EXTENDING MOORE'S LAW THROUGH INNOVATIVE ACTIVE COOLING

Moderator: Chris Caylor
Chris is the Technical Director of the Electronics Cooling Business Unit at Phononic. He earned his PhD in Chemistry from the University of California at Berkeley. He is an engineering, research and product leader with over 10+ years in managing engineering programs and teams.

Panel Participants:

Abhishek Yadav
Abhishek is the Sr. Device and Applications Engineer at Phononic Devices Inc. He graduated with a PhD from University of Michigan in Mechanical Engineering. His main interests lie in the development of novel cooling technologies based on solid state heat pumping.

Jesse Edwards
Jesse has over 20 years of experience in entrepreneurism and new product development, with more than 10 years dedicated to the development and manufacturing of alternative and traditional refrigeration and cooling technologies, including solid-state, single stage/cascade vapor compression, Stirling, and cryogenic liquid methods.

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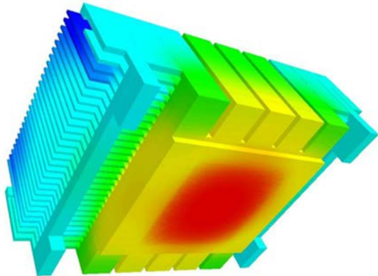
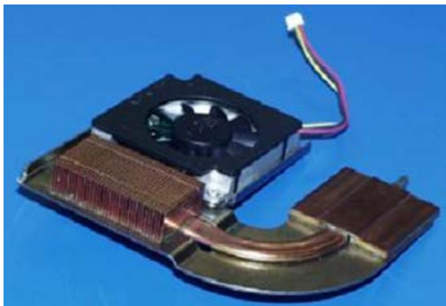
Introduction

This discussion will focus on the pros and cons of different approaches to electronics cooling and the impact on system performance from component temperature control, form factors, power consumption, and cost trade-offs.

Gain insight into the most recent advances in electronics cooling, including the ability to use active heat pumps based on thermoelectric devices, to provide superior cooling performance while minimizing the aggregate capex and opex costs.

Temperature Control and Thermal Management





Direct Conduction

- Simplest
- Effective over short distances
- Inefficient with large loads

Pumped Loop

- Extended distance capability
- Increased effective heat conductance
- Complicated

Convection

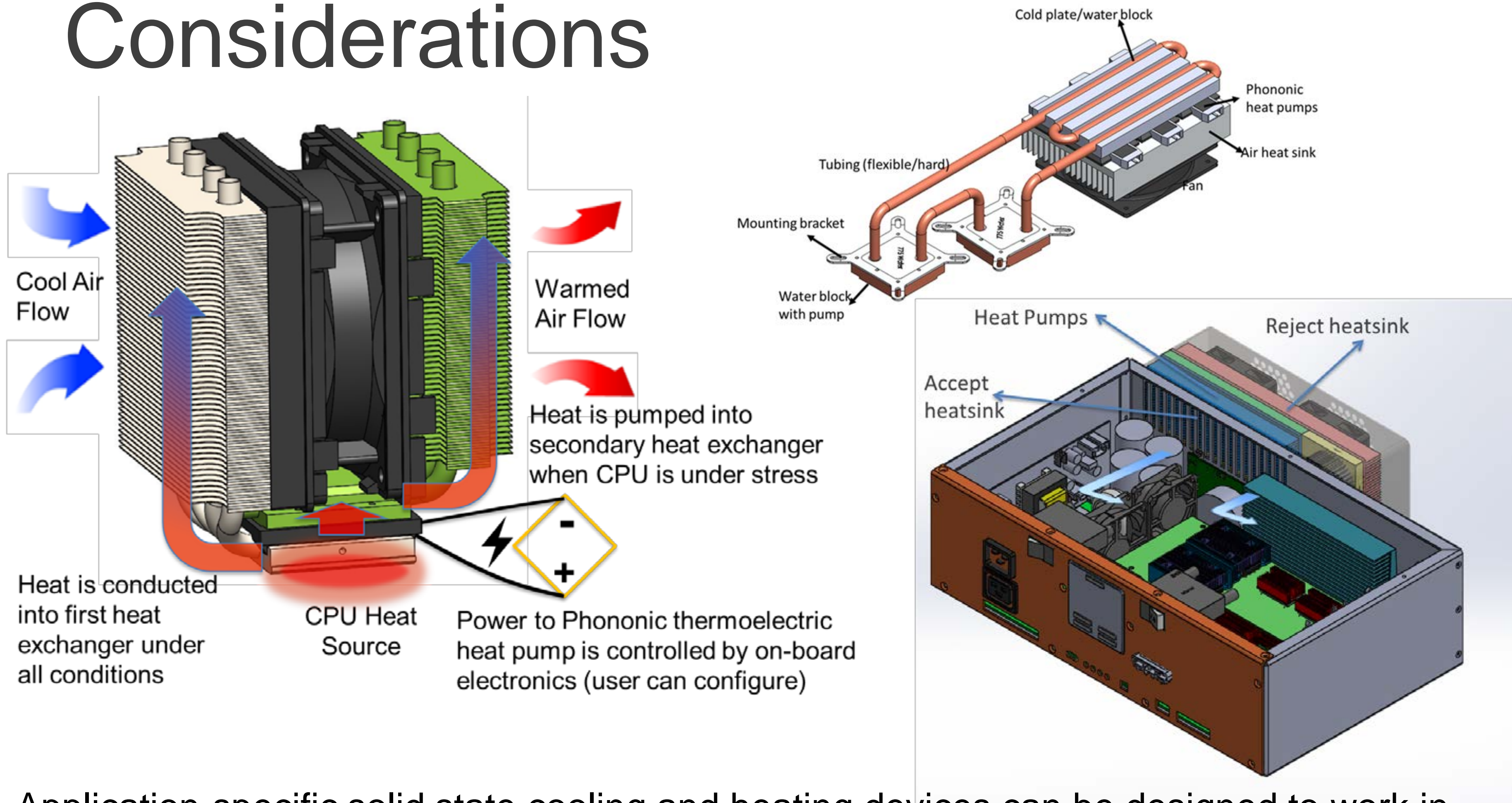
- Good uniformity
- Better "reach" than conduction
- Integration challenges

Heat Pipe/Thermosiphon

- Inexpensive (thermosiphon)
- "Simple" in execution
- Completely passive
- Integration challenges

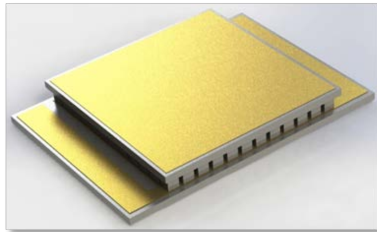
Image courtesy of: http://www.dansdata.com/images/coolercomp/ac7080240.jpg
Image courtesy of : http://www.hardracing.com/AUTO/IMAGES/coolShirt.jpg
Image courtesy of :http://2-pi-r.com/news/2002/02/020201_PC/AMD_HeatPipe.jpg

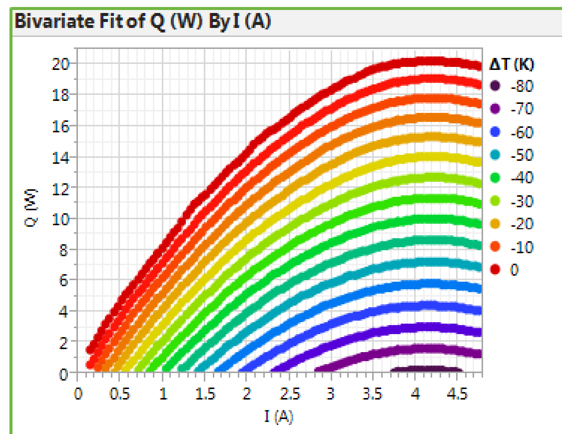
Form Factor and Space Claim Considerations

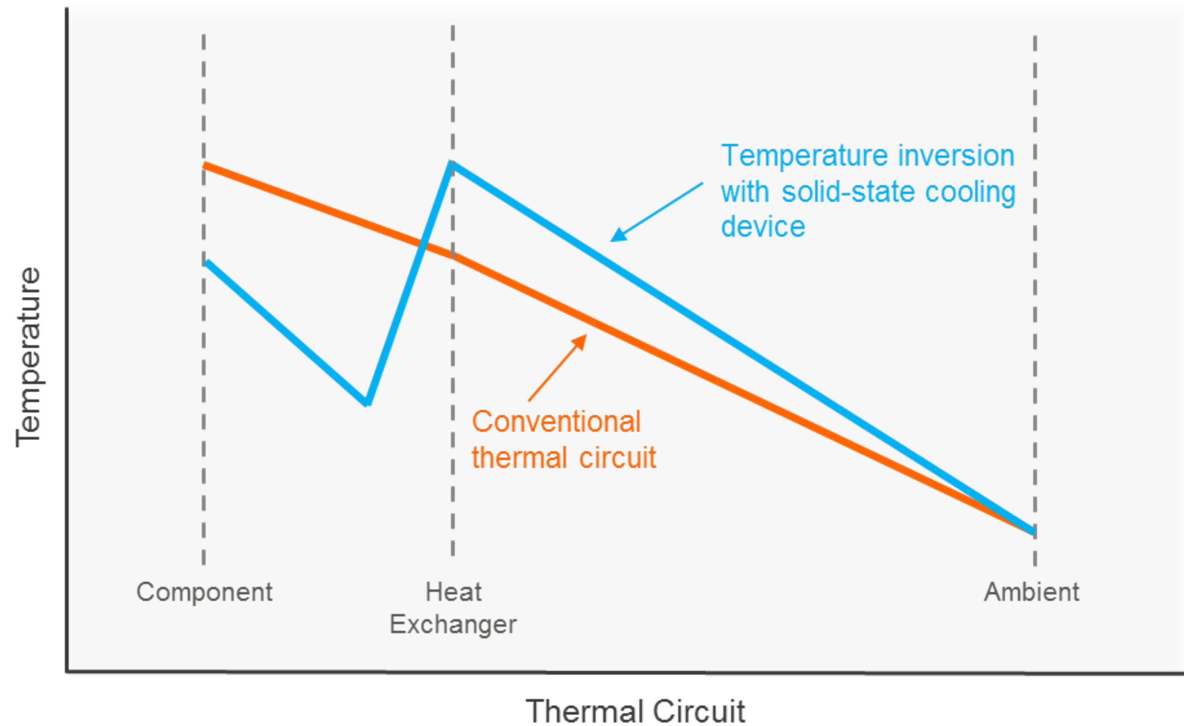


Application-specific solid state cooling and heating devices can be designed to work in combination with existing heat sinks and fans, resulting in an improvement in performance in form-factor flexible designs

Thermoelectric Heat Pumps and Temperature Inversion

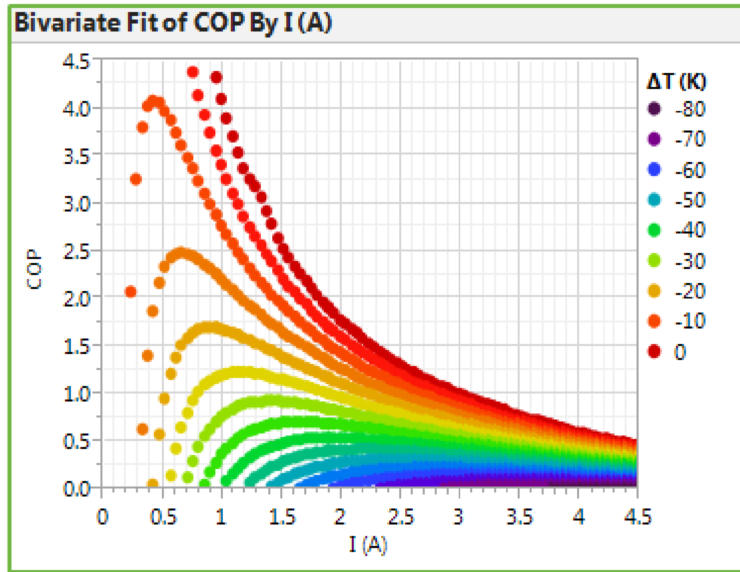




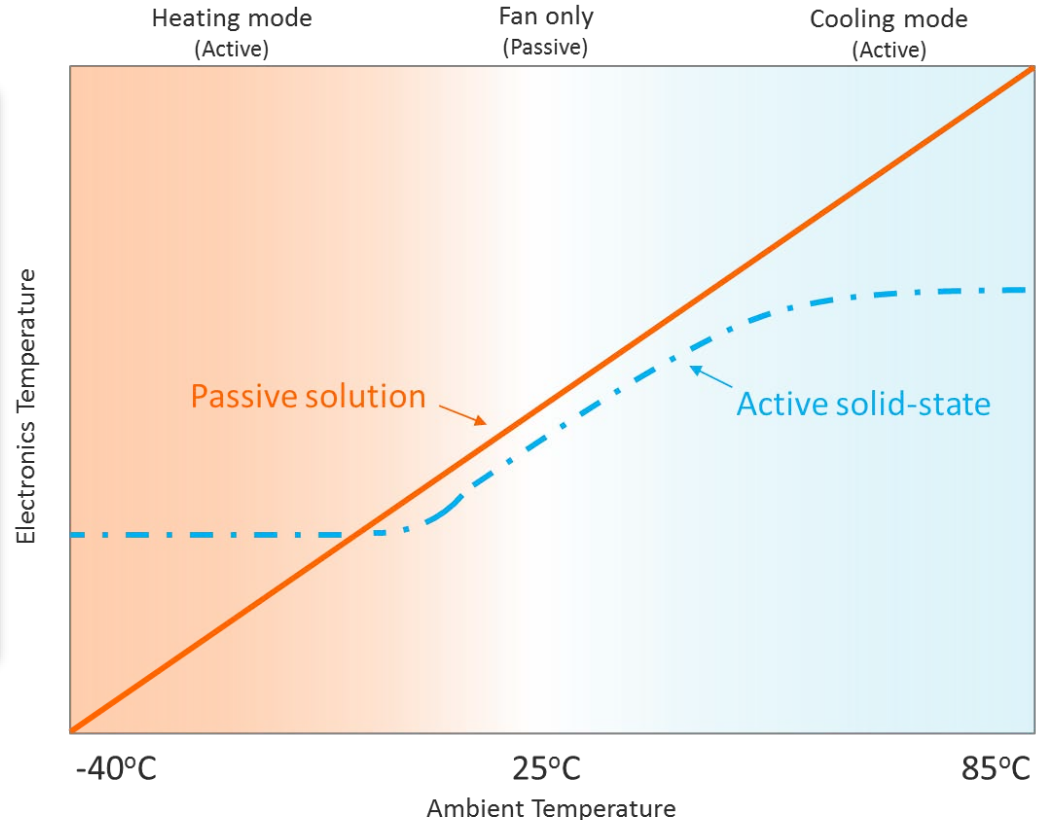


Typical passive thermal reject circuit (in orange) compared to an active solid-state thermal reject circuit (in blue). The active cooler can produce a temperature inversion in the thermal path, maintaining a lower temperature of the target area.

Power Consumption and Thermoelectric Heat Pumps



$$COP = \frac{Heat\ Pumped}{Electrical\ Power}$$



The addition of a solid-state cooling and heating device to a thermal system allows for thermal relief in both cold and hot ambient conditions. Power consumption can be lowered by engineering for low temperature differences at the system level.

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