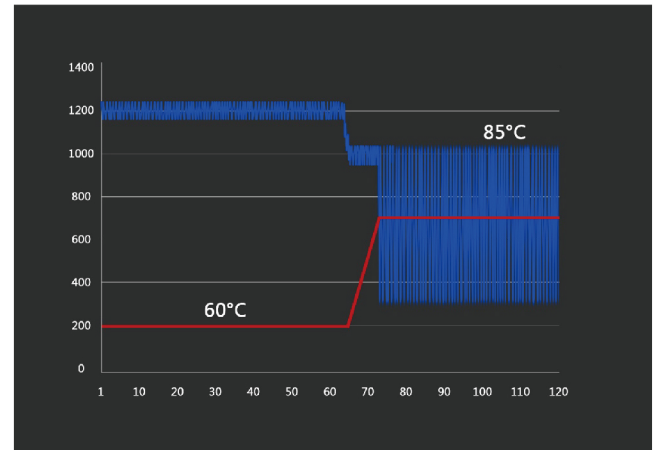


Does thermal control have downsides?

There is no way around it: in order to stabilize increasing temperatures in an SSD, it is necessary to decrease the SSD's performance.

When the SSD's firmware determines that these datapoints suggest that overheating is under way, it dramatically reduces SSD performance, thus avoiding temperatures from getting out of control. Unfortunately, dramatic drops in performance are often noticeable for the user and sometimes even detrimental to the application. For example, an SSD used for recording high-bitrate video will almost certainly start dropping frames once the firmware throttles performance to combat rising temperatures.

Of course, if the SSD in the example above did not throttle performance, the damage would be far worse than a choppy video recording. However, the dramatic, often one or two-step thermal throttling seen in most SSDs is unnecessarily disruptive and unpredictable.



Traditional SSD with thermal throttling. The performance drops dramatically, then jumps back again when the temperature has stabilized before quickly dropping back again... and again... and again...

How does climate change play into the scenario?

So, can performance and power be balanced?

Higher performance goes hand in hand with high power draw. In an age where global warming has become a reality, finding low-power storage solutions that manages to provide the same high sustained performance is both urgent and important.

The issue of disruptive thermal control in modern PCIe NVMe SSDs can be solved by leveraging both the hardware and firmware of its flash storage solutions. **The goal: intelligent thermal control that is not disruptive to users or their applications. The result: adaptive thermal control.**

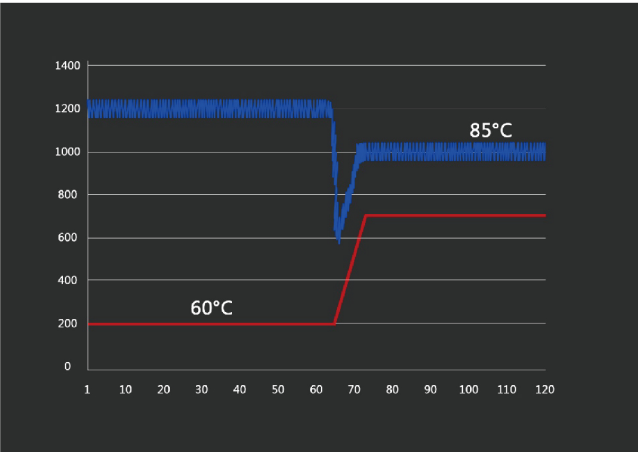
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How do we make thermal control adaptive?

Through a combination of adaptive hardware power reduction and precise SSD performance control, Adaptive Thermal Control (ATC) finds the perfect balance between the highest possible performance and a safe operating temperature.

With ATC, SSD maintains steady high performance where it can operate indefinitely without any risk of overheating or thermal runaway. In contrast, with thermal throttling in a regular SSD, the performance suddenly drops once a certain temperature has been reached, then climbs back up again only to drop once the temperature inevitable reaches the throttling threshold again.

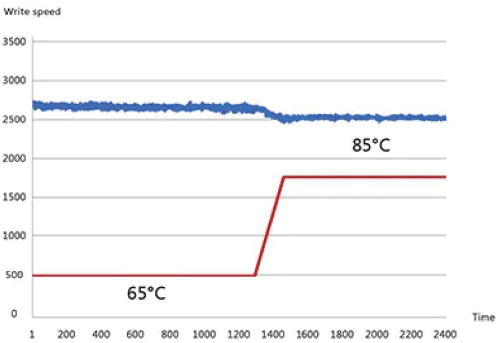
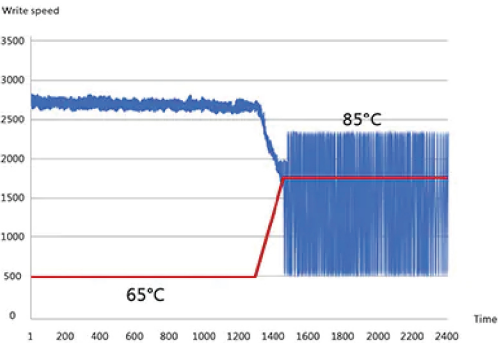


SSD with Adaptive Thermal Control. After reducing performance when the temperature reaches its threshold, the SSD gradually increases performance until it reaches a point where it can maintain stable performance at an acceptable temperature.

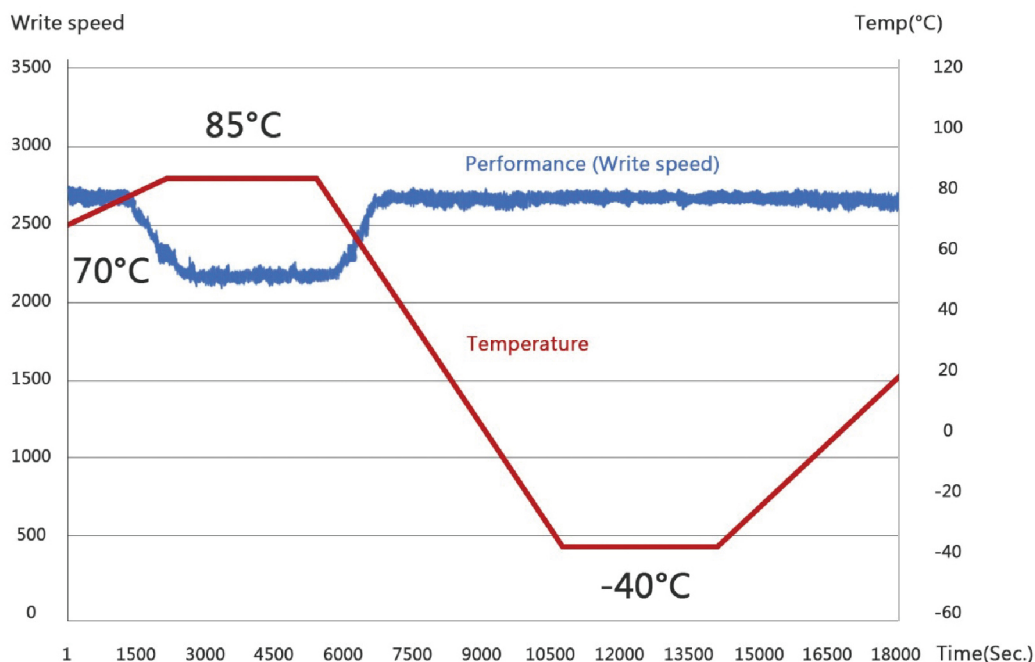
At the core of this innovation is firmware algorithm design. Constantly aware of the SSD’s operating environment, the firmware algorithm continuously monitors and fine-tunes drive performance during operation. This uniquely intelligent method of operation ensures the highest possible level of sustained performance in each drive’s operating environment.

Importantly, Adaptive Thermal Control, as the name implies, is fully adaptive. Should temperatures or the application’s read/write behavior change, Adaptive Thermal Control keeps up and adjusts the drive’s performance accordingly. That result is that the application will always enjoy the highest possible sustained performance, automatically and intelligently without any input from the user or host device.

Adaptive Thermal Control™ Performance comparison



Adaptive Thermal Control: step by step



When the Adaptive Thermal Control algorithm detects that the temperature has reached its threshold, the SSD automatically initiates its thermal control operation.

The thermal control algorithm reduces performance and the overall system power consumption, allowing the temperature to drop below the thermal threshold.

The thermal control algorithm gradually increases the SSD's performance to find the highest performance where the temperature can be maintained below the threshold.

If the operating environment changes, e.g., the ambient temperature rises, ATC will intelligently re-tune the optimal performance level for its new operating environment.

About Exascend, Inc.

Exascend is a service-oriented provider of innovative standard and custom storage solutions specialized in low-power, high-performance, and high-reliability products. Since its founding, the company has been awarded more than 45 U.S. and worldwide patents on storage-related technologies. With full product lines of enterprise and industrial PCIe NVMe and SATA-III SSDs, CFast, CFexpress cards and DRAM, Exascend's capabilities span across hardware, firmware, software, product engineering, manufacturing and customization services. Exascend takes pride in enabling its global customers to push the boundary of possibilities and to differentiate with quality, reliability and flexibility – Engineering Imagination to Innovation. For more information, visit: <https://exascend.com/>.



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