

## Summary

- The Hex 2.0 can function as a traditional fan air-cooler or as a thermoelectric-enhanced cooling beast due to its unique Active-Passive design
- The benefits of the Active-Passive design are: low power consumption at CPU idle, superior performance under load, small form factor and no risk of condensation from the active cooling

## Introduction

When a new product comes into the market, many ask “What makes this different?” For the Phononic HEX 2.0 CPU cooler, it is the integration of the best methods and designs into one high performance package. There is a state-of-the-art, custom designed, high-performance thermoelectric device to provide *refrigeration* for your CPU combined with on-board electronic controls to control that heat pump. Furthermore, all this is integrated in a heat exchanger design to maximize efficiency and cooling performance that Phononic calls *Active-Passive*. The active-passive design provides two separate paths for heat to be rejected to the ambient – one that directly links the CPU to the ambient and a second one that is pumped by the thermoelectric cooler. This allows the cooler to perform as a good CPU cooler, even when the thermoelectric device is not powered, but transforms into a superior CPU cooler when the thermoelectric heat pump is activated.

## Design Description

The goal for the HEX 2.0 CPU cooler was to provide similar cooling performance to all-in-one (AIO) liquid coolers or the very largest fan-heat sinks in a package that could fit into the smallest PC form factors (like mini-ITX). The active-passive design is what makes this possible. By splitting the CPU heat into two paths, as shown in Figure 1, the thermoelectric device can be sized at an optimal point where it can provide the most benefit for lowering CPU temperature without having to be large enough to pump the entire CPU thermal load. We also designed electronic controls to turn off the thermoelectric heat pump at times of low CPU load, making for an energy efficient cooler that provides adequate cooling with zero power draw at low CPU loads. However, when the CPU is stressed and the CPU heat load increases, the electronic controls energize the thermoelectric heat pump, lowering the temperature of the passive base plate and the CPU itself. The active-passive design has one further benefit – when used in conjunction with the electronic controls, this design virtually eliminates the risk of condensation for the HEX 2.0. Further details on the electronic controls and the removal of the risk of condensation with the HEX 2.0 can be found in companion articles on the Phononic website.

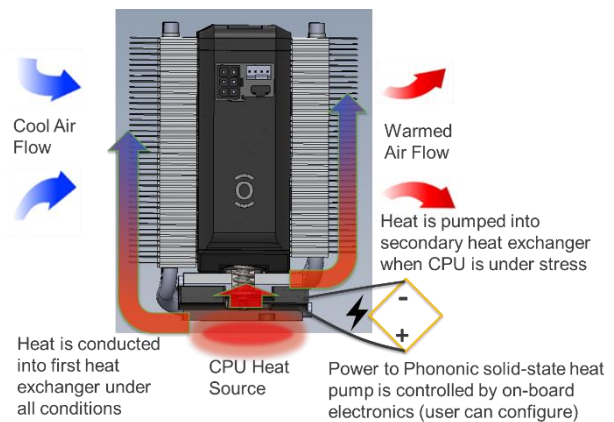


Figure 1: Phononic HEX 2.0 with Active-Passive design that splits the CPU heat reject through two

## Conclusion

Phononic believes that the HEX 2.0 provides the best CPU cooling in this small form factor that can be found in the market. Further products based on this active-passive design are planned and this basic architecture can be employed for maximizing the cooling performance while minimizing size and power consumption for other thermoelectric-based systems.