Delta Liquid Cooling Solution

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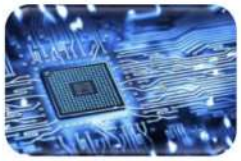
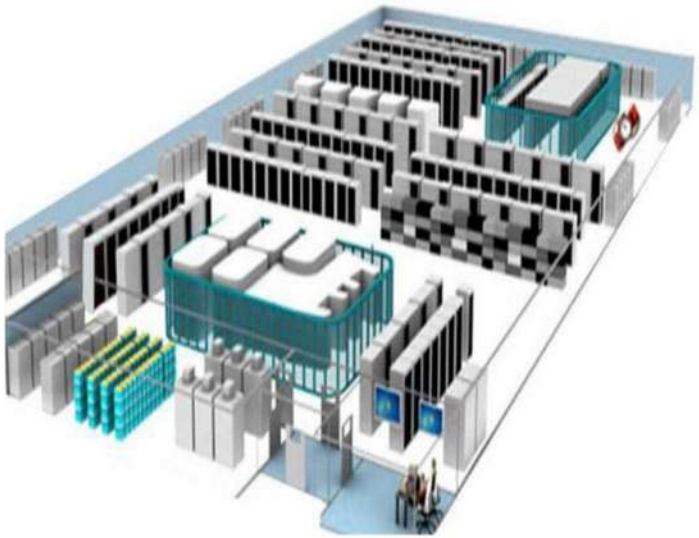
Delta Liquid Cooling Solution Portfolio

Big Data

High Performance Computing

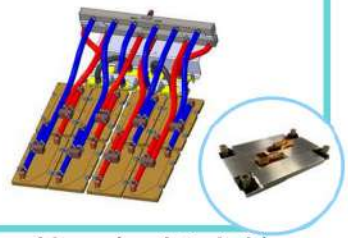


AI



Data Center Construction

Server Level



Closed loop (assisted air)
Open loop (assisted air/ facility water)

Rack Level

Liquid to Air CDU
Liquid to Liquid CDU

System level

Manifold
In-row CDU
Immersion Cooling

Feature

- Various high performance standard cold plate for data center liquid cooling
- Optimization for cold plate and loop design
- Integrating Delta DC fan and DC pump

Cold plate › Cold plate loop solution

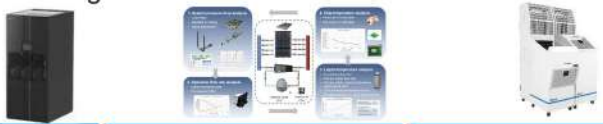
Feature

- Low power consumption
- Integrating Delta fan and pump
- Redundant pump design

L-A CDU › RPU › L-L CDU

Feature

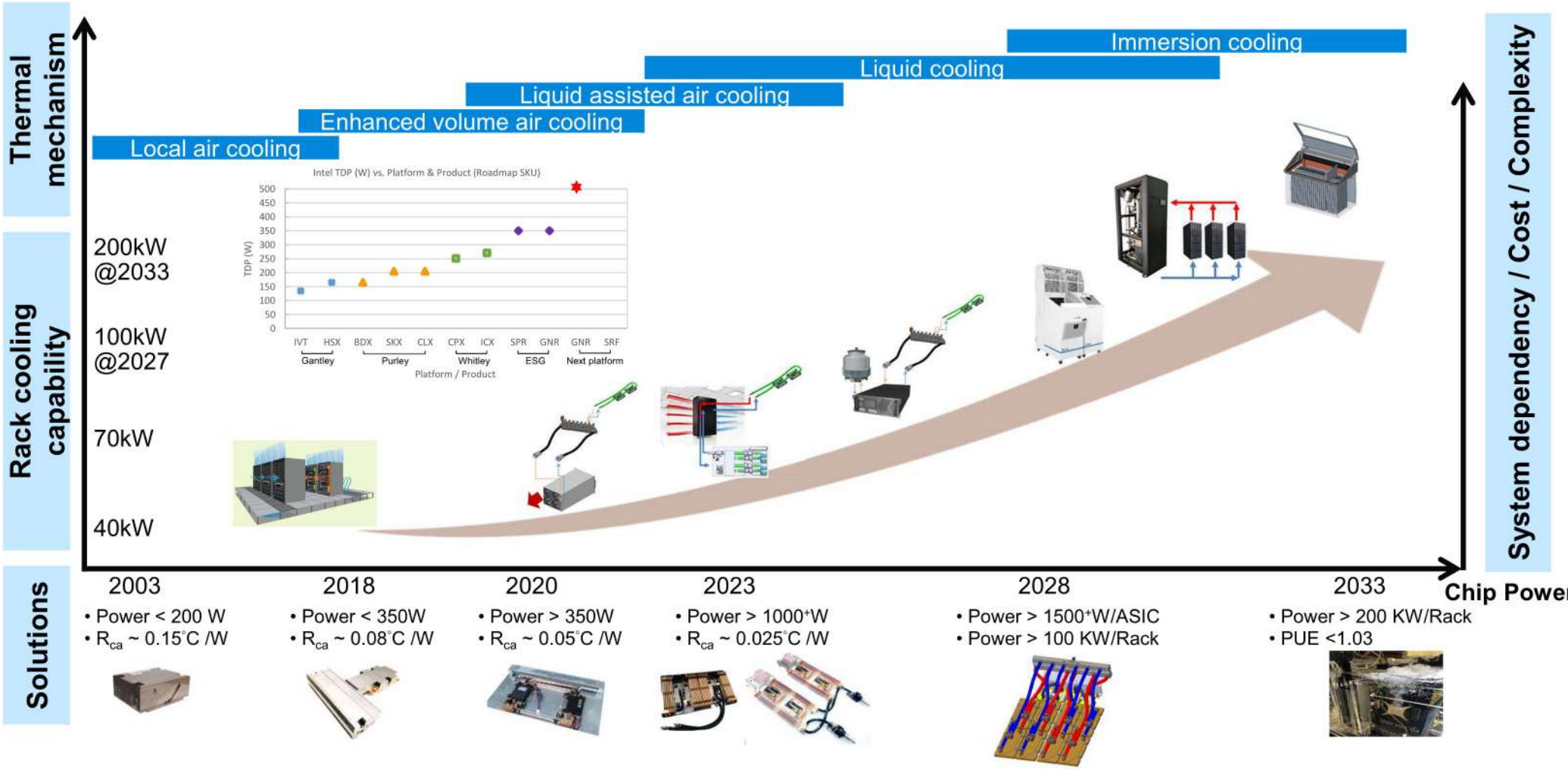
- High cooling capacity in row CDU
- Standardized, modularized design for immersion cooling solution



In- row CDU › Optimization LCS process › Immersion cooling

RPU: Reservoir pumping unit

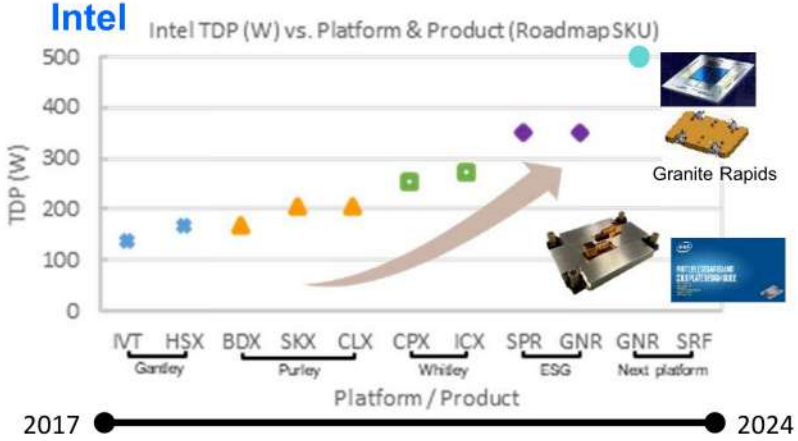
Data Center Thermal Solution Resolution



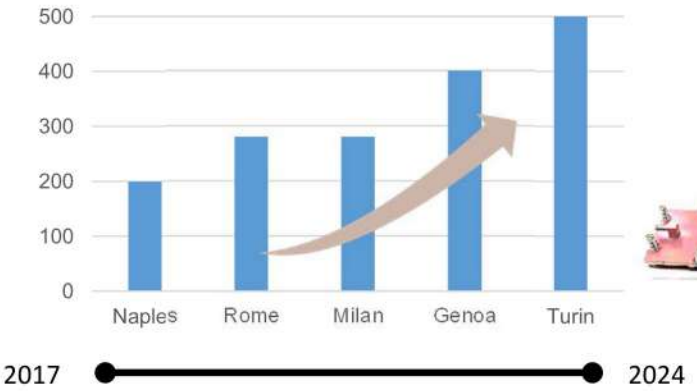
Commodity CPU/GPU vs Delta Cold Plate Solution

CPU

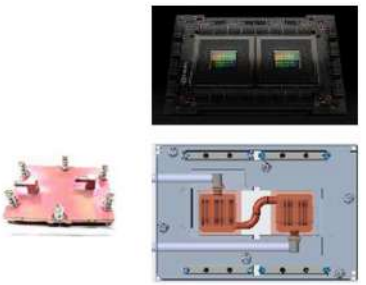
Intel



AMD



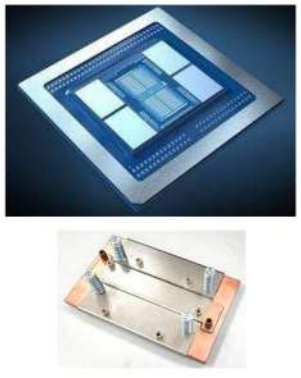
nVIDIA – C2



~600W

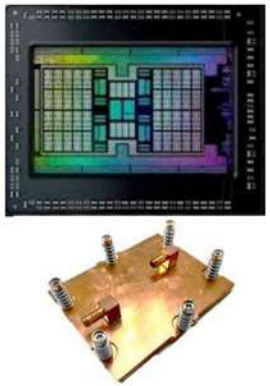
GPU

AMD- MI200



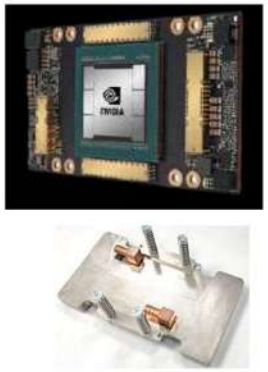
~560W

AMD- MI300C



~550W

nVIDIA – SXM4

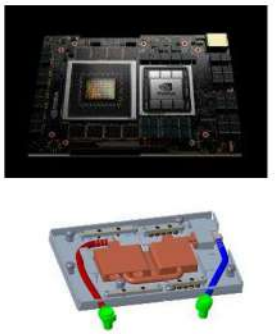


~500W

nVIDIA – SXM5

~700W

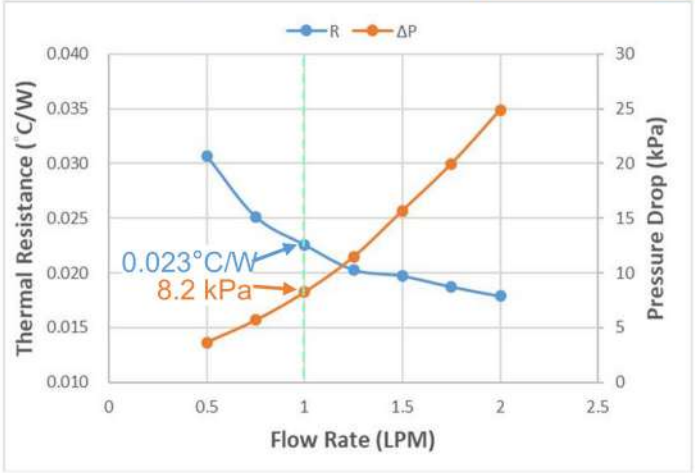
nVIDIA – GH200



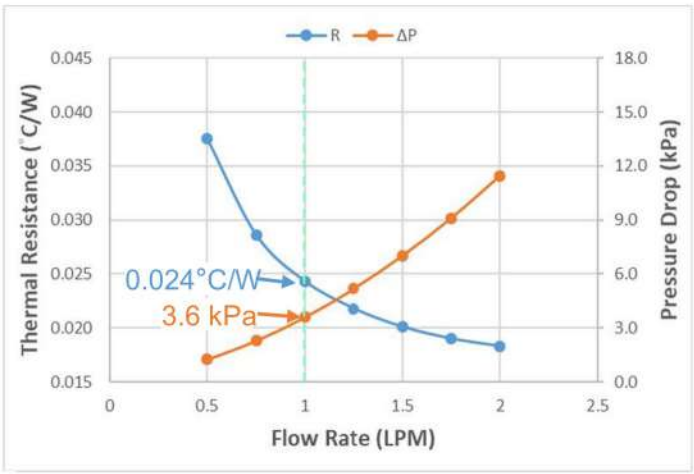
~1000W

Commodity CPU Cold Plate Performance

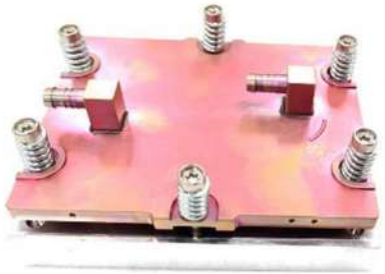
- Model: Intel Sapphire Rapids
- TDP: 350 W
- Stage: MP

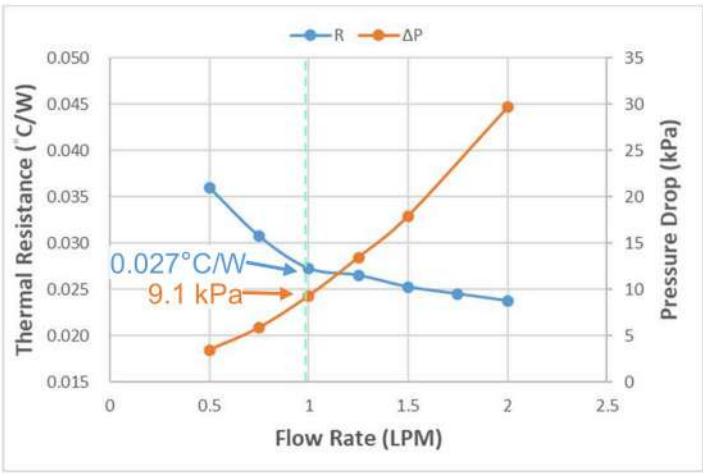


- Model: Intel Granite Rapids
- TDP: 500 W
- Stage: 2023/Sep MP



- Model: AMD Genoa
- TDP: 400 W
- Stage: MP

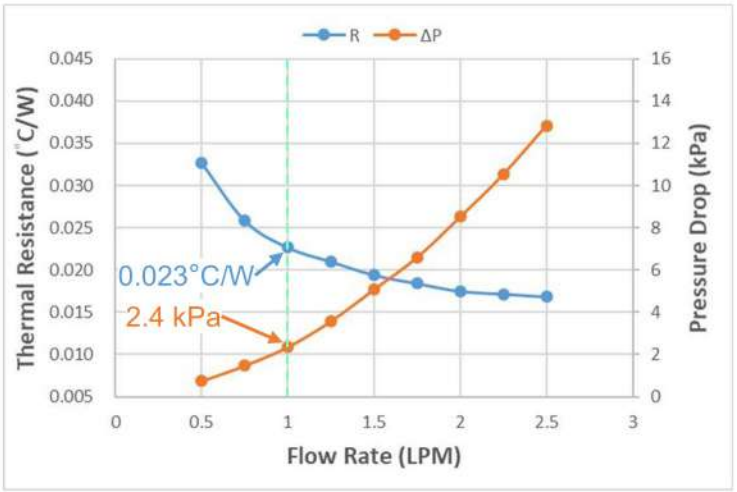




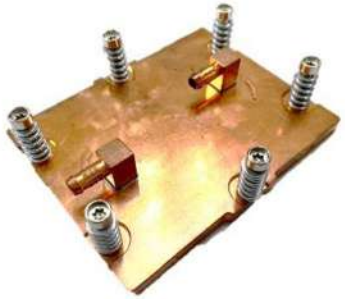
Intel doc#: 602060
Approved by Intel as LCS ecosystem solution listed in design guideline

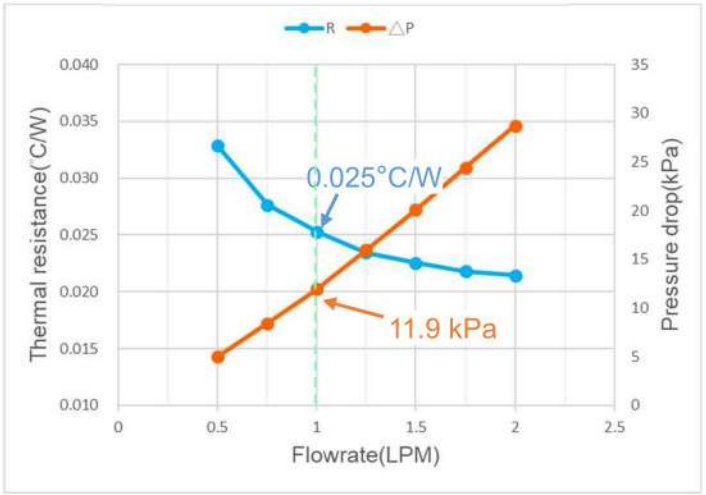
Commodity GPU Cold Plate Performance

- Model: AMD MI200
- TDP: 560 W
- Stage: MP

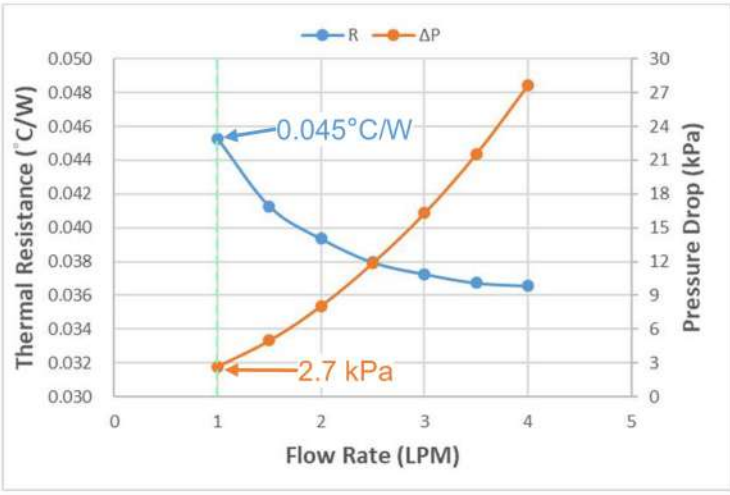


- Model: AMD MI300 C
- TDP: 550 W
- Stage: MP



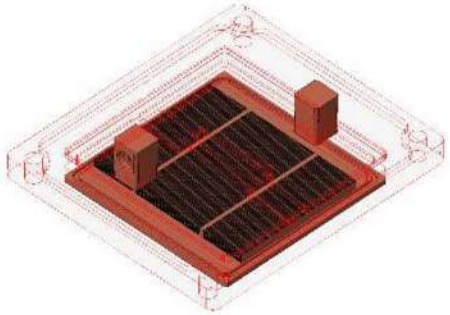


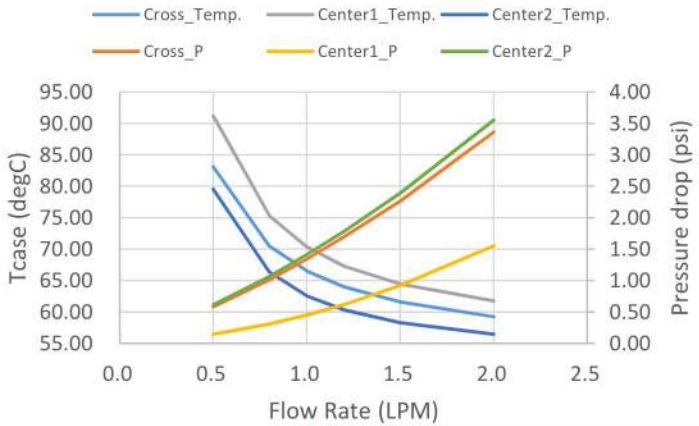
- Model: nVIDIA H100
- TDP: 700 W
- Stage: MP

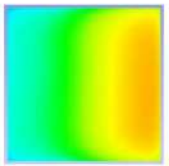
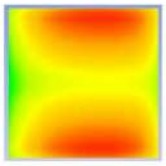
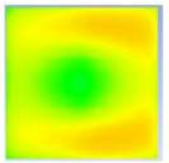


High TDP Liquid Cooling Technology - 1.5KW ASIC

- **Heat source : 70x70 mm**
- **Power: 1500W**
- **Coolant : PG25**





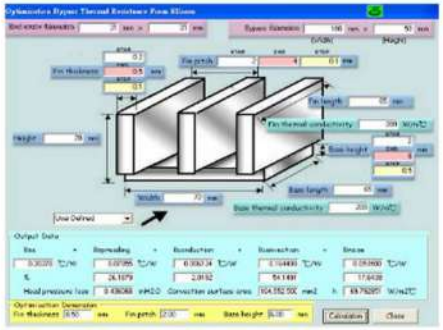
	Version A	Version B	Version C
Flow schematic	Cross flow	Low flow impedance design	Low thermal resistance design
Fin Density (FPI)	84.6	84.6	84.6
Fin Width (mm)	70.0	70.0	70.0
Fin thickness (mm)	0.15	0.15	0.15
Flow rate (LPM)	1.0	1.0	1.0
Thermal Resistance (^{o}C/W)	0.0190	0.0216	**0.0164**
T_{inlet} (^{o}C)	38.0	38.0	38.0
T_{case} (^{o}C) , center of lid	66.5	70.4	62.6
Pressure drop (psi)	1.34	**0.45**	1.41
Temperature distribution			

Ready technology for high thermal design power ASIC

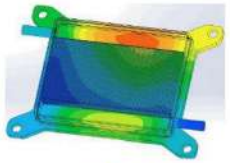
TDP: Thermal design power

Cold Plate Technology

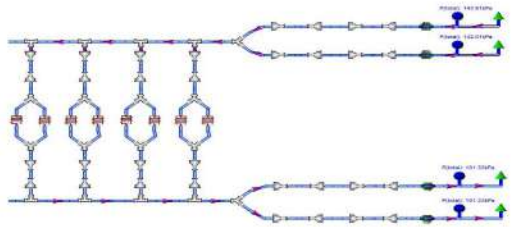
Analysis Tool – Self-developed Program/ Simulation Software



Self-developed program



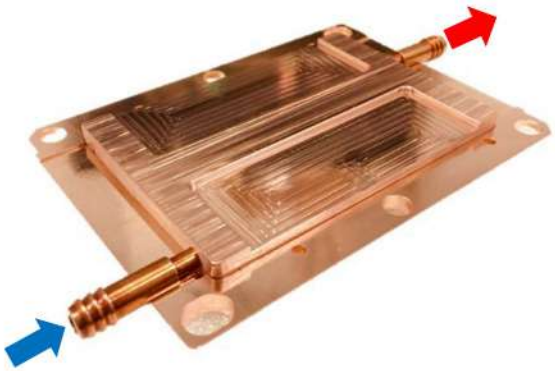
ANSYS icepak



FloTHERM®

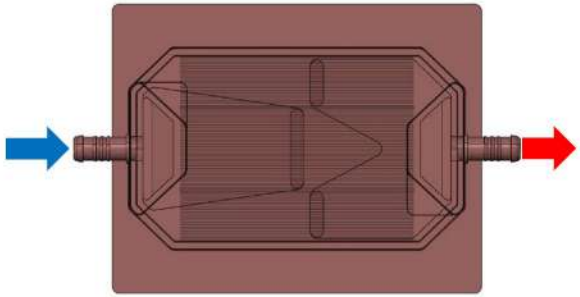
MACROFLOW

Cold Plate Design Technology



Impingement flow design

Pressure Impedance 15% ↓

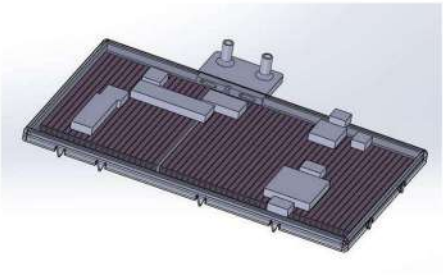


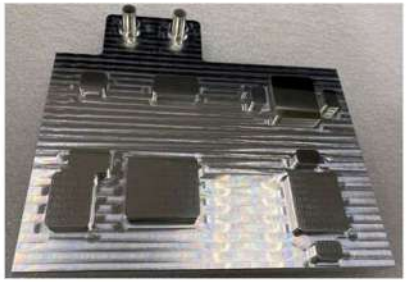
Impingement flow & reflow design

Performance 10% ↑ with Same Pressure Impedance

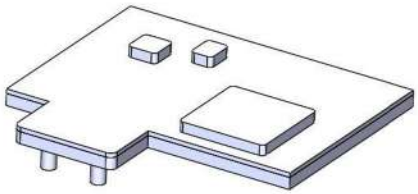
DELTA

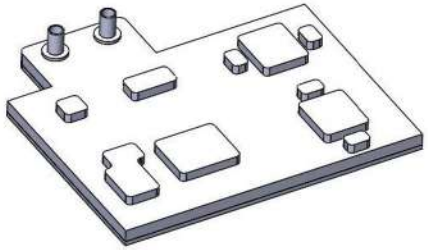
AL Brazing Cold Plate



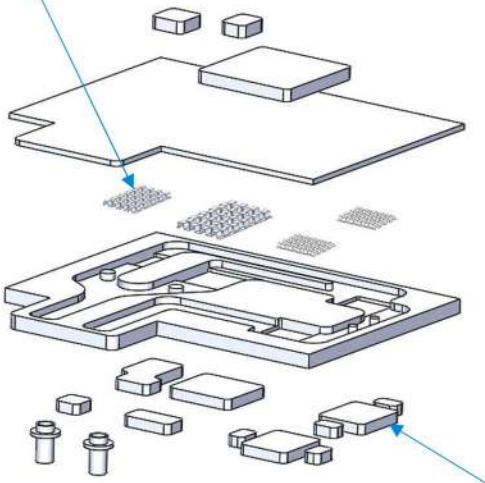


Brazing coldplate

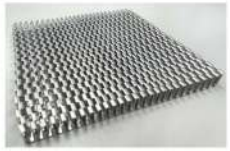




- Inner structure – Stacked fin/Folded fin/Skiving fin can be selected



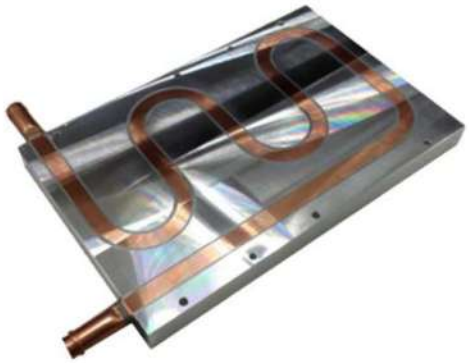
- Multiple heat sources contact

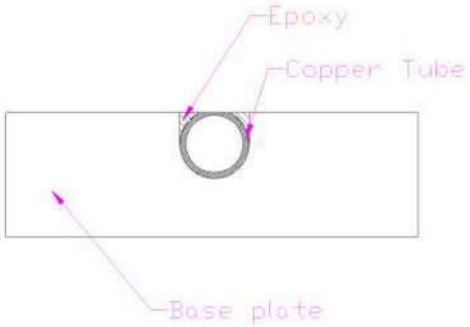


Capacity

- Composite material
- Brazing material
- Various fin structure:
  extrusion/stacked fin/skive fin/Folded fin
- Stacked fin:
  fin thickness: 0.3mm; fin gap: 0.5mm

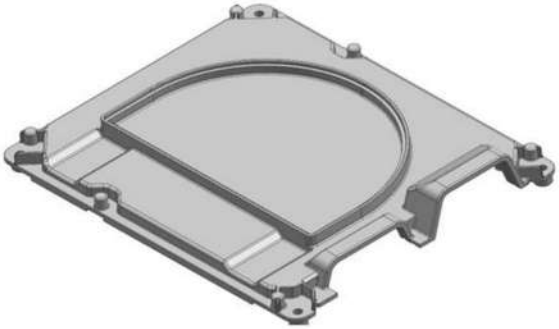
Tube Embedded Cold Plate

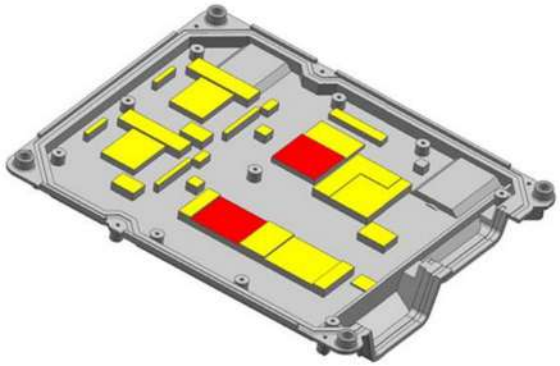


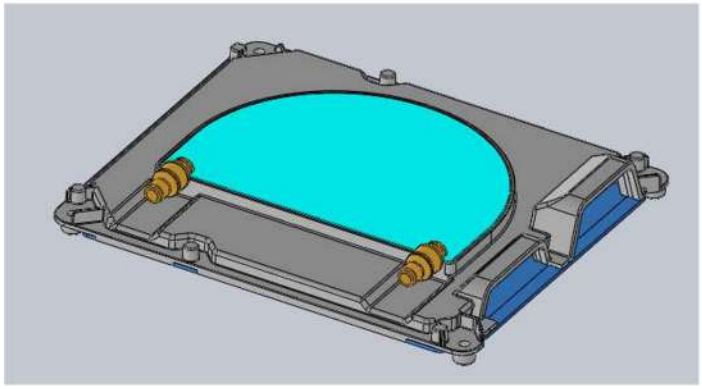


Capacity

- Al/Cu base
- C12200 tube material
- High thermal conductivity epoxy
- Tube exposed

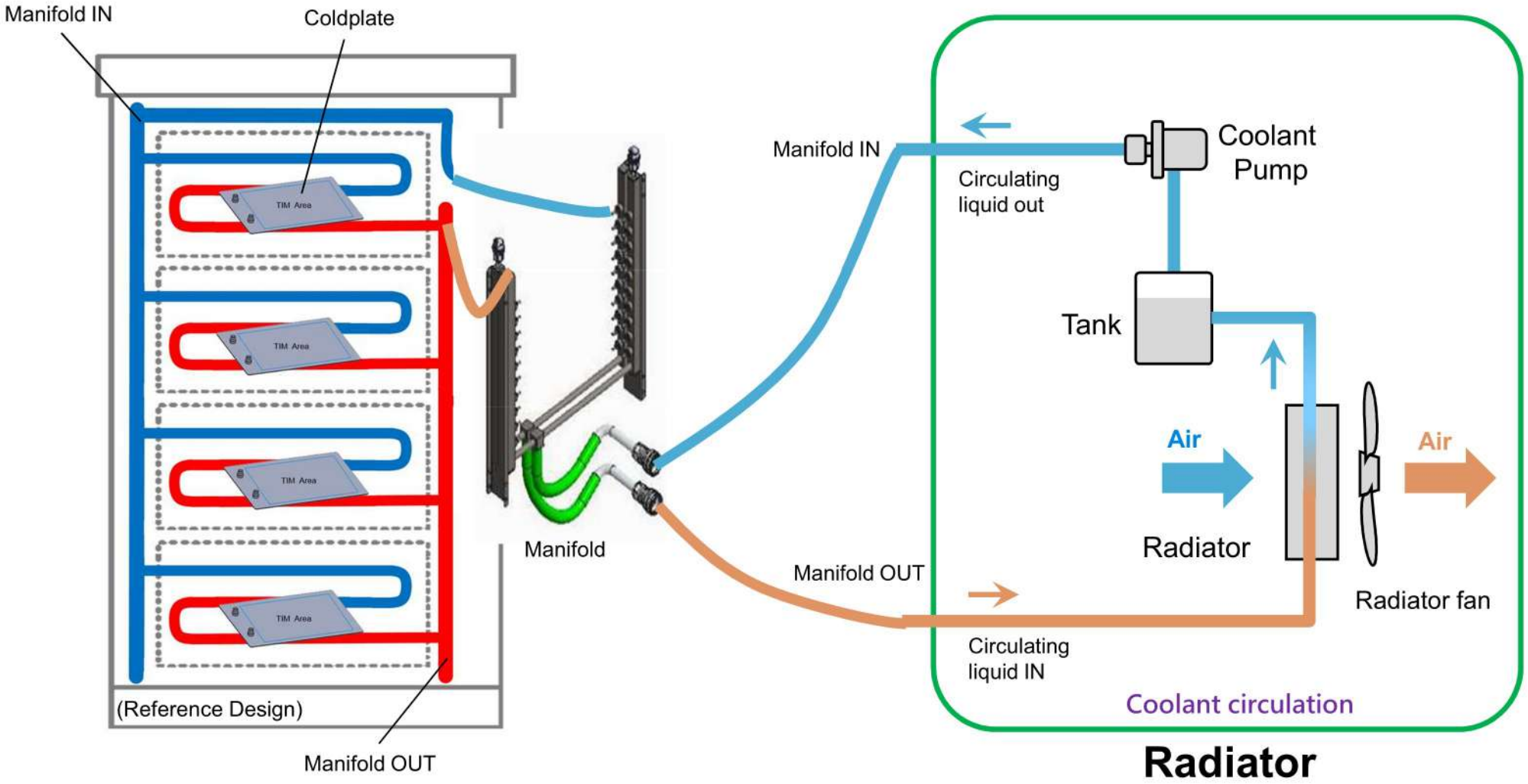






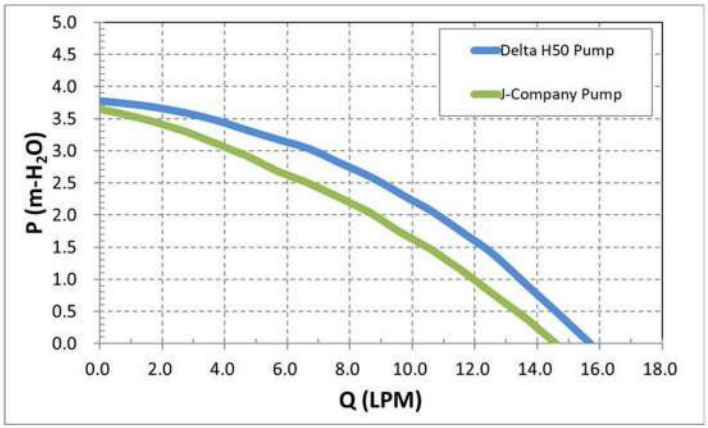
- By using copper tube embedded in **die casting** to handle the heat for control unit

Radiator option proposal



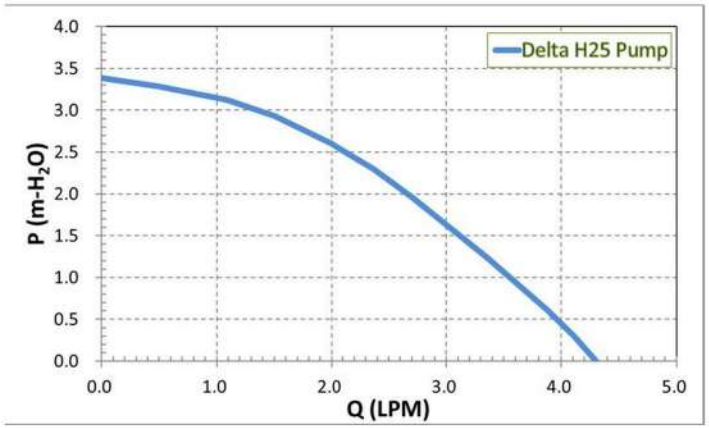
Delta Pump Performance

2U Application (H50mm)



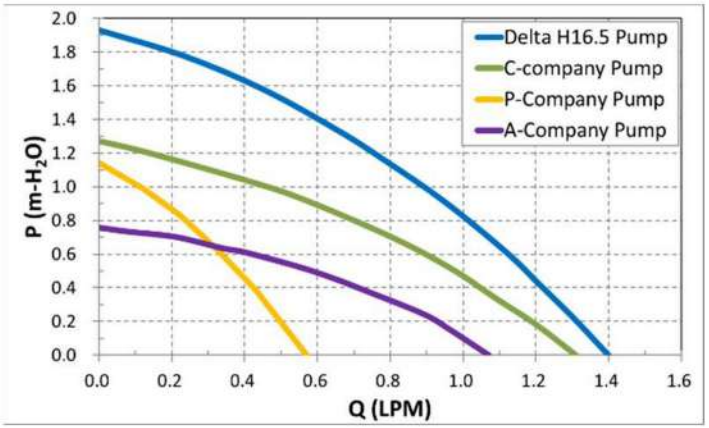
Verified MTTF 50 ℃ (hrs)	2,077,723
Verified L_{10} 50 ℃ (hrs)	296,818

1.5U Application (H25mm)



Verified MTTF 50 ℃ (hrs)	532,407 (Processing)
Verified L_{10} 50 ℃ (hrs)	76,058 (Processing)

1U Application (H16.5mm)



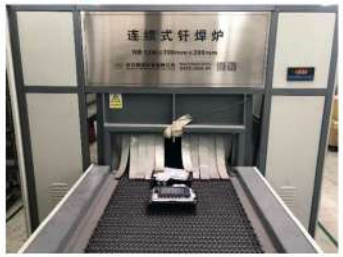
Verified MTTF 50 ℃ (hrs)	775,632
Verified L_{10} 50 ℃ (hrs)	110,805

With self-developed technology
Delta pump features both high PQ performance with long life expectancy

Liquid Cooling Solution Manufacturing Capability

■ Brazing oven - Copper

■ Brazing oven - Aluminum



■ Brazing material dispenser

■ Welding

■ Flow & Thermal Testing

■ Cleaning

■ Drying

■ Vacuum Oven

■ Helium Testing

■ Run In & Burn In Chamber

■ Pressure Holding Test

■ Pressure Pulse / Decay Test

■ Reliability : Burst Test

In-line process/testing and inspection for quality control

Coolant Distribution Unit

Liquid to Liquid CDU

Model:DHS-X430175-01

- 4U height
- 450 (W) x 900 (D) x 175 (H) mm
- Cooling capacity: 100 kW @$T_{approach}$=18°C
- Full load power consumption: 580 W
- Modbus / Redfish / Webserver
- Smart self-protection & High performance pump
- Facility chiller
- Comply UL 62368

Intel doc#: 636703
Approved by Intel as LCS ecosystem solution listed in design guideline

Liquid to Air CDU

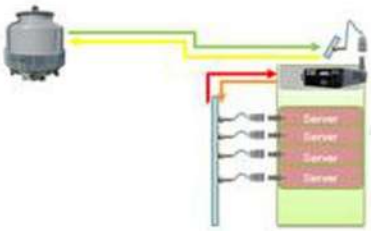
Model:FHS-X440350-01

- 8U height
- 450 (W) x 900 (D) x 350 (H) mm
- Cooling capacity: 14 kW @$T_{approach}$=25°C
- Full load power consumption: 2,200 W
- Modbus / Redfish / Webserver
- Smart self-protection &
- High performance pump & fan
- CDU cooling fan
- Comply UL60335

Approved by Intel as liquid cooling solution ecosystem listed in design guideline

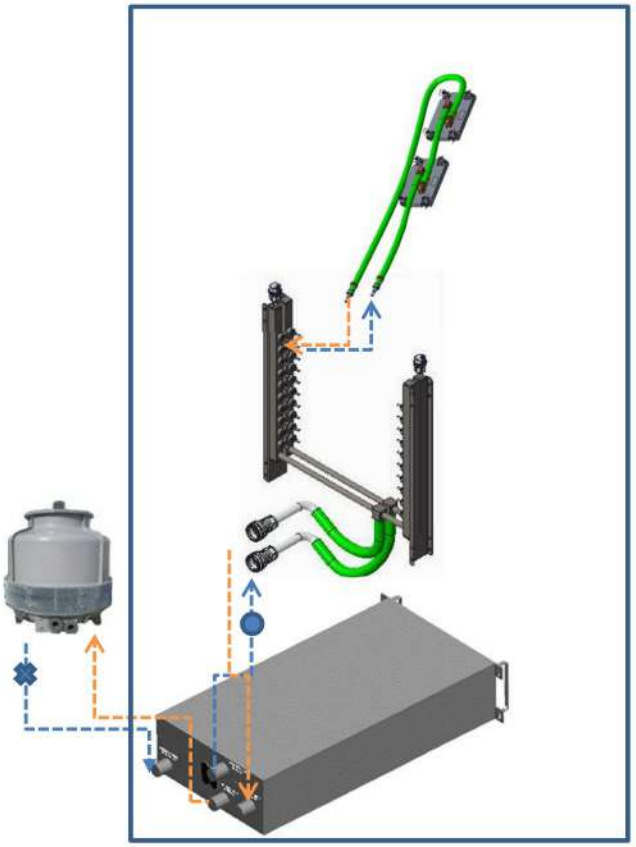
Coolant Distribution Unit – Liquid to Liquid

Liquid to Liquid CDU



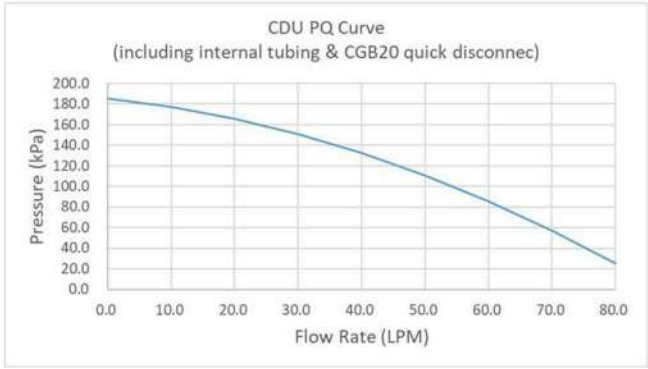
Liquid to liquid CDU (4U height)

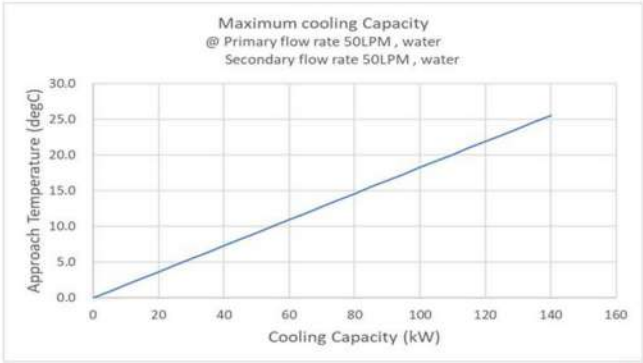
- **Need facility chiller**
- 450 (W) x 900 (D) x 175 (H) mm
- Cooling capacity is 100 kW
  @ approach temperature = 18°C
- Pressure control/
  Dew point temperature control/
  Liquid flow control/
- Redundant pump design
- Leakage and condensation alarm
- Power consumption: 580 W
- Low power consumption



T app (Approach temperature)
= Secondary supply (●) – Primary supply (✖)

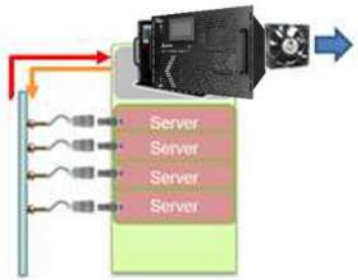
PQ Curve of CDU





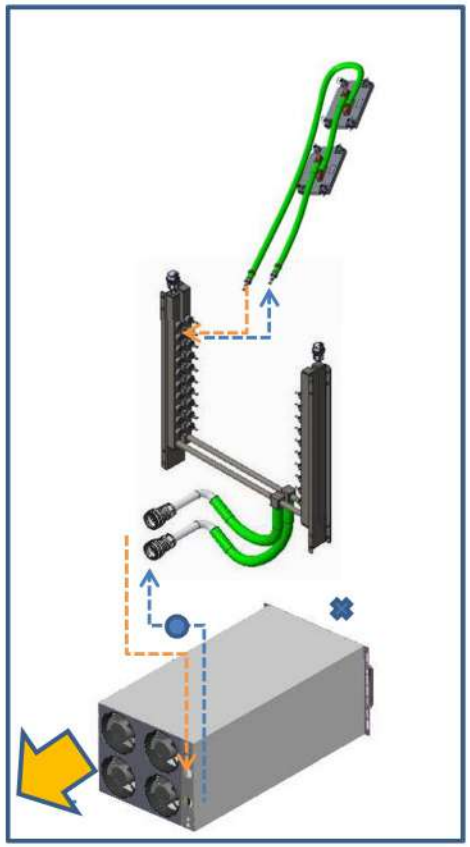
Coolant Distribution Unit – Liquid to Air

Liquid to Air CDU

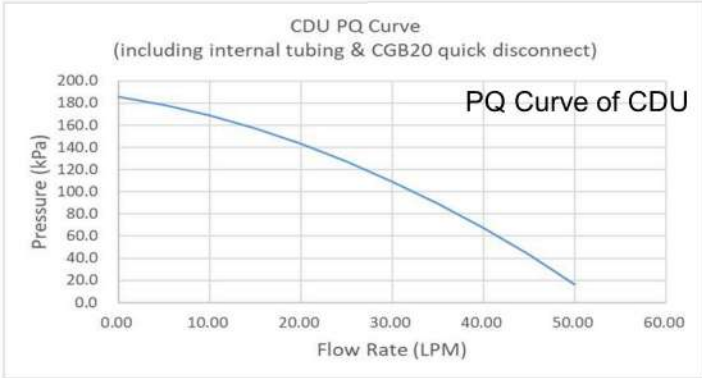


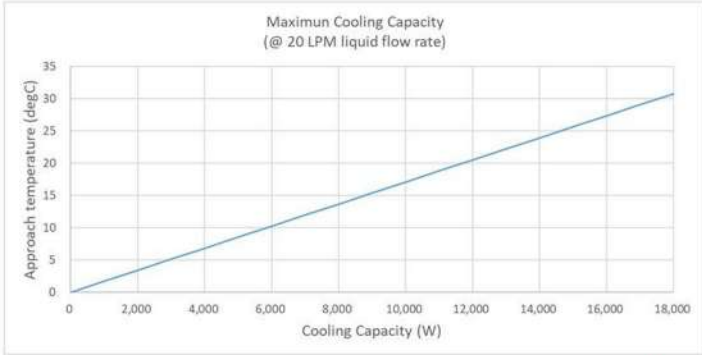
Liquid to Air CDU (8U height)

- **No need facility chiller, easy to build up liquid cooling solution**
- 450 (W) x 900 (D) x 350 (H) mm
- Cooling capacity is 14 kW
  @ approach temperature = 25°C
- Pressure control/
  Liquid flow control/
  liquid-air heat exchange
- Redundant pump design
- Leakage alarm
- Power consumption: 2,000 W



T app (Approach temperature)
= Secondary supply (●) – Primary supply (✖)



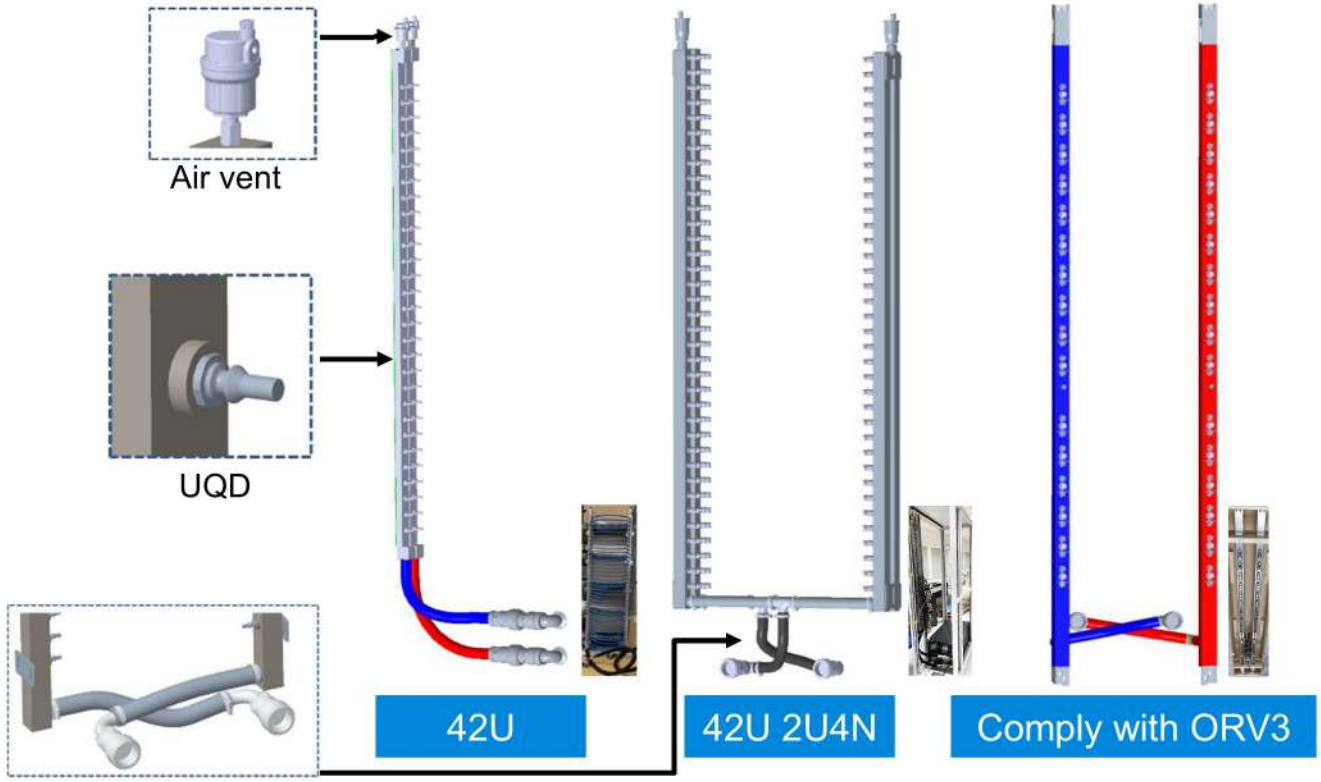


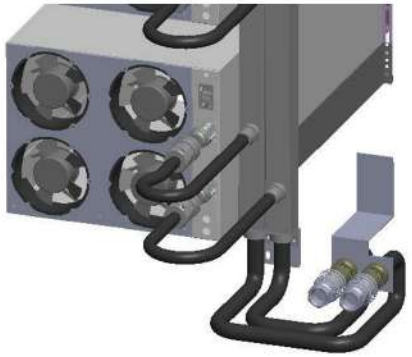
Manifold Design Capability

Manifold design

- Customized per demand
- QD selection
- Highly reliable
- Easy to use
- Materials compatibility

- Hose consideration
- Fluid compatibility
- Wetted material consideration



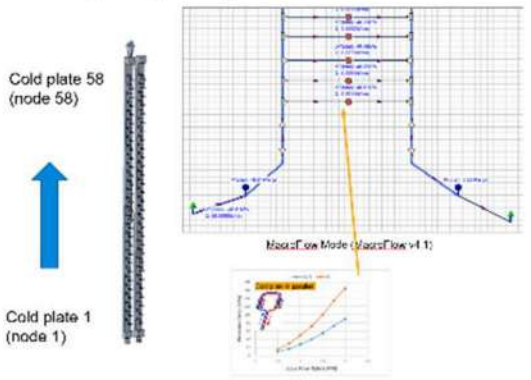


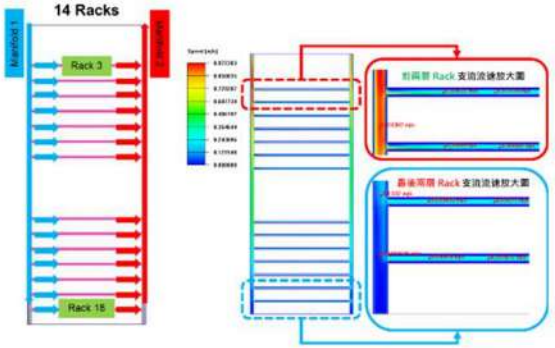
Manifold Design Capability

Even Distribution

Manifold Distribution Analysis

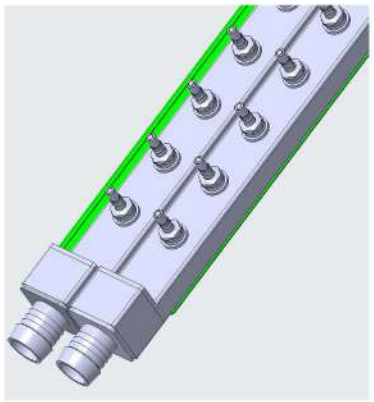
Manifold
- Total 58 nodes (58 cold plate loops)



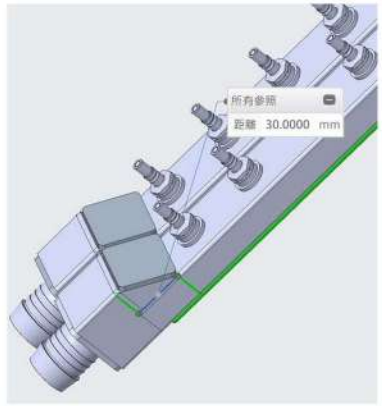


Rack 1 (LPM)	Empty
Rack 2 (LPM)	Empty
Rack 3 (LPM)	1.630
Rack 4 (LPM)	1.626
Rack 5 (LPM)	1.618
Rack 6 (LPM)	1.611
Rack 7 (LPM)	1.605
Rack 8 (LPM)	1.600
Rack 9 (LPM)	1.596
Rack 10 (LPM)	Empty
Rack 11 (LPM)	Empty
Rack 12 (LPM)	1.586
Rack 13 (LPM)	1.584
Rack 14 (LPM)	1.582
Rack 15 (LPM)	1.580
Rack 16 (LPM)	1.579
Rack 17 (LPM)	1.579
Rack 18 (LPM)	1.579
Average $\bar{X}$ (LPM)	1.597
standard deviation σ (LPM)	0.018
ΔP_{Total} (Pa)	12832.5
Total Flow Rate (LPM)	22.4
Flow Uniformity ($\sigma/\bar{X}$*100%)	1.109 %

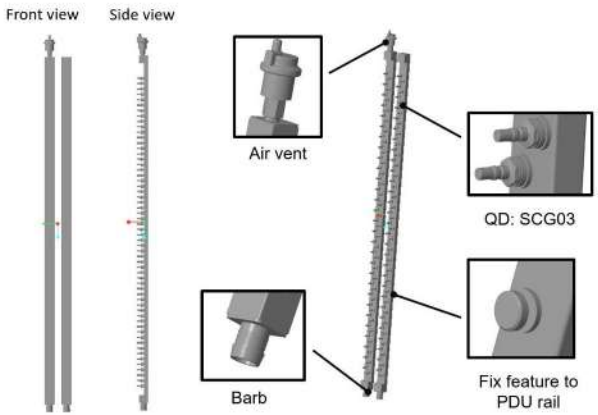
Low Pressure Drop



Improve pressure drop



Customized per Demand



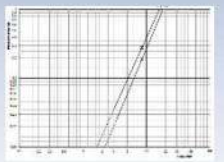
Integration Capability for Total Liquid Cooling Solution

1. System pressure drop analysis

- Cold Plate
- Manifold & Tubing
- Quick disconnect

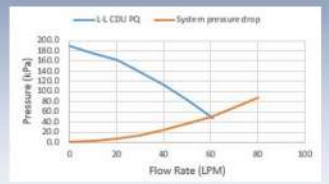


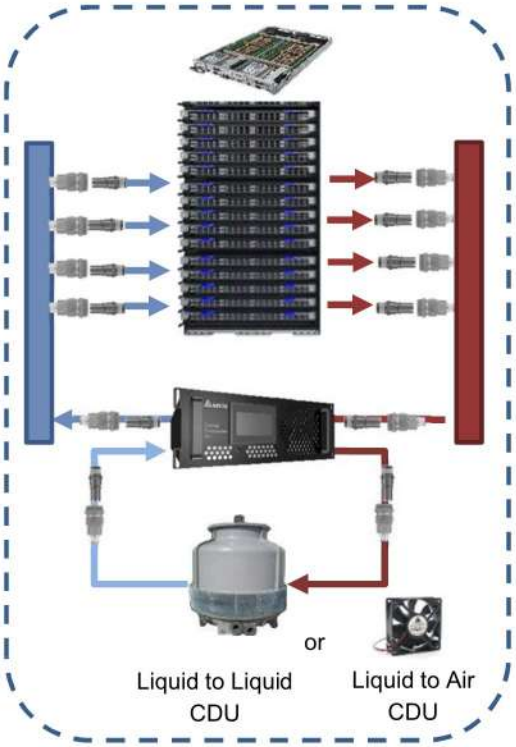




2. Operation flow rate analysis

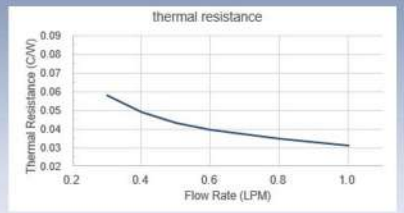
- System pressure drop
- PQ curve of CDU

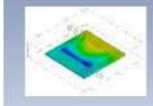
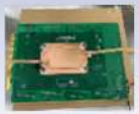




4. Chip temperature analysis

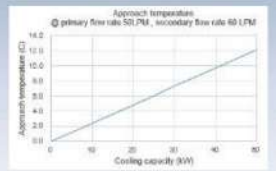
- Flow rate of cold plate
- RQ curve of cold plate

3. Liquid temperature analysis

- Secondary flow rate
- Primary water flow rate
- Primary water supply temperature
- Heat load of rack
- CDU thermal performance curve (Cooling capacity vs. app. temperature)

Delta could integrate and provide total liquid cooling solution

CDU Manufacturing Capability

CDU Production Line

Intelligent Visual Image Detection

Smart screwdriving system

Function Test

Equipment Coolant: Dow PG25%
Equipment Filter mesh:25um
Equipment PH Monitor: 8.0~10.5

Burn-in Test

Equipment Coolant: Dow PG25%
Equipment Filter mesh:25um
Equipment PH Monitor:8.0~10.5

Drying & Filling

Filling with Nitrogen