Eliminating DDR5 Thermal Throttling with Solid-State Cooling

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THE PROBLEM

DDR5 introduces a new thermal bottleneck.
By integrating voltage regulation onto the DIMM, heat is concentrated in the PMIC, creating a localized hotspot that is difficult to cool in dense server environments. Limited airflow and elevated inlet temperatures lead to performance throttling.

- On-board PMIC → localized hotspot formation
- Temperature rise: +10–15°C vs DRAM
- Heat flux: ~12 W/cm² in <1 cm² area
- *Impact → Thermal throttling reduces memory bandwidth*

WHY COOLING FAILS

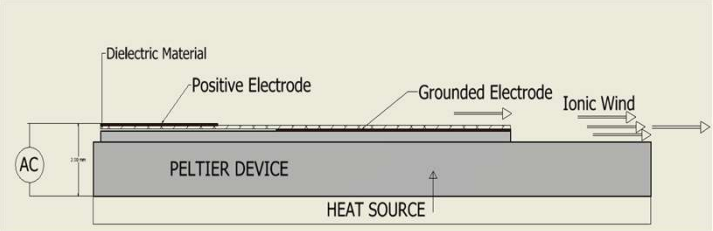
Airflow is no longer effective at the component level. In high-density OCP environments, memory modules operate in confined geometries with pre-heated air and high flow resistance. Airflow becomes laminar between DIMMs, limiting mixing and reducing heat removal at the PMIC surface.

- Inter-DIMM spacing: <3 mm → high flow impedance
- Flow regime: Laminar (Re < 2300)
- Thick thermal boundary layers form on surfaces
- Air bypasses critical regions (flow prefers low-resistance paths)
- *Result → Poor convective heat transfer at the hotspot*

THE SOLUTION

A hybrid solid-state approach targets the hotspot directly. Instead of relying on bulk airflow, the system combines active heat pumping with localized airflow control to remove heat at the source and enhance its rejection.

- **Micro-TEC (Peltier)**
  - Directly cools the PMIC hotspot
  - Pumps heat to a larger spreader
  - Reduces junction temperature
- **DBD Ionic Wind**
  - Generates local airflow (2–6 m/s)
  - Disrupts thermal boundary layers
  - Enhances convective heat transfer
- **Combined effect**
  - Decouples hotspot from bulk airflow
  - Enables cooling in ultra-confined spaces
  - No moving parts → solid-state reliability



PERFORMANCE

Delivers measurable thermal gains at the hotspot.

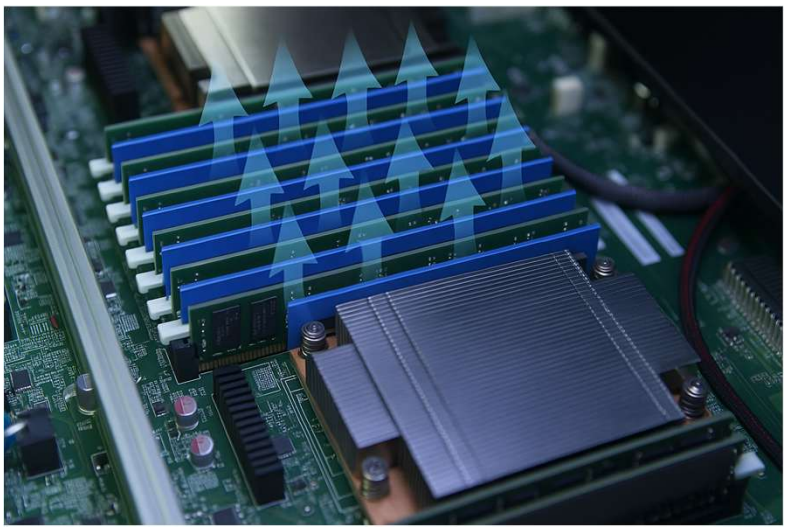
- +1.5–2.75× increase in heat transfer (Nu)
- −10°C+ PMIC temperature reduction
- Sustains performance → **reduces thermal throttling events**

INTEGRATION

Drop-in compatible with existing server architectures.
The system fits within standard DIMM constraints without requiring changes to airflow or infrastructure.

Ultra-thin form factor

- TEC: **<0.6 mm**
- DBD: **<0.2 mm**
- Fits within **standard DIMM pitch (7–10 mm)**
- Operates in **<3 mm airflow gaps**
- No moving parts → **high reliability**
- No liquid cooling → **no plumbing, no risk of leaks**
- **Drop-in compatible** with existing air-cooled racks



Eliminates DDR5 thermal throttling without liquid cooling

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