COOLING:
COLD PLATE

HFH Thermal

Cooler System Hotter Innovation

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3.1 Different cold-plate solutions
3.2 TIMs for Pluggable Interfaces

Thermal BU global engineering and manufacturing footprint

China

Dongguan

Thermal R&D center

Meizhou

Thermal module base



Thailand

Bangkok

Liquid cooling coldplate production base



US

Offices

Cupertino, CA

West coast

Houston, TX

Gulf coast

Rich in technology & experience:

GPU/CPU/Switch/NIC cold plates | Optical-module cold plates | DIMM/SSD cold plate | PSU cold plates | Manifold

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Integrated Engineering, Prototyping & Validation Capabilities

Design and simulation

- Thermal flow mechanical simulation
- Design, prototype and test in one team
- Joint research with XJTU and SCUT

Manufacturing

- CNC, skiving, friction stir welding
- Vacuum brazing, laser welding
- Diffusion welding in development
- Cleanroom welding and assembly

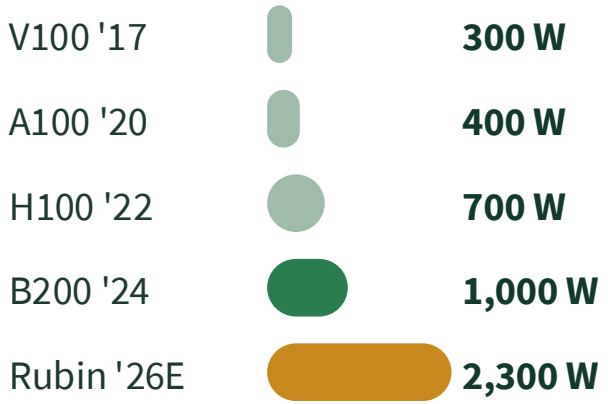
Test and validation

- Five 100% checks on every cold plate
- Helium leak < 1×10^{-6} mbar·L/s
- Flow and thermal resistances measured
- C-scan on every brazed joint

Closed-loop workflow: simulate, prototype, test, iterate

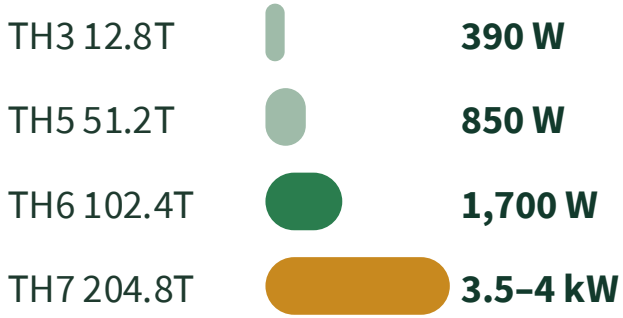
AI keeps pushing power and heat flux up

AI GPU · per-chip TDP



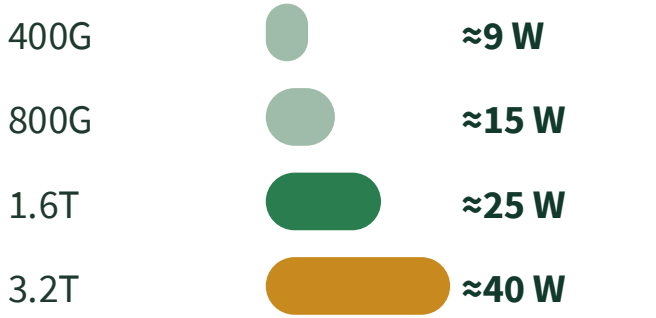
×7.7 per chip · 2017 → 2026E

Switch ASIC · design load



×10 per chip · TH3 → TH7

Optical module · per unit



Cage contact heat flux: 2 → 6 W/cm²

×4.5 per module · 400G → 3.2T

More advanced cooling technologies are urgently needed.

Four steps: air, regular liquid, advanced liquid, two-phase

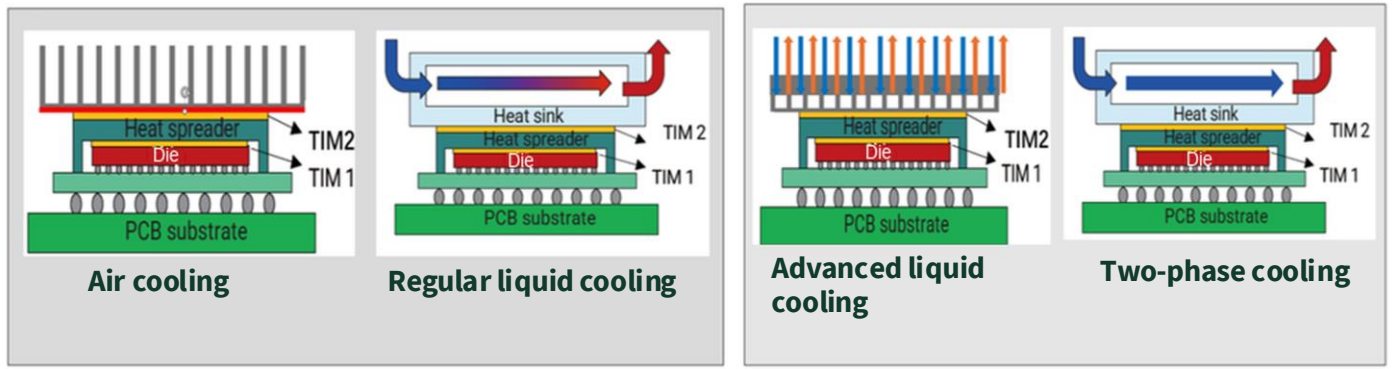
Air cooling
Heat pipes · VC · 3DVC
up to 150 W/cm²

Regular liquid
Microchannel cold plate
up to 250 W/cm²

Advanced liquid
Manifold + microchannel
up to 500 W/cm²

Future
Two-phase
beyond 500 W/cm²

conventional cooling | **advanced cooling**



Air cooling | Regular liquid cooling | Advanced liquid cooling | Two-phase cooling

Why it matters

- **Air: TIM, lid and fins add resistance, leaving high *Rth***
- **Cold plate: lower fluid temperature & lower Rth**
- **Manifold microchannel: lower *Rth* & pressure drop**
- **Two-phase: much lower fluid-side *Rth* & fluid temperature**

HFH works on all four steps at the same time.

HFH liquid cooling roadmap: 2025 to 2027 and beyond

2025

MCCP in mass production

2026

mJet and VC LCP in MP

2027

P2P two-phase, under development

Beyond

Diamond-copper, thermosyphon

mJet LCP

- 500 W/cm² hotspot flux
- Significant reduction in *Tj* and pressure drop

VC-LCP composite

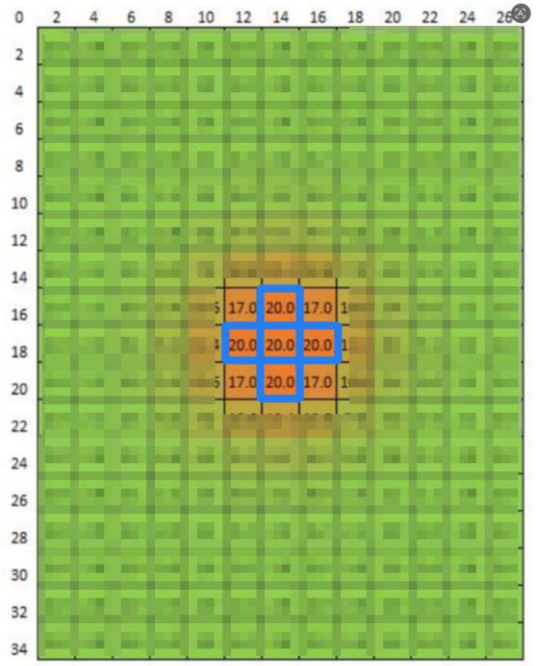
- Vapor chamber built into the fin base
- Verified at ≥ 500 W/cm² hotspot flux

P2P two-phase

- Pumped two-phase refrigerant
- Chip-level test planned in Q1 2027
- Improved performance expected

One rule: increase the coolant-side HTC as much as possible.

Manifold + microchannel: high-efficiency convective heat transfer



Chip core power map

500 W/cm² hotspot zone

Challenge

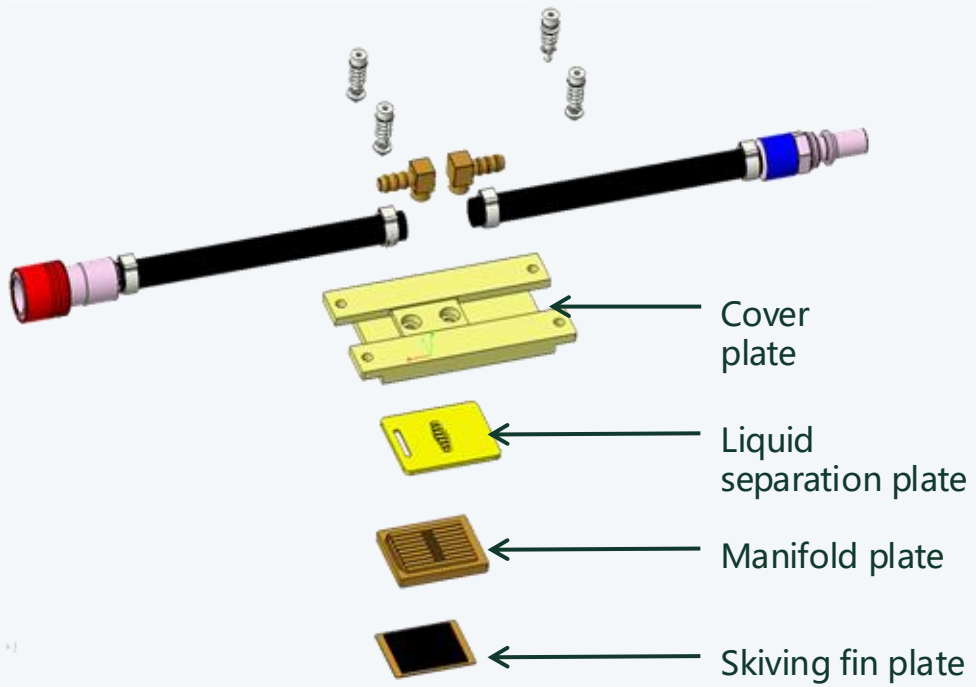
On-chip heat sources are highly non-uniform — the central region exhibits far higher heat flux than peripheral areas. Conventional liquid cooling fails to deliver targeted cooling to these hotspot zones.

Solution

A compact manifold divider directs additional coolant jets precisely at hotspots, allocating low-temperature fluid and pressure-drop budget where peak heat flux occurs. This achieves maximum heat-transfer efficiency with minimal pressure drop, because:

1. Jet impingement yields a dramatically higher heat-transfer coefficient.
2. It shortens the thermal path between cold coolant and hotspots.
3. Lower heat-flux regions receive reduced flow and higher-temperature fluid.

Typical structure and component functions



In some designs, the bottom plate and the fin are integrated into one part.

Cover plate

Seals the top of the core and closes the flow path

Liquid separation plate

Distributes inlet fluid into the microchannels
Need well-designed structure for proper flow distribution

Manifold plate

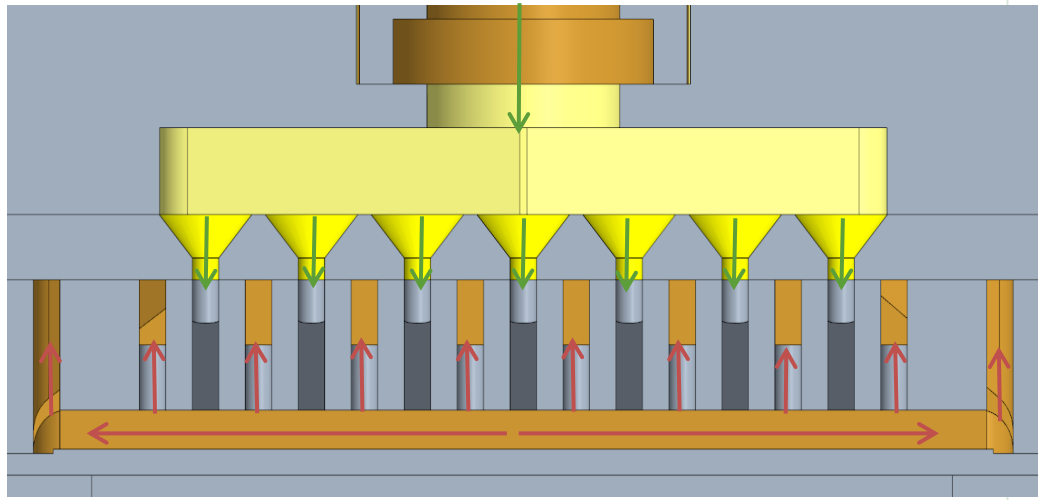
Collects the heated fluid toward the outlet

Skiving fin plate

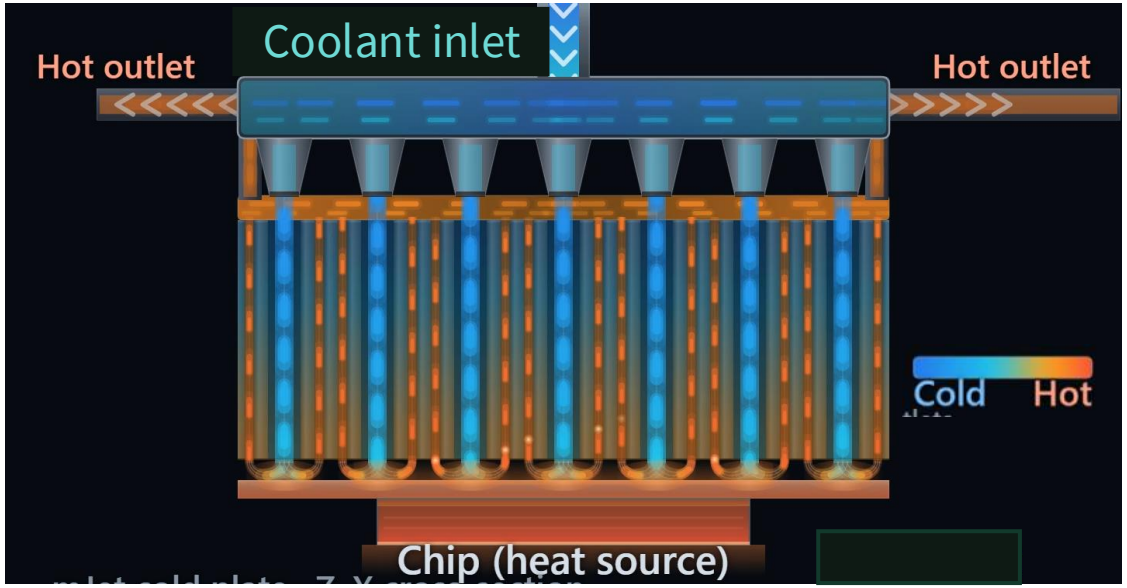
Primary heat-transfer surface
Innovative structure: tapered-width fins

mJet LCP: lower temperature, far less pumping power

mJet LCP cooling head one-piece vacuum-brazed copper



mJet LCP flow and temperature fields



800–3,500 W
chip power

>500 W/cm²
hotspot flux capability

1.35–4.5 L/min
flow rate

25–45 °C
inlet

VC LCP: VC and skived fins as one part

The problem with a stacked cold plate

Cover, skived fin, brazing layer, VC: four parts, three interfaces, three leak paths.

The HFH choice: fin and VC cover as one part

The fins are machined directly into the VC upper cover, so the brazing layer between them disappears. *Rth* and material costs are reduced.

Challenge

Complex welding process and quality assurance

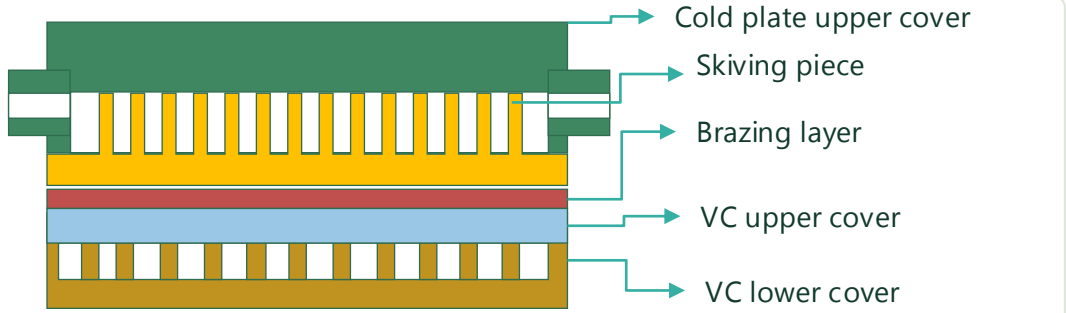
One part

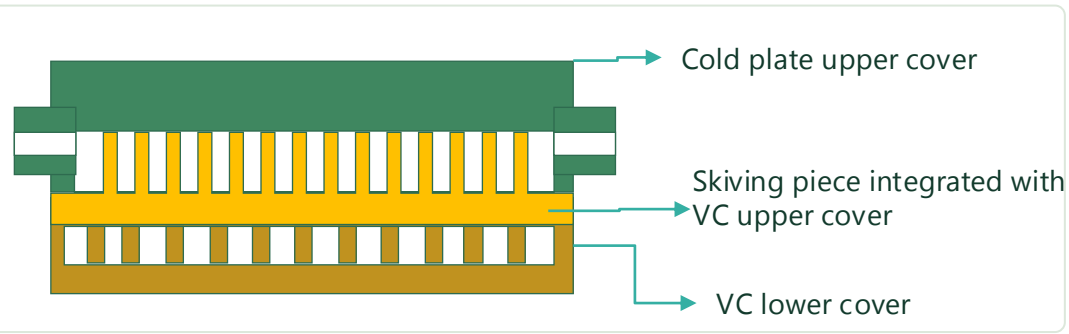
Simple & low cost

≥ 500 W/cm²

hotspot flux capacity

Traditional: VC and cold plate separated

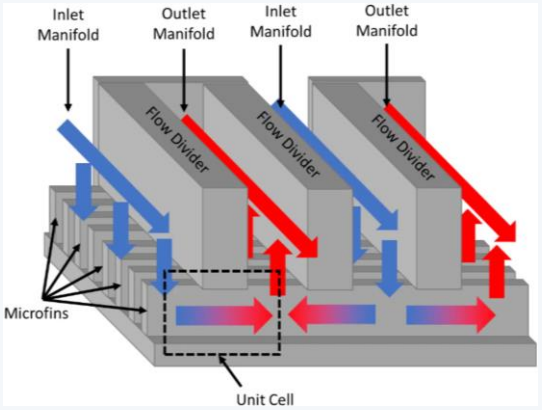




Now: VC and cold plate are integrated into one part

mJet LCP for TH7

Manifold Structure

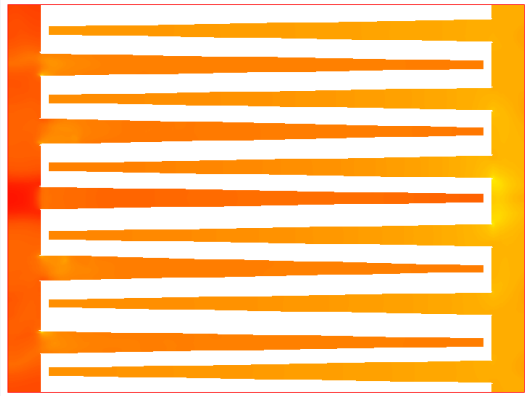


Flow dividers
Split the jet into parallel channels

Microfin array
High-density fins between dividers

Unit cell
Pattern repeats across the die

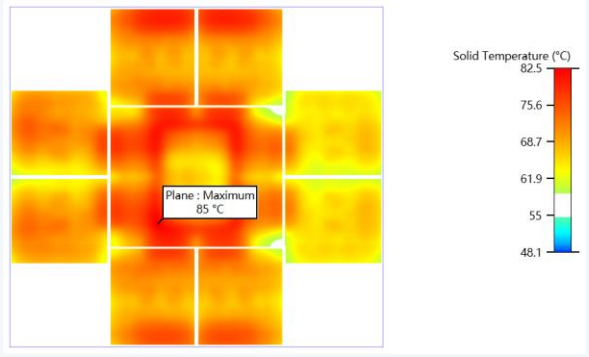
Microfin Temperature



Material	**Cu**
Fin height	**1.2 mm**
Fin thickness	**0.1 mm**
Fin spacing	**0.12 mm**

Tapered-width Fins are used to ensure high flow and thermal performance

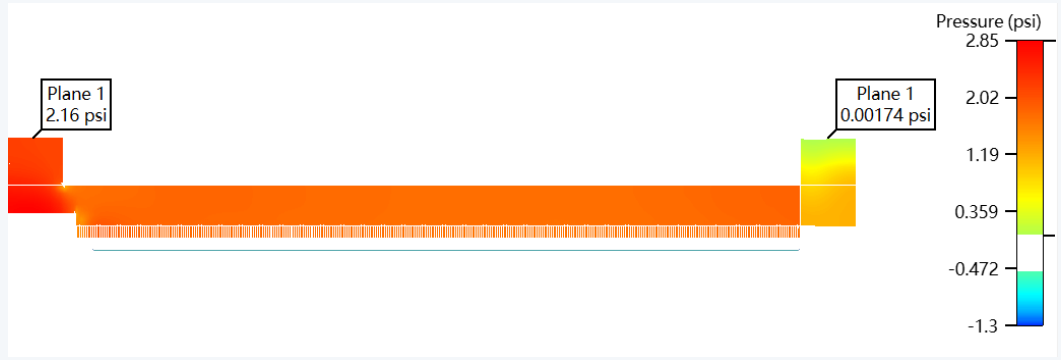
Temperature Field



Plane maximum	**85 °C**
Tcase limit	**90 °C**
Margin	**5 °C**

Pressure Distribution

2.16 psi



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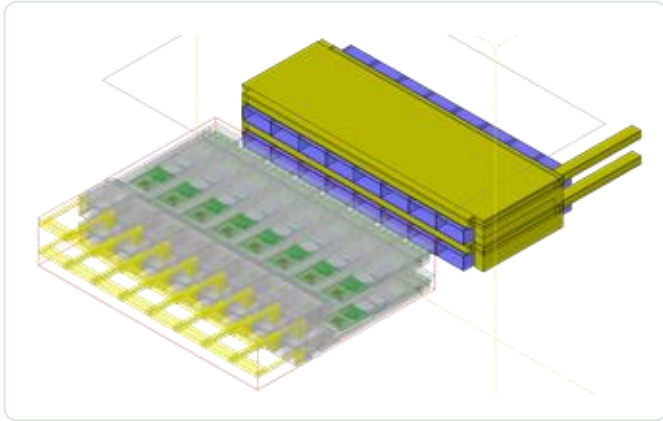
03 Cooling solutions for optical modules

3.1 Different cold-plate solutions
3.2 TIMs for Pluggable Interfaces

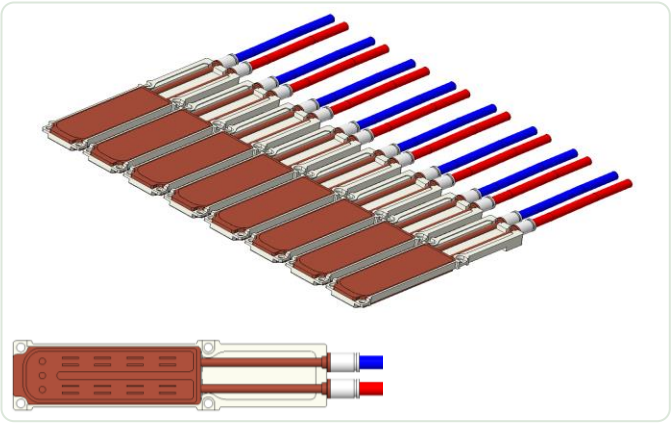
Optical modules: the floating cold plate

Why floating?

- Modules slide in flat; the cage cannot move up or down
- The cold plate floats instead, with even downforce on each module



2×8 floating cold plate, 3D view



1×1 floating cold plate, 3D view

1×16 shared

Simple, but modules may interact.

2×8 joint

Independent, but more joints.

1×1 floating · patent pending

Best contact, lowest pressure drop.

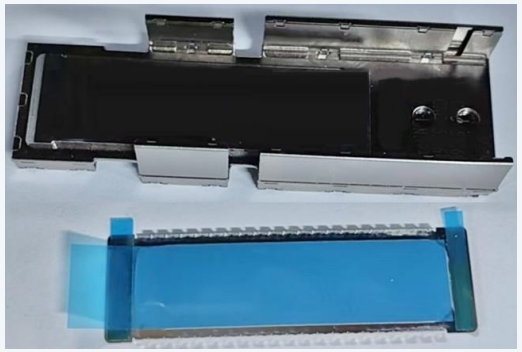
Customer defines the system · HFH makes the cold plates.

TIMs for Pluggable Interfaces

Thermal Tape



Thermal Skateboard



Thermal Coating



Specification	Thermal Tape	Thermal Skateboard	Thermal Coating
Thickness (mm)	0.1–1.6	0.26	0.03
Material	PCM + PI film	SUS301 + PCM	Silicone Composite
Interface ΔT @ 30 W	3–4 ℃	4–6 ℃	4-6 ℃
Heat stability	Medium	High	High
Insert / pull cycles	≤ 200	> 500	≥ 200
Material cost	Low	High	Medium

Thank You!

