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Eco-System Enabling of Liquid Cooling Ingredients

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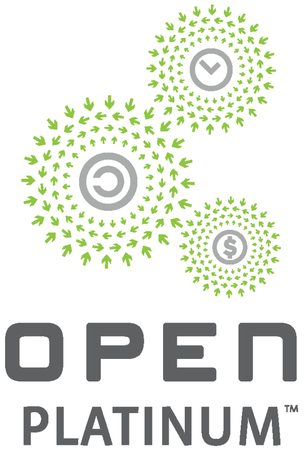


Introduction - Liquid Cooling

Advanced Cooling

Continued demand for increased compute performance result in increased power and power density

- More efficient cooling than air cooling required ➔ liquid cooling
- Greater cooling capability
- Higher density

Intel working with suppliers to enable liquid cooling ingredients to:

- Increase availability
- Lower risk
- Generational and system supplier compatibility
- Faster time to market opportunity

Intel’s Eco-System Enabling

Advanced Cooling

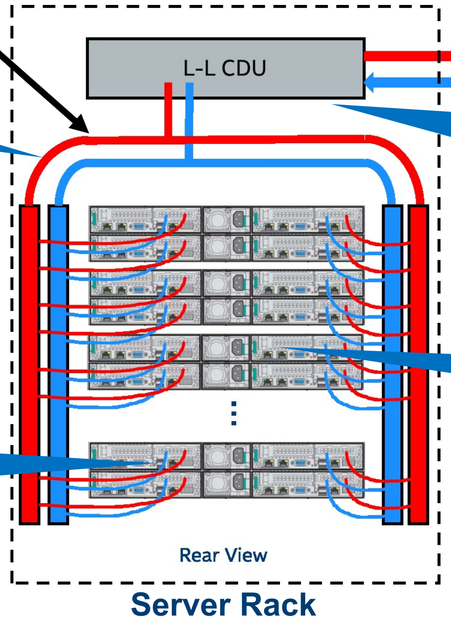
Focus: Manifold Distributed Liquid Cooling Ingredients

Secondary Fluid Loop = from CDU through the rack

Facility Water System (Primary Side)

Cooling Fluid

Universal Quick Disconnects (UQD)



CDU Guidelines Liquid-to-Liquid

Cold Plate Design

Ingredient Requirements and specs

Outline

Advanced Cooling

- Secondary Loop Ingredients
  - Cooling Fluid
  - Universal Quick Disconnects (UQDs)
  - Cooling Distribution Units (CDUs)
  - Cold Plates
- Summary

Cooling Fluid

Advanced Cooling

- Wetted materials and cooling fluid compatibility extremely important
  - Wetted materials = All materials in contact with the cooling fluid
- Quality requirements of cooling fluid needs to be determined
  - corrosion, fouling, scale, microbial, …
- Maintenance of fluid as required by manufacturer
- Cooling Fluid Options:
  - Water with additives
  - Glycol based
  - Dielectric Fluids

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  - Glycol based: Propylene Glycol – PG 55 & PG 25
  - Dielectric Fluids

Cooling Fluid

Wetted Materials in Secondary Loop

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Copper
Ethylene Propylene Diene Monomer (EPDM)
Fluoroelastomer (FKM) (Viton GF, Viton ETP)
Fluorinated Ethylene Polypropylene (FEP)
High Density Polyethylene (HDPE)
Polyphenylene Sulfide (PPS) 40% Fortron reinforced
Polytetrafluoroethylene (PTFE)
Polypropylene (PP)
Polysulfone
Stainless Steels
Stainless Steel; Solution Treated and Passivated
Stainless Steel; 316L or 304L
Thread Sealant

Important to identify ALL wetted materials to ensure material compatibility

Cooling Fluid

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Fluid Operating Range

Parameters	Value	Comments
Shipping & Storage Temperature	- 40°C to 70°C	- 40°C is commonly used for shipping and storage temperature
Operating Temperature	17°C to 65°C	ASHARE recommendation 17°C dew point

Important to work with fluid supplier to understand fluid maintenance and treatment requirements

Important to determine fluid operating range and fluid maintenance requirements

Universal Quick Disconnect (UQD)

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IT Equipment is connected to the cooling fluid: Quick Disconnects (QD's) or blind mate

Purpose: Generate Universal connectors that allow for interchangeability to simplify installations of liquid cooled IT equipment

Objective of UQD Initiative:

- Specify the interface dimensions for interchangeability
- Defining minimum acceptable performance for a no-drip fluid coupling
- Work with multiple suppliers to ensure global availability
- Phase I – Hand Mate Connect ~Q2'19
- Phase II – Blind Mate Connect ~Q4'19

UQD - Nomenclature & Markings

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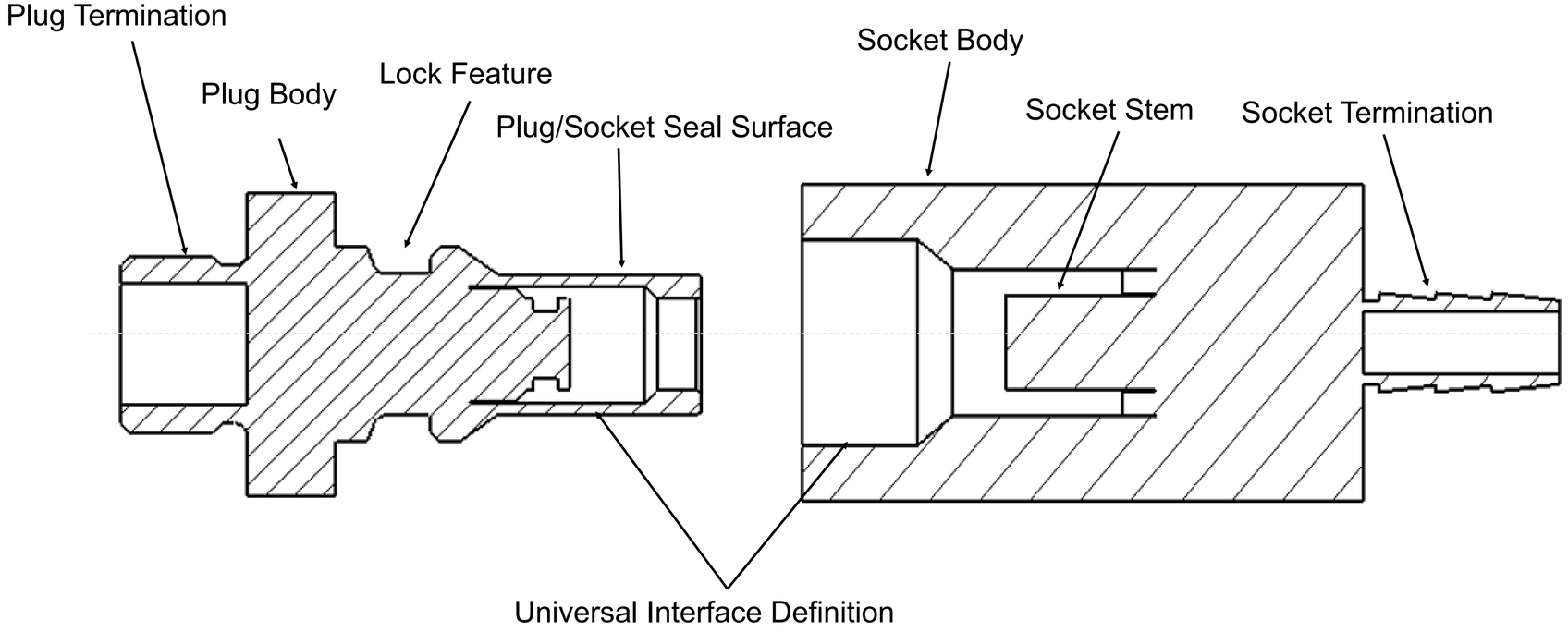
UQD Plug

UQD Socket



Identification

Every plug and socket that is designed to the Universal QD Requirements will be marked with the following:

Marking	Nominal Valve Size
UQD02	1/8”
UQD04	1/4”
UQD06	3/8”
UQD08	1/2”

Purpose: Obvious & Interchangeable

UQD - Interface Specifications

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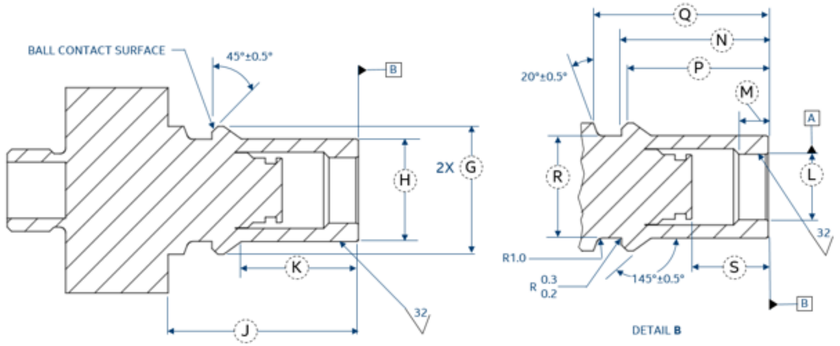
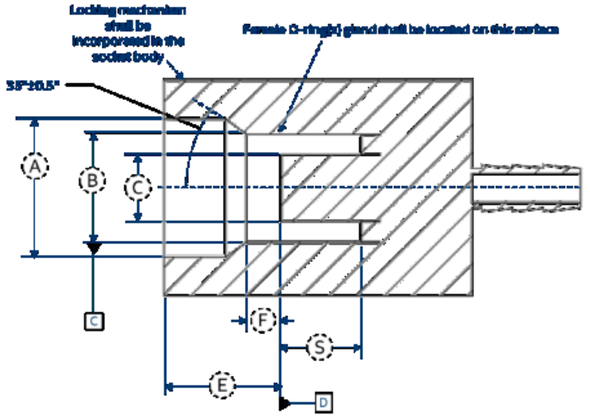
UQD PLUG



Size	G	H	J	K	L	M
	±0.025	±0.025	MIN	±0.3	±0.025	
UQD02	ØXX.X	ØXX.X	XX.X	XX.X	ØXX	
UQD04	ØXX.X	ØXX.X	XX.X	XX.X	ØX	
UQD06	ØXX.X	ØXX.X	XX.X	XX.X	Ø	
UQD08	ØXX.X	ØXX.X	XX.X	XX.X		

UQD SOCKET



Size	A	B	C	E	F	S
	MIN	±0.025	±0.025	Max/Min	±0.10	REF
UQD02	ØXX.XX	ØXX.XX	ØXX.XX	XX.X XX.X	X.X	XX.X
UQD04	ØXX.XX	ØXX.XX	ØXX.XX	XX.X XX.X	X.X	XX.X
UQD06	ØXX.XX	ØXX.XX	ØXX.XX	XX.X XX.X	X.X	XX.X
UQD08	ØXX.XX	ØXX.XX	ØXX.XX	XX.X XX.X	X.X	XX.X

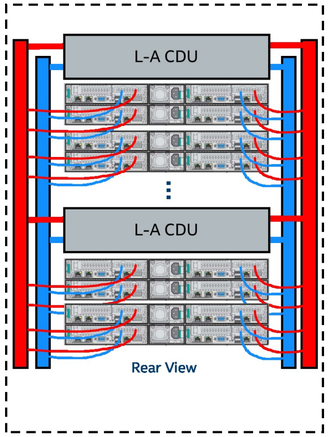
Purpose: Minimum Specifications to Ensure Universal Interface

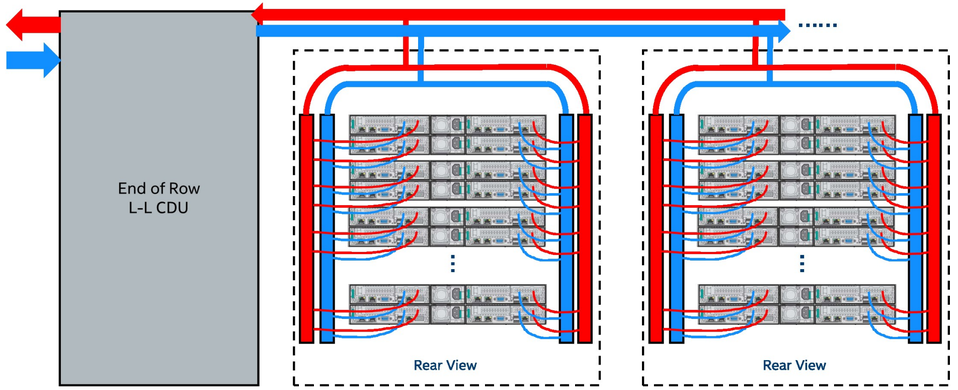
Cooling Distribution Unit (CDU)

Advanced Cooling

CDU options:

- In-rack CDU/End of row CDU/Virtual CDU
- Liquid-to-Liquid CDU
- Liquid-to-Air CDU





Important to work with CDU suppliers to ensure material compatibility with cooling fluid

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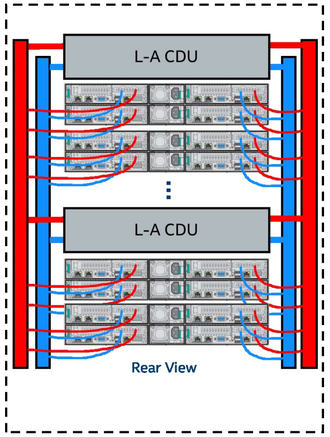
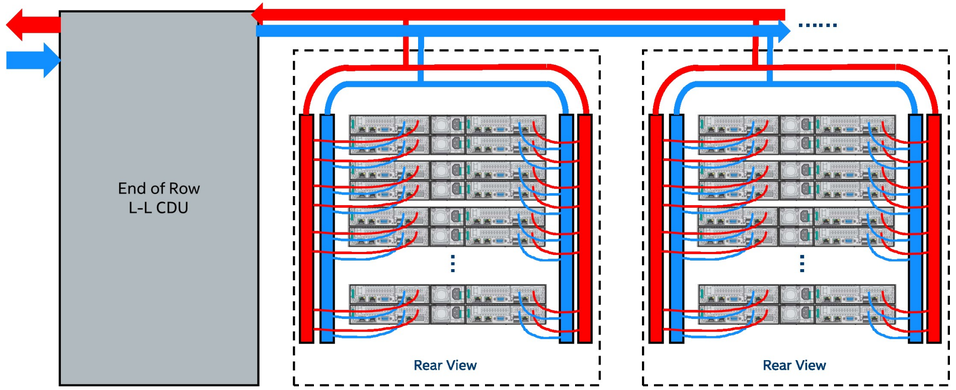




Important to work with CDU suppliers to ensure material compatibility with cooling fluid

Cooling Distribution Unit (CDU)

Advanced Cooling

Parameters to consider for evaluating fluid compatibility in commercially available CDUs

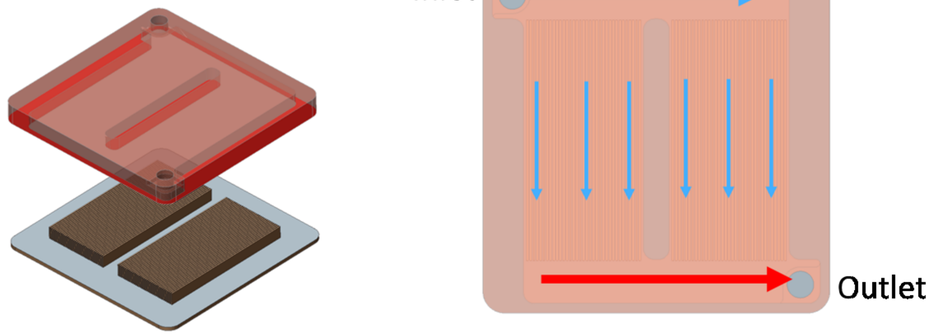
Category	Parameters
L_{10} Pump Life	• Time taken for 10% sample population to reach failure.
System MTBF	• Calculate mean time between failure for critical CDU components (e.g., pumps, etc.)
Mechanical	• T=0, T=*i*, T = 10 years; where *i* represents additional time points. • Leak testing, compression testing of seals, gaskets, etc.
Chemical	• Analysis of cooling fluid to demonstrate chemical compatibility of wetted materials with fluid
Heat Exchanger Thermal Performance	• Effect of fluid on heat exchanger thermal performance (derating on CDU, approach T, etc.)
Pump Performance	• Compare pump curves and efficiency at T=0, T=*i* and T=10 years; where *i* represents additional time points
Thermal Cycling: Operating Temperature	• Ramp between min/max operating temperatures, ramp rate, dwell time, cycle count (life expectancy)
Thermal Cycling: Non-operating Temperature	• Fast ramp rate between shipping temperature and storage temperature, dwell time, cycle count

Note: The specific validation and qualification plan will vary depending on the design/risks/etc

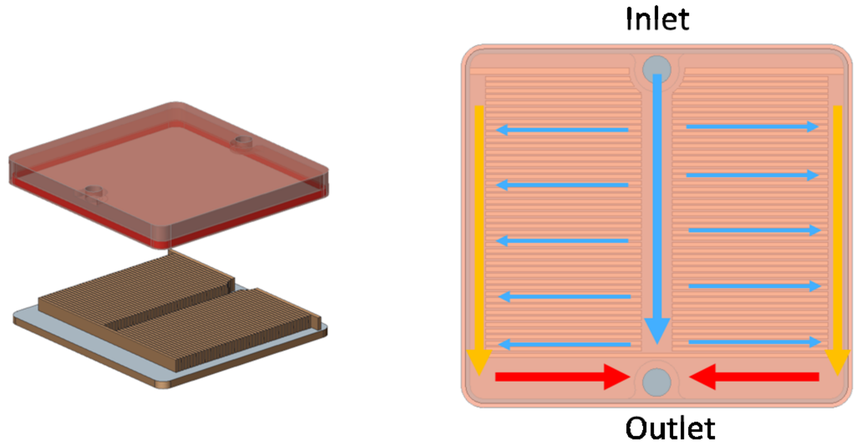
Cold Plates

Advanced Cooling

- Cold plate design need to meet cooling requirement for specified cooling fluid, flow rate, and fluid temperature
- Many different cold plate designs possible
- Example of microchannel cold plate designs below



Cross flow parallel plate fin cold plate example



Center flow parallel plate fin cold plate example

Cold Plates

Advanced Cooling

Parameters to consider for cold plate design

Category	Parameters
Chemical Requirements	• Material compatibility between fluid and all cold plate wetted materials • Brazing fillers, Connectors, Fins, Cover, Base
Internal Pressure Rating	• Internal pressure safety parameters (IEC 62368-1)
Mechanical Requirements	• Compatibility required with platform/socket/CPU (Load, Stiffness) • Tubing layout (Inlet, Outlet), connector/fitting type
Operating Conditions	• Operating pressure, flow rate, thermal performance (inlet and outlet temperatures)
Microchannel Design Parameters	• Fin area coverage, height, pitch, length, thickness

Summary

Advanced Cooling

Eco-system Enabling of Liquid Cooling Ingredients in Secondary Loop

- Cooling Fluid – PG 55 & PG 25
- Universal Quick Disconnects (UQDs) – Shown
- Cooling Distribution Units (CDUs) – Parameters of importance
- Cold Plates – Parameters of importance

Intel contributing UQD interchangeability and information to the OCP Advanced Cooling Solutions – Cold Plate Work Stream

Advanced Cooling – Cold Plate

Advanced Cooling

How to get involved!

Join the mailing lists:

- Advanced Cooling Solutions: https://ocp-all.groups.io/g/OCP-ACS
- Cold Plate Work Stream: https://ocp-all.groups.io/g/OCP-ACS-Cold-Plate

Project Wiki:

https://www.opencompute.org/wiki/Rack_%26_Power/Advanced_Cooling_Solutions

Call Calendar:

https://www.opencompute.org/projects/rack-and-power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