HEX 2.0 Performance: i7-6700K vs i7-5960X

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Summary

- HEX 2.0 performance, while leading over similar sized coolers regardless of processor, exhibits differing rank in performance against larger air and liquid coolers depending on the processor platform.
- The HEX 2.0 outperforms all but the much larger liquid coolers at lower and higher power CPU stress on the Intel i7-6700K-type processor (LGA1151 socket)
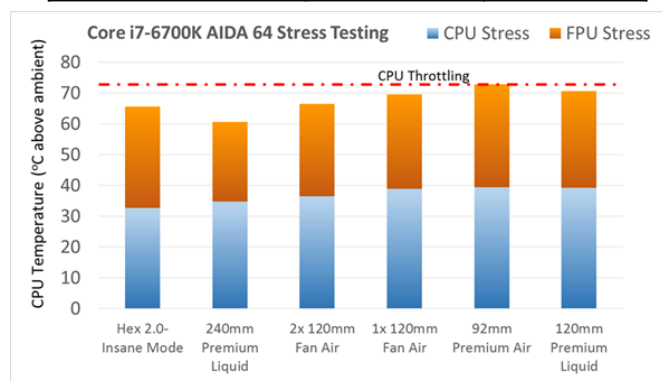
Introduction

The HEX 2.0 was designed to offer the best performance in a small cooler that could be used by enthusiasts in the smallest cases (mini-ITX) without giving up the ability to overclock to the fastest processor speeds. To do this, the HEX 2.0 had to provide the same cooling performance as larger air and liquid coolers that could not be installed in such small cases, with characteristics valid for all case sizes. The most common high-performance processors used in these types of builds are the Intel i7-4790K and the next generation of this processor, the Intel i7-6700K. These processors have high performance and speed, are unlocked for overclocking, and have prices that make them a common choice for builders. These CPUs use the LGA115x socket (specifically the LGA1151 for the i7-6700) which is a much more common motherboard option for mini-ITX cases. Another common processor used for testing and performance evaluation is the i7-5960X, the extreme edition of Intel's server-based Xeon processors. This processor has some important differences to the i7-4790K/6700K processors – it is much larger with superior heat spreading and packaging, uses the LGA2011-3 socket, has slower speeds, higher core count (8 vs 4) and higher prices. Although the motherboard options for the i7-5960X are limited for mini-ITX builds, it was important to understand potential differences in performance for the HEX 2.0 for these different processors.

Testing

Cooler performance comparisons were made on two processors, an i7-6700K overclocked to 4.6GHz and an i7-5960X overclocked to 3.7GHz. AIDA64 was used to provide two stress levels called CPU and FPU stress. Figure 1 and 2 describe the TDP associated with each stress level and processor. Testing was conducted in the same cases for each processor and ambient temperature was controlled within 1-2oC. Also, the tests were conducted with the CPU coolers in maximum performance modes or with 100% fan speeds to give each cooling solution the best possible display of cooling power. Figure 1 shows the data for the i7-6700K CPU temperatures above ambient for varying CPU cooling solutions. Under the maximum stress (FPU), the CPU runs near the throttling limit (reducing processor speed). The HEX 2.0 provides

Figure 1: Processor temperature above ambient for differing stress (CPU and FPU via AIDA64) for Intel i7-6700K with varying CPU cooler solutions

Processor and Stress Levels for Comparison Testing	CPU Stress	FPU Stress
i7-6700K (4.6GHz)	65-70 Watts	125-130 Watts
i7-5960X (3.7GHz)	75-80 Watts	135-140 Watts

similar cooling to the much larger 2x120mm and 240mm based solutions. Only the 240mm AiO cooler was able to outperform the HEX 2.0.

Similar sized coolers using 92mm or even larger single 120mm solutions were consistently lower in performance and actually cased throttling of the processor in the case of similar-sized 92mm air cooler.   For the i7-6700K, the HEX 2.0 design provides the cooling performance of a much larger cooler and enables overclocking which other similarly sized coolers cannot support. Although the ability to maintain processor speed and limit throttling is the first job of a CPU cooler, understanding the CPU temperature for this socket versus another, like the i7-5960X is important. Figure 2 shows the same CPU temperature above ambient for this processor under the two different stress levels from AIDA64 shown again for reference.   As the data shows, the HEX 2.0 compares very well to the other cooling solutions, but some important features are different on the i7-5960X. First, there is no throttling of the processor with any of the coolers. Second, the temperatures above ambient are much lower although the actual TDP from AIDA64 are higher in both CPU and FPU stress versus the i7-6700K. This is consistent with the better packaging and lower speed for this processor and is a benefit of the server-class construction of the i7-5690X.

Figure 2: Processor temperature above ambient for differing stress (CPU and FPU via AIDA64) for Intel i7-5960X with varying CPU cooler solutions

Processor and Stress Levels for Comparison Testing	CPU Stress	FPU Stress
i7-6700K (4.6GHz)	65-70 Watts	125-130 Watts
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Comparing trends from Figure 1 and Figure 2 shows the performance ranking holds for most of the coolers except for the HEX 2.0, which shows lower performance in comparison to the same coolers it bettered with the i7-6700K system. This curious trend may give us some insight into the differences an active heat pumping system, like the HEX 2.0, might have versus the typical CPU cooler. However, the practical result of this testing is that the HEX 2.0 gives the most benefit over other CPU coolers on the i7-6700K type of processors (or i7-4790K), which are much more common and affordable to the majority of users and use less power overall for faster processor speeds.
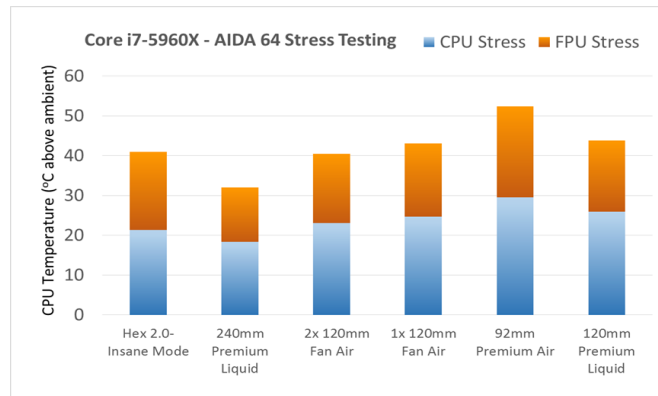
Processor Performance

The i7-6700K is part of a class of processors which make up the majority of builds for enthusiasts (i5-6600K, i7-4790K, i5-4690K) which are affordable and have high processing speeds with overclocking potential. Research shows (http://cpu.userbenchmark.com/) that these processors make up over 10% of the market share while the i7-5960X and its class of processors (i7-5930K, i7-5820K) are near 1-2% of the market. This is why the HEX 2.0 design was focused on performance on the more plentiful i7-6700K family of processors. However, judging performance is dependent on user needs and specific applications, but the following links have been included to give some insight into differences in these processors.

http://cpuboss.com/cpus/Intel-Core-i7-6700K-vs-Intel-Core-i7-5960X

http://processors.specout.com/compare/1679-1873/Intel-i7-5960X-vs-Intel-i7-6700K

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Conclusion

The HEX 2.0 provides more CPU cooling performance than any other similarly-sized cooler tested so far, including AiO liquid coolers with a single 120mm fan – regardless of CPU and socket. The HEX 2.0 has also shown superior performance to larger coolers with 120mm+ fans and larger AiO coolers on processors like the i7-6700K or i7-4790K. This performance advantage changes when tested on the i7-5960X processor most likely due to the larger size of the processor and packaging differences for these Xeon-like, server-class processors. Although more modeling and testing is required, the larger size and better heat spreading of the i7-5960X processor seems to engage with the full surface of the typical coolers and allows them to perform better on this larger processor than the smaller i7-6700K. The HEX 2.0 deals well with the smaller heat source due to the active heat pumping of the thermoelectric element and the multi-layers of heat pipes stacked above the central heat source. Look for a more in-depth technical brief on this comparison in the coming weeks as more information and test data are gathered. Keep checking on phononic.com/hex for more information and updates to firmware and software for your HEX 2.0.