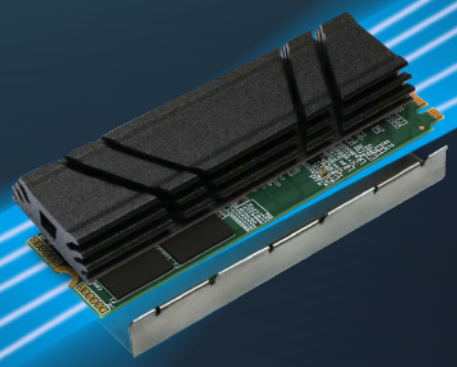
Customizable Thermal Management Solutions

Overheating is a major challenge for high-performance, high-speed solid-state drives such as NVMe modules. Common causes of overheating include multiple die stacking per integrated circuit (IC), controller heat and intensive components in the limited printed circuit board (PCB) space, especially for double-sided designs, and intense workloads.

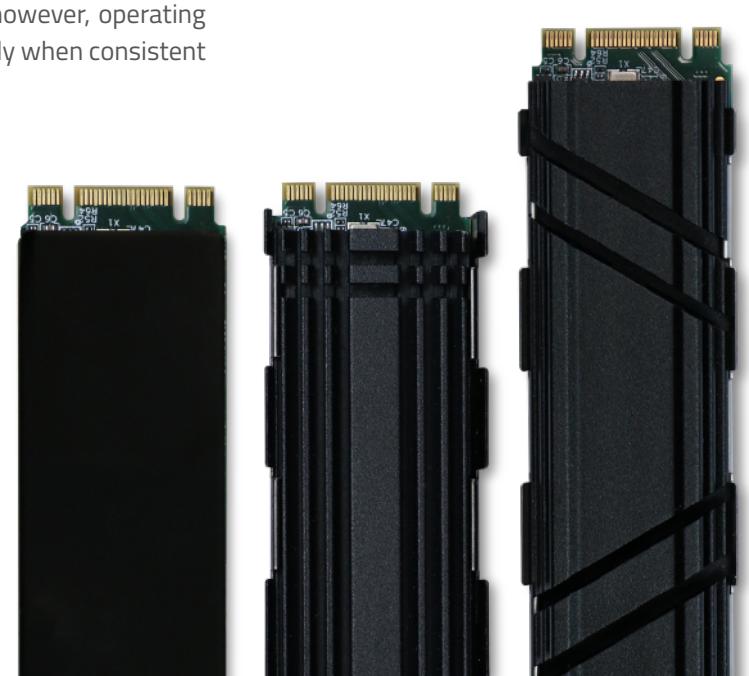


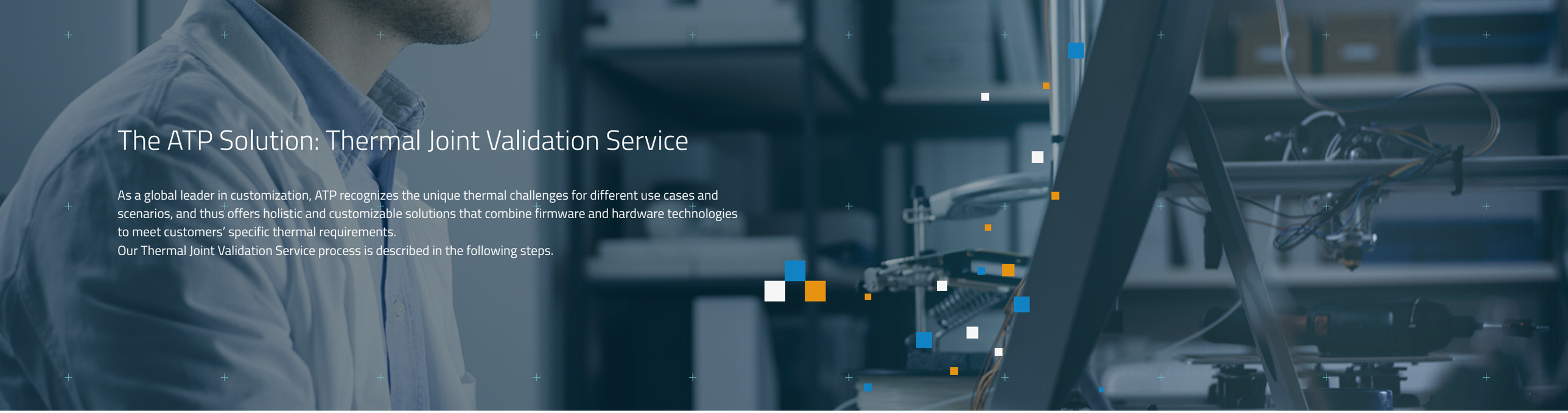
Why Traditional Solutions May Not Suffice

Excessive heat can cause thermal shutdown, which can damage the SSD and compromise the data stored in it. To prevent this, SSDs are typically equipped with a thermal throttling mechanism, which cools the device by reducing the clock speed when a certain temperature is reached. The challenge, however, is that such mechanism causes drastic performance drops and thus makes it difficult to sustain the performance.

Enhanced Sustained Performance in Various Scenarios

It is common to associate industrial temperature rating with the drive's ability to operate within -40°C to 85°C; however, operating temperature is just one thing to consider, especially when consistent sustained performance is critical.





The ATP Solution: Thermal Joint Validation Service

As a global leader in customization, ATP recognizes the unique thermal challenges for different use cases and scenarios, and thus offers holistic and customizable solutions that combine firmware and hardware technologies to meet customers' specific thermal requirements.
Our Thermal Joint Validation Service process is described in the following steps.

ASSESSMENT

- Customer's system/mechanical and performance criteria
- User applications
- System specifications including, but
  - Temperature
  - Airflow
  - Mechanical design
  - Workload and performance requirement

SIMULATION

Proprietary ATP-built mini chamber to simulate and adjust thermal environments based on customer's profile.

ATP Mini Chamber Gen. 2

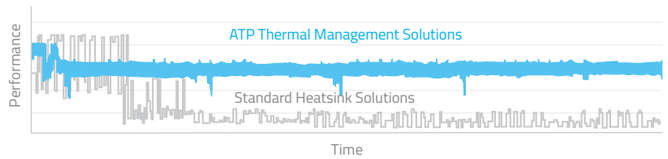
CUSTOMIZATION

ATP's customized thermal management solution consists of the following components:

- **Adaptive Thermal Control** through the ATP Dynamic Thermal Throttling mechanism, which provides a delicate balance between performance and temperature instead of dramatic performance reduction. Temperature sensors continuously detect the device temperature. After sophisticated FW transactions, the performance gradually declines, and the temperature is adjusted.
- **H/W Heatsink Solution:** A variety of HW heatsink options (materials, dimensions, types) are available to match the mechanical constraints of each system design.
- **Garbage Collection F/W Tuning.** A periodic background refresh offsets the significant performance drop caused by the long garbage collection process.

OPTIMIZATION

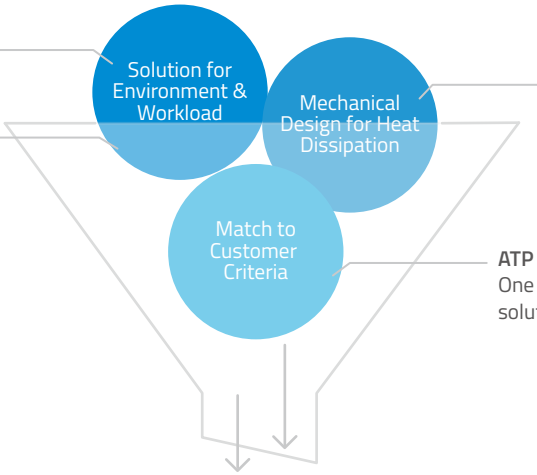
An optimized solution combines both HW and FW to meet customer's needs. As the graph below shows, performance can drop sharply when standard thermal throttling is used. ATP NVMe SSDs with the customized thermal management solution, on the other hand, deliver higher sustained write performance.



Overview of ATP's Joint Validation Service for Thermal Management

Understand environment for customer's application:
ATP air flow suggestion

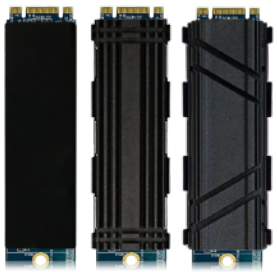
ATP Dynamic Thermal Throttling:
Sustained performance at high temperature



Customized Heatsink: Designed to dissipate heat effectively and fit into customer's system device.
- Heatsink material
- Heatsink specifications

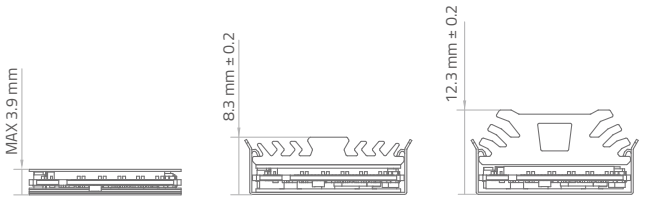
ATP Joint Validation Package
One size doesn't fit all. ATP offers a total solution for sustained value.

ATP Thermal Management Solutions

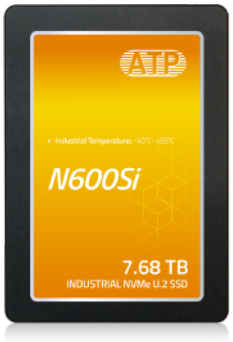


NVMe M.2 2280 with Copper Foil Heatsink, 4 mm / 8 mm Fin-Type Heatsink

- Recommended for applications requiring stable/sustained Read/Write performance at high temperatures.
- Various heatsink solutions (Copper foil / 4 mm or 8 mm fin-type options)
- Adaptive Thermal Control through Dynamic Thermal Throttling
- Power Loss Protection Design
- LDPC (Low Density Parity Check) ECC algorithm
- RAID Engine Support
- End-to-End Data Path Protection



Copper Foil Heatsink | 4 mm Fin-Type Heatsink | 8 mm Fin-Type Heatsink



High Density U.2 Thermal SSD

- Recommended for applications requiring stable/sustained Read/Write performance at high temperatures.
- Thermal pad covering the controller and NAND flash area to dissipate heat through the U.2 aluminum housing
- Advanced Thermal Control (ATC) Technology ensuring data reliability
- Power Loss Protection Design
- LDPC (Low Density Parity Check) ECC algorithm
- RAID Engine Support
- End-to-End Data Path Protection

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