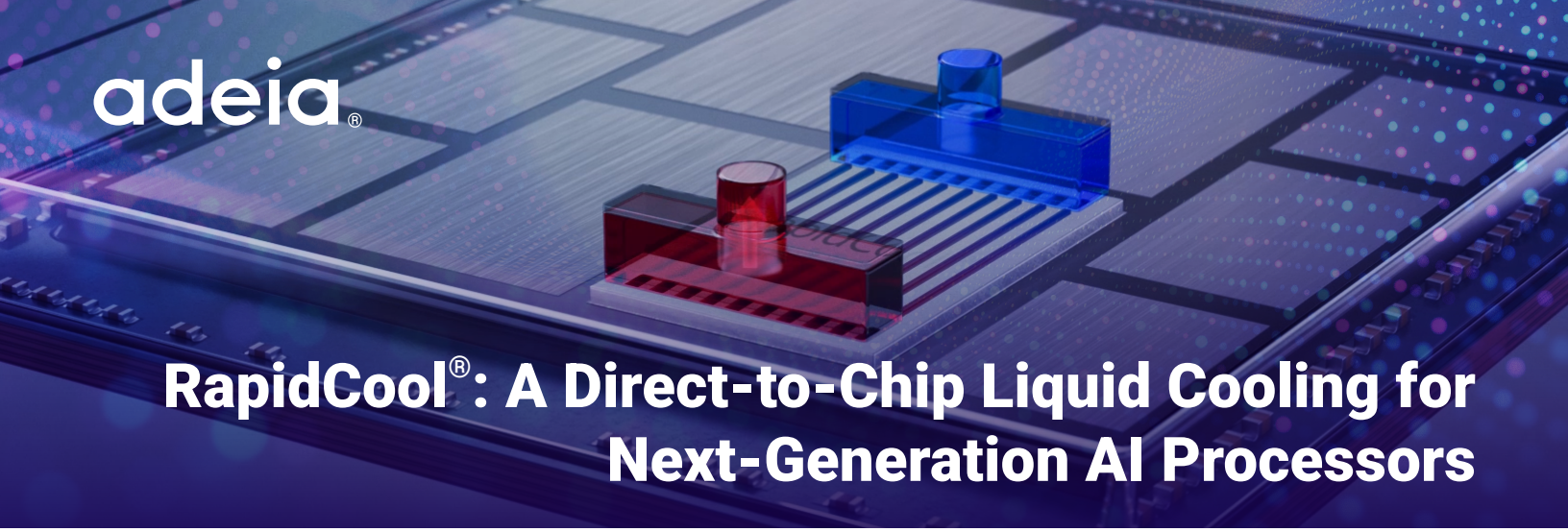


# RapidCool®: A Direct-to-Chip Liquid Cooling for Next-Generation AI Processors

## Introduction

Artificial intelligence (AI) is driving a rapid increase in computing performance. As AI processors handle larger datasets and more complex models, they consume more power and generate more heat. In some advanced systems, chip power can approach 1 kilowatt. In addition, small regions on the chip, called hotspots, can produce extremely high heat in very localized areas.

When this heat is not removed efficiently, it leads to several problems. Chip performance can be reduced, energy efficiency drops, and long-term reliability can be affected. Because of this, thermal management is now one of the most important challenges in modern electronics design.

## Limitations of Traditional Cooling Methods

Most high-performance processors today use liquid cooling systems that rely on a metal cold plate. This cold plate sits on top of the chip and removes heat using a flowing liquid coolant.

Between the chip and the cold plate, there is usually a layer called a thermal interface material (TIM). A TIM is used to improve contact between surfaces and help transfer heat. However, it also introduces a problem.

The TIM adds thermal resistance, which means it impedes heat flow from the chip into the cooling system. As chip power increases, this extra resistance becomes a major limitation.

Over time, thermal interface materials (TIMs) can degrade and lose effectiveness. They may dry out, form small air gaps (voids), or fail to maintain full contact between the chip and the cooling plate. As a result, heat transfer becomes less efficient, which can reduce cooling performance and raise long-term reliability concerns.

## The Need for a New Approach

As AI and high-performance computing systems continue to evolve, traditional cooling methods are reaching their limits Removing more heat requires getting closer to the source of that heat, the chip itself.

To improve thermal performance, a new approach must:

- Reduce or eliminate thermal resistance between the chip and cooling system
- Handle very high heat flux in small areas (hotspots)
- Maintain reliability over long operating lifetimes
- Fit within existing system designs without major redesign

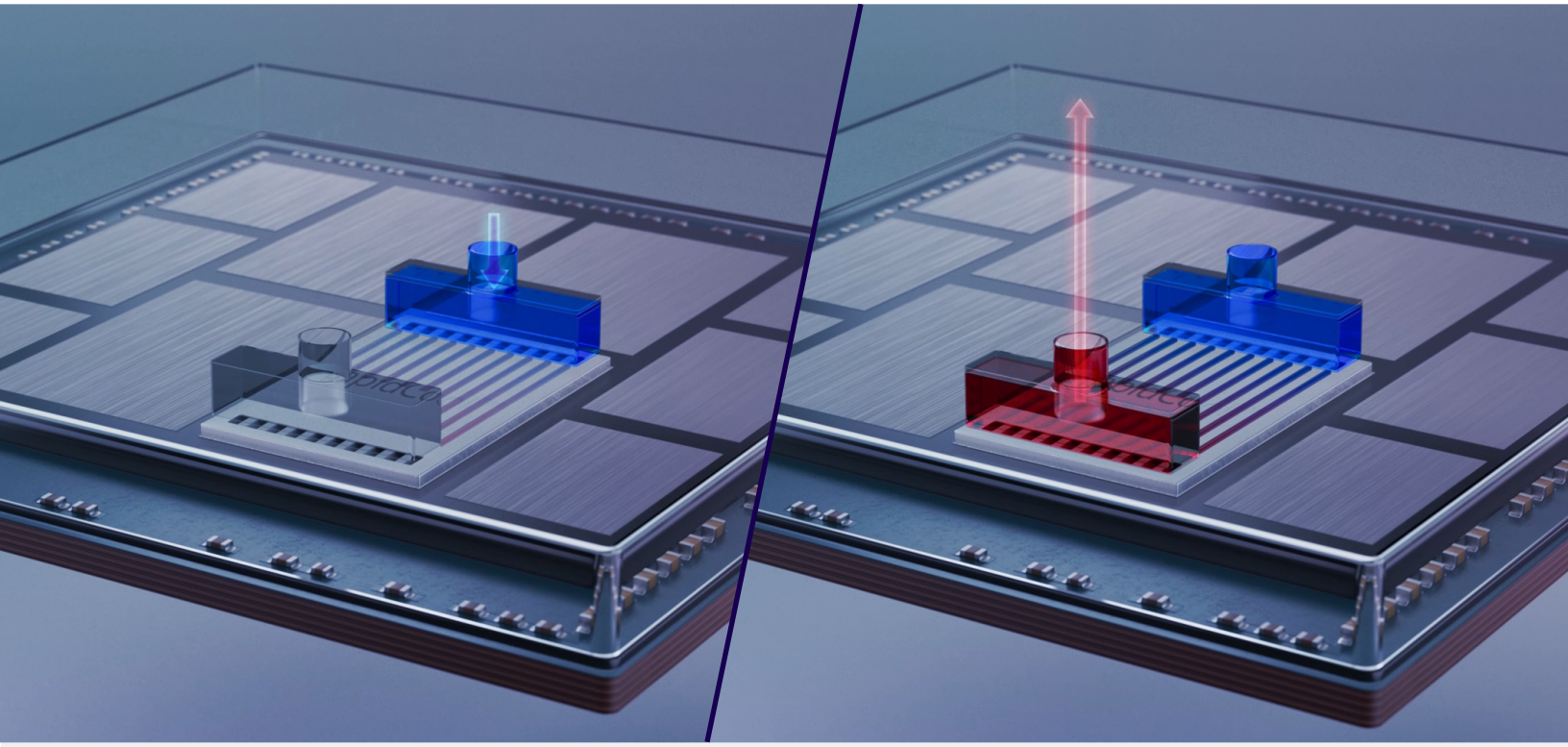
# RapidCool®: A Direct-to-Chip Liquid Cooling for Next-Generation AI Processors

## RapidCool® Technology Overview

RapidCool® is a direct-to-chip liquid cooling solution designed to overcome the limitations of traditional cold plate systems.

Instead of using a TIM and a separate metal cold plate, RapidCool® integrates cooling directly at the chip level. It uses a silicon-based microchannel cold plate that is directly bonded to the backside of the chip.

This design removes the need for a TIM layer and brings the coolant much closer to where heat is generated.



## How RapidCool® Works

The key feature of RapidCool® is the use of a silicon cold plate with microchannels, small fluid channels.

Coolant flows through these microchannels, allowing heat to be removed efficiently from the chip surface. Because the channels are extremely small and close to the heat source and designed to provide:

- Larger surface area for heat transfer
- Efficient heat removal from hotspots
- Faster response to changing power conditions

By eliminating the TIM layer and reducing the distance between the chip and coolant, RapidCool® significantly lowers thermal resistance.

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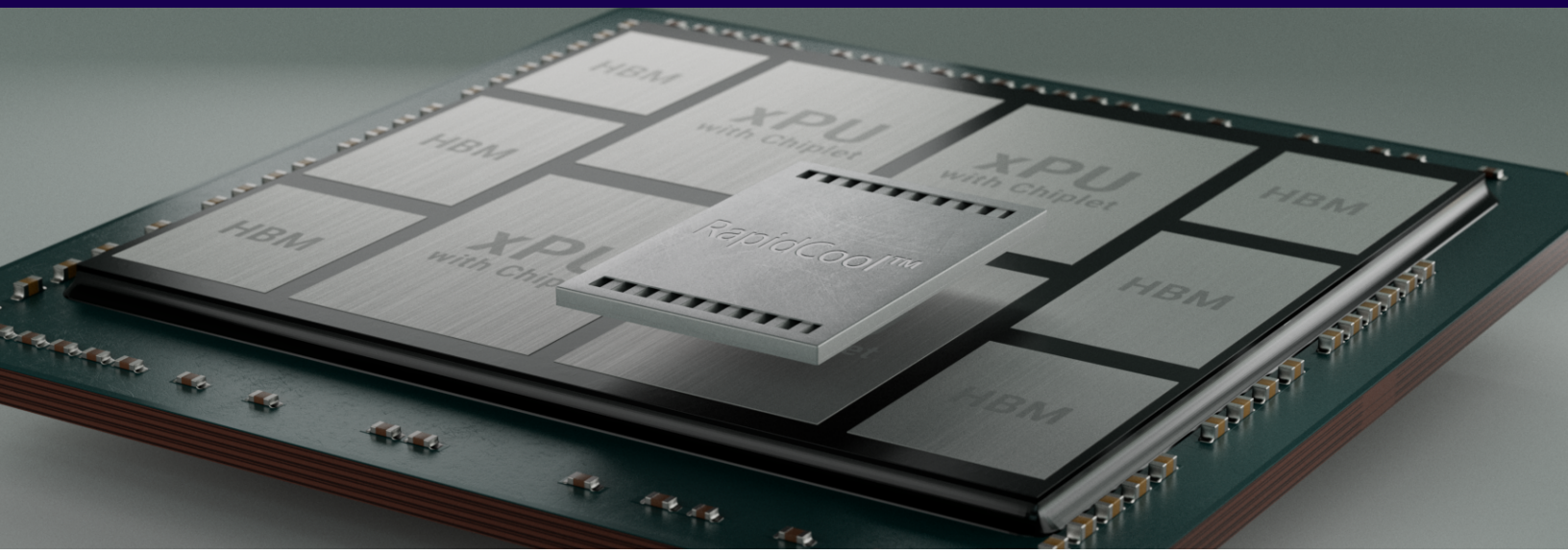



## Performance Advantages

RapidCool™ offers several important benefits compared to traditional cooling systems:

**Lower Thermal Resistance**

By removing the TIM layer and placing a nearly zero resistance interface between the chip and the cold plate, RapidCool™ can reduce the system thermal resistance by up to 80% compared to conventional solutions.

**Improved Heat Removal**

The custom microchannel design allows for efficient heat extraction, even in areas with very high power densities.

**Support for Higher Power Devices**

As chips continue to increase in power, RapidCool™ enables systems to operate at higher performance levels without overheating.

**Better Reliability**

Without a TIM layer, there is no risk of material degradation, pump-out, or void formation over time. This improves long-term system stability.

**System Integration**

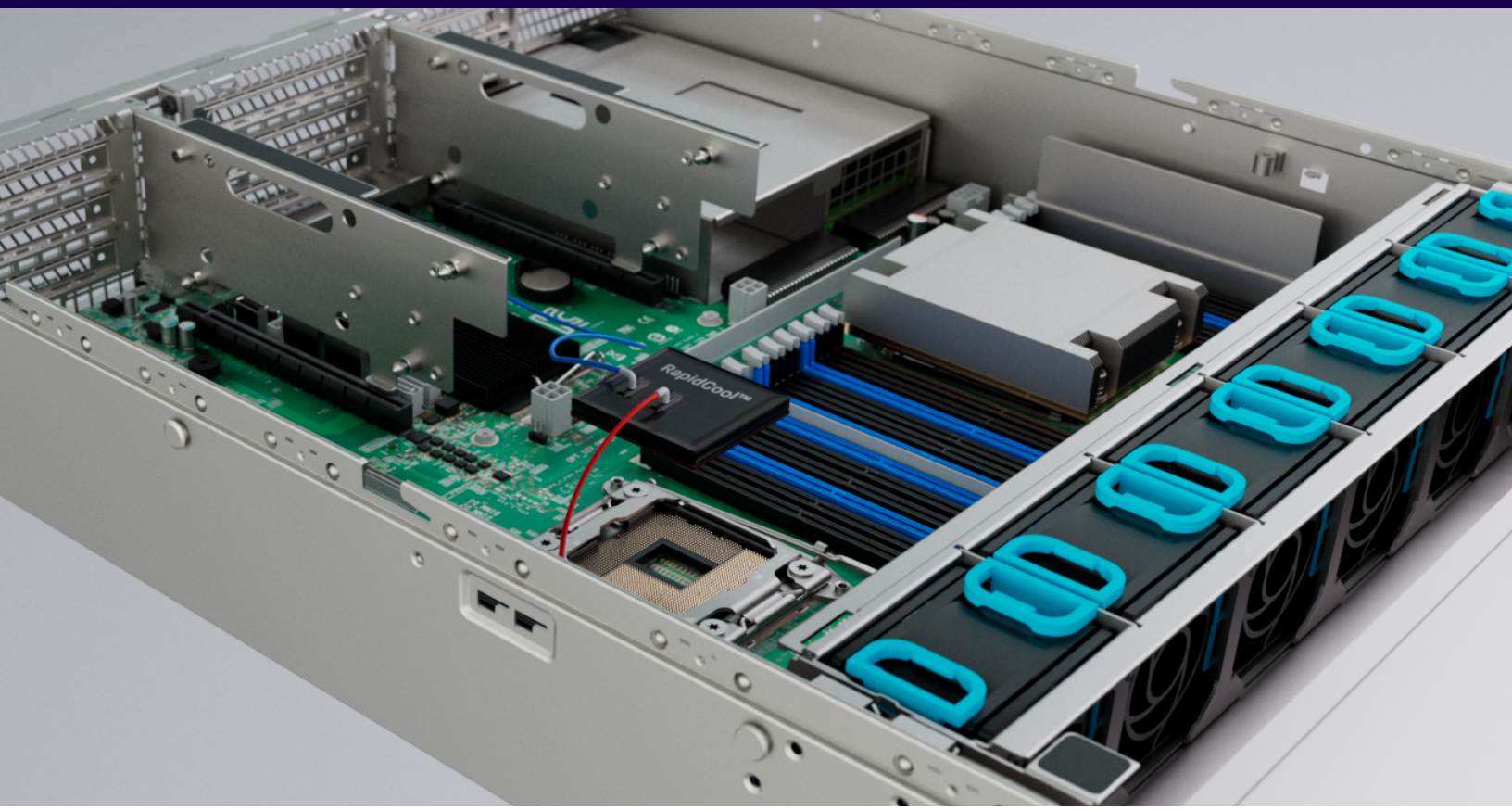
RapidCool™ is designed to work within existing system architectures. It can be manufactured using the current advanced packaging supply chain. System architects are empowered to design the thermal solution with the IC heatmaps.

The system includes:

- A custom silicon microchannel cold plate and integrated manifold for fluid delivery to the hot ICs
- Integrated on a standard package ready for board mounting

This allows designers to upgrade cooling performance without completely changing the infrastructure at the datacenter.

# RapidCool™: A Direct-to-Chip Liquid Cooling for Next-Generation AI Processors




## Applications

RapidCool™ is particularly well suited for applications that require high power and high performance, including:

- AI processors and accelerators
- High-performance computing (HPC) systems
- Data center servers
- Advanced semiconductor packages

These applications often face extreme thermal challenges, making efficient cooling essential.

## Conclusion

As computing demands continue to grow, thermal management is becoming a key factor in system performance and reliability. Traditional cooling methods, especially those relying on thermal interface materials, are no longer sufficient for next-generation devices.

RapidCool™ provides a new solution by removing the limitations of TIM-based cooling and bringing liquid cooling directly to the chip. By reducing thermal resistance and improving heat removal, it enables higher power densities, better efficiency, and more reliable operation.

For future AI and high-performance systems, direct-to-chip cooling technologies like RapidCool™ will play a critical role in enabling continued performance scaling.