



Sub-Cryogenic Peltier Cooling - Capability Note

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MicroPower's Peltier cooling mode has been demonstrated in a multi-stage laboratory cascade reaching cold-side temperatures below $-150\text{ }^{\circ}\text{C}$. The demonstration was a pre-MicroPower technology demonstration in an alternative material system not presently in production, but the principle carries over to the current MicroPower production material. This capability note describes the laboratory result, the bounded performance envelope, and where the capability fits on the platform's cooling-mode roadmap.

1 • The cascade demonstration

MicroPower's Peltier cooling mode – the same MicroPower chip architecture that operates in Seebeck mode for power generation, run in reverse with driven current – has been demonstrated in a multi-stage cascade laboratory configuration reaching cold-side temperatures below $-150\text{ }^{\circ}\text{C}$. This corresponds to the cryogenic temperature region historically served by liquid-nitrogen cooling.

The demonstration was a research-grade cascade of multiple Peltier stages, each stage's cold side serving as the next stage's heat sink. Performance was characterized at chip and stage level under controlled laboratory conditions. Demonstrated in an alternative material system not presently in production, but the principle carries over to the current MicroPower production material – the chip architecture, contact engineering, and cascade discipline are common to both.

2 • Bounded performance envelope

- Cold-side temperature. Below $-150\text{ }^{\circ}\text{C}$ in cascade configuration. Stage-by-stage temperature drop characterised under laboratory conditions; ambient hot-side rejection.
- Coefficient of performance. Cascade COP falls steeply as ΔT widens. Field-validated COP at sub-cryogenic temperatures has not been characterised; laboratory data establishes that the platform reaches the temperature, not the energy cost of useful refrigeration capacity at that temperature.
- Duty cycle. Short-duration laboratory characterisation. Continuous duty-cycle operation at scale, defrost cycling, and integration with downstream cold-load thermal mass remain commercial engineering work.
- Form factor. Research-grade cascade rig. No commercial-scale cryostat product exists today.

3 • Why the architectural option matters

Conventional cryogenic cooling at this temperature range relies on liquid nitrogen (transport, storage, handling, boil-off losses, regulatory overhead) or mechanical Stirling and pulse-tube coolers (rotating machinery, cold-head wear, vibration). A solid-state Peltier path with no moving parts and no working fluid is a meaningful architectural alternative. Not "if a commercial product can be" — rather "when a commercial product is engineered" around the demonstrated physics.

The cryogenic envelope is therefore a development direction reachable from the same platform that powers MicroPower's current waste-heat and high-temperature cooling work, not a current commercial deliverable.

4 • Position on the platform

The cryogenic cascade demonstration is one of three Peltier-mode capability notes on the MicroPower platform. High-temperature Peltier operation in the 150–600 °C hot-side range supports downhole electronics cooling and biopharma precision thermal applications. Precision sub-ambient cooling supports laboratory and process-stream temperature control where refrigerant handling is constrained. Sub-cryogenic cascade extends the envelope to below -150 °C — demonstrated in an alternative material system not presently in production, but the principle carries over to the current MicroPower production material. Together these define the cooling-mode envelope of the dual-mode platform described in the Dual-Mode Platform paper (No. 06).

References

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© 2026 MicroPower Global. The cryogenic cascade demonstration was on a pre-MicroPower predecessor material system; the principle carries over to the current MicroPower production material but the demonstrated result is not yet a feature of production-spec PbTe / TAGS modules. No commercial cryostat product exists today. Contact MicroPower via www.micropower-global.com/contact for site-specific modelling.