TECHNICAL CASE STUDY

Thermoelectric Cooling · Biotech Instrumentation

High-Performance TEC Cold Plate Assembly for 96-Well Biotech Instrument

At a Glance

Advanced Thermal Solutions, Inc. (ATS) engineered a compact thermoelectric cold plate assembly with precise closed-loop temperature control to regulate a 96-well cooling fin block (CFB). The system was designed to maintain a sample interface between 8°C and 10°C on a benchtop biotech instrument while integrating high cooling capacity, multi-point sensing, and compact deck-mounted packaging.

CUSTOMER OVERVIEW

The customer needed a compact deck-mounted thermal assembly for a biotech instrument that uses a 96-well cooling fin block to cool bio samples held in a polypropylene deep well. The system had to keep the sample interface within a narrow temperature band while fitting within a highly constrained instrument envelope.

- Cooling fin block designed for rapid cooling and heating of bio samples
- Sample interface required controlled operation between 8°C and 10°C
- Compact drop-in architecture for benchtop instrument integration

CHALLENGE

The assembly needed to provide precise closed-loop temperature control in a compact package while integrating a high-power TEC, dual PWM fans, thermistor feedback, and a production-ready mechanical stack. The design also had to support reliable sensing and thermal coupling across the cold and hot sides of the assembly.

Thermal design requirements:

- Cold side regulation: 8–10°C
- 12V TEC power supply
- 24V PWM-controlled fans with TACH output
- Integrated thermistors: 2 cold side, 2 hot side
- Compact envelope: ≤ 90 mm × 140 mm × 50 mm (fan excluded)
- Deck drop-in mounting configuration

The core challenge was combining aggressive thermal control, compact packaging, and closed-loop readiness in a practical assembly suitable for biotech instrument deployment.

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METHODOLOGY

ATS combined analytical sizing with CFD validation to select the TEC, heat sink, airflow hardware, and interface stack for the cooling fin block assembly (Figure 1). The work focused on thermal coupling, deep-well interaction, and closed-loop-ready sensor placement.

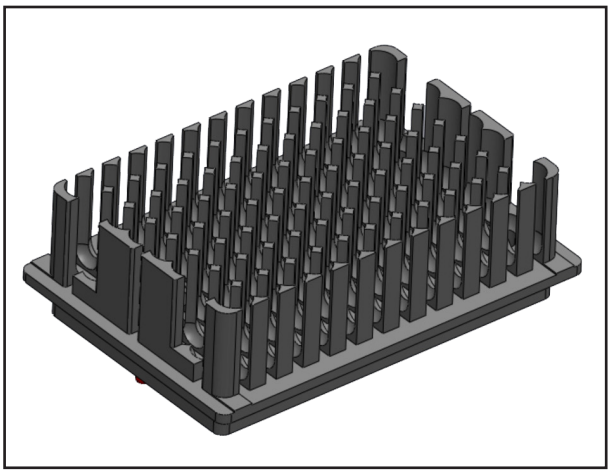

Figure 1. CFD Model of the CFB's Cooling Fins

Heat Sink and TEC Selection

- Selected a standard ATS extruded aluminum finned heat sink in a 60 mm length
- Achieved heat sink thermal resistance of 0.23°C/W with dual fans at 60% duty cycle
- Used an ATS standard TEC sized at: 50 mm × 50 mm × 3.8 mm

Mechanical Integration and Control Strategy

- ATS-EXL76 extrusion heat sink
- 2× Sanyo Denki 9GA0424P3J001 PWM fans
- ATS-TEC50-38-016 TEC module
- Chomerics T670 TIM
- Deep well polypropylene interface modeling (Figure 2)
- Multi-point thermistor feedback integration

CFD was used to validate the full stack, including the cooling fin block, mounting plate, TEC gap region, TIM, finned heat sink, fans, shroud, and thermistor locations (Figure 3).

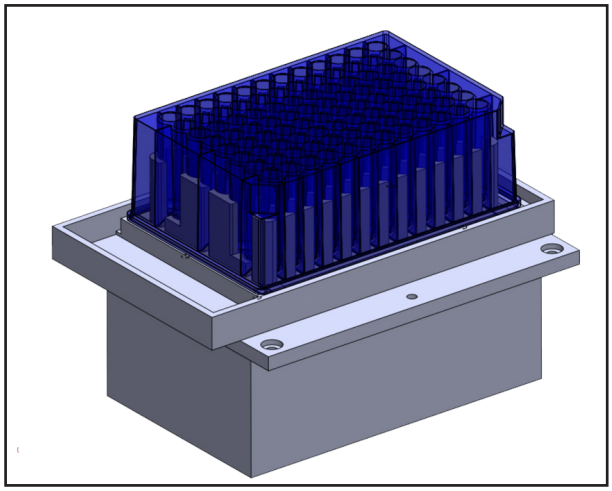

Figure 2. A Sample-Holding Polypropylene Deep Well Deck Drops into the Cooling Fin Block for Temperature Management

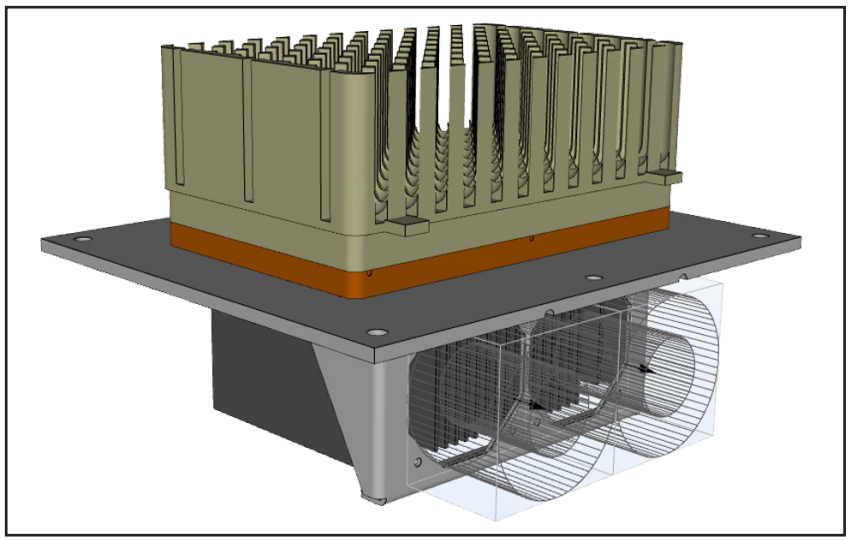

Figure 3.
CFD Simulation of CFB Assembly

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SOLUTION

ATS developed a compact TEC cold plate assembly combining a 50 mm × 50 mm TEC (Figure 4), ATS-EXL76 extrusion heat sink, dual PWM fans, thermal interface material, and multi-point thermistor integration. The architecture was configured as a closed-loop-ready deck-mounted assembly capable of regulating the 96-well cooling fin block within the required operating range.

- Integrated a standard ATS TEC into a compact cold plate stack
- Used dual PWM fans to support controlled hot-side heat rejection
- Applied Chomerics T670 TIM for effective thermal coupling
- Included multiple thermistors for cold-side and hot-side feedback
- Validated deep-well interaction and assembly-level thermal behavior with CFD (Figure 5)
- Designed a production-ready deck drop-in mechanical configuration

This produced a compact thermal control assembly that combined precise regulation, manufacturable packaging, and closed-loop integration readiness.

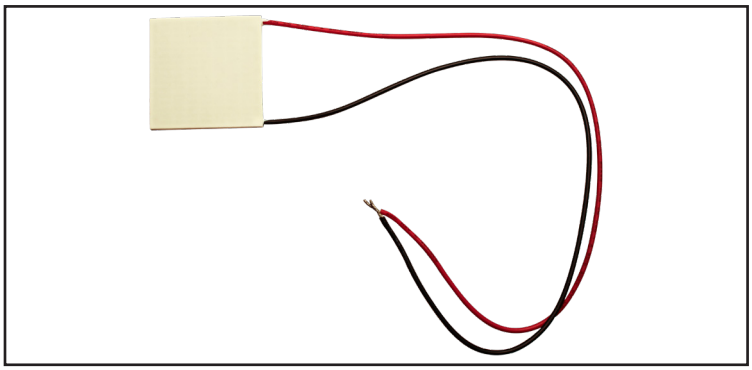

Figure 4.
Selected ATS TEC, 50 × 50 × 3.8 mm

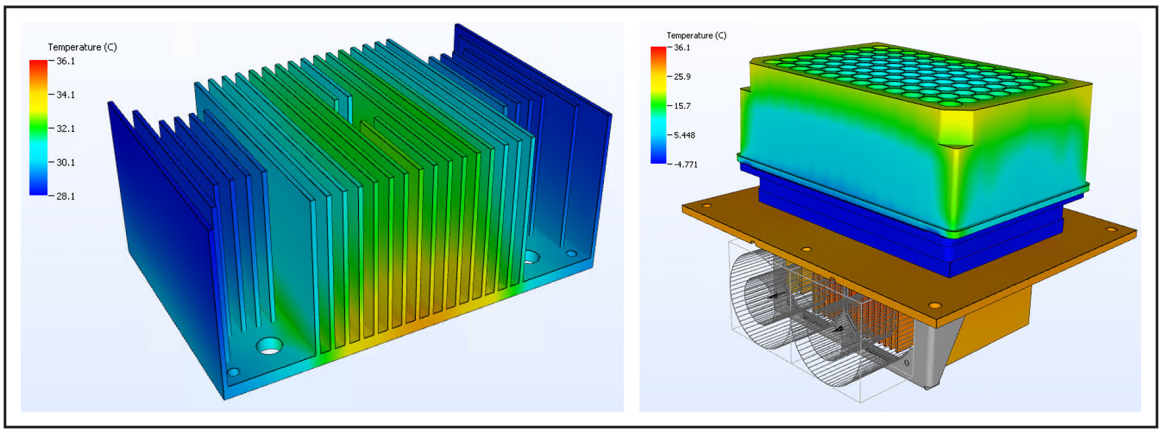

Figure 5.
CFD Simulation of Bottom Side Heat Sink and Assembly with the Polypropylene Deep Well Dropped into the Cooling Fin Block

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RESULTS & DATA

CFD confirmed that the assembly provided sub-zero cooling capability while enabling controlled regulation to the required 8°C to 10°C range.

CFD performance results:

- With the deep well added, at 12V and 2.5A TEC current, the CFB temperature could be controlled between approximately -4.7°C and -3.8°C
- Heat sink thermal resistance of 0.23°C/W achieved with dual fans at 60% duty cycle
- Analytical and CFD correlation validated the thermal design

The results showed that the assembly had enough cooling capacity to support closed-loop regulation of the sample interface in the target 8°C to 10°C operating band.

Thermal engineering outcomes:

- Sub-zero cooling capability with controlled regulation to 8–10°C
- Analytical and CFD correlation validated
- Compact deck-integrated cold plate architecture
- Closed-loop control-ready thermal design
- Production-ready mechanical integration

ANALYSIS & CONCLUSION

This study shows that compact TEC cooling for biotech instrumentation depends on more than TEC selection alone. Performance came from the integration of the thermoelectric module, heat sink, airflow hardware, thermistor feedback, and the mechanical interface to the deep-well sample block.

- Closed-loop-ready sensing was essential to practical temperature regulation
- Heat sink and fan selection provided the hot-side rejection needed for stable operation
- CFD confirmed that the assembly could support the required regulated sample range
- The final design combined compact packaging with production-ready integration

ATS delivered a compact, CFD-validated TEC cold plate architecture for a 96-well biotech instrument, enabling precise, closed-loop-ready temperature control in a manufacturable deck-mounted assembly.

Take control of your thermal performance with expert analysis and design services, contact ATS to speak with our engineers and start optimizing your system today.