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Universal Quick Disconnect Blind-Mate

Fluid Connector Development, Testing and Specification

OCP GLOBAL SUMMIT

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CE (Cooling Environments)

Universal Quick Disconnect Blind-Mate

Fluid Connector Development, Testing and Specification

Mark Sprenger, Tech Lead, Intel
Jordan Johnson, Mechanical Engineer, Intel

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Intel Corporation and OCP

RACK & POWER

Starting in 2017 Intel engaged with OCP industry partners to enable liquid cooling ingredients

- Hand-mate Universal Quick Disconnects Specification: approved 2020
  Specification presented at OCP Global Summit 2019
- Blind-mate Universal Quick Disconnects
  Whitepaper and Specification Approved 2021
- UQDB was presented in ACS Cold Plate call and OCP Incubation Committee

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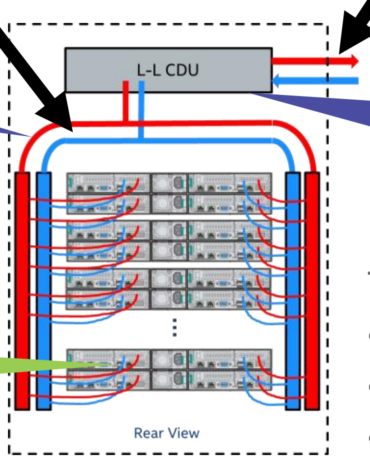
Intel's Eco-System Enabling

Focus: Manifold Distributed Liquid Cooling Ingredients



TCS Cooling Ingredients:

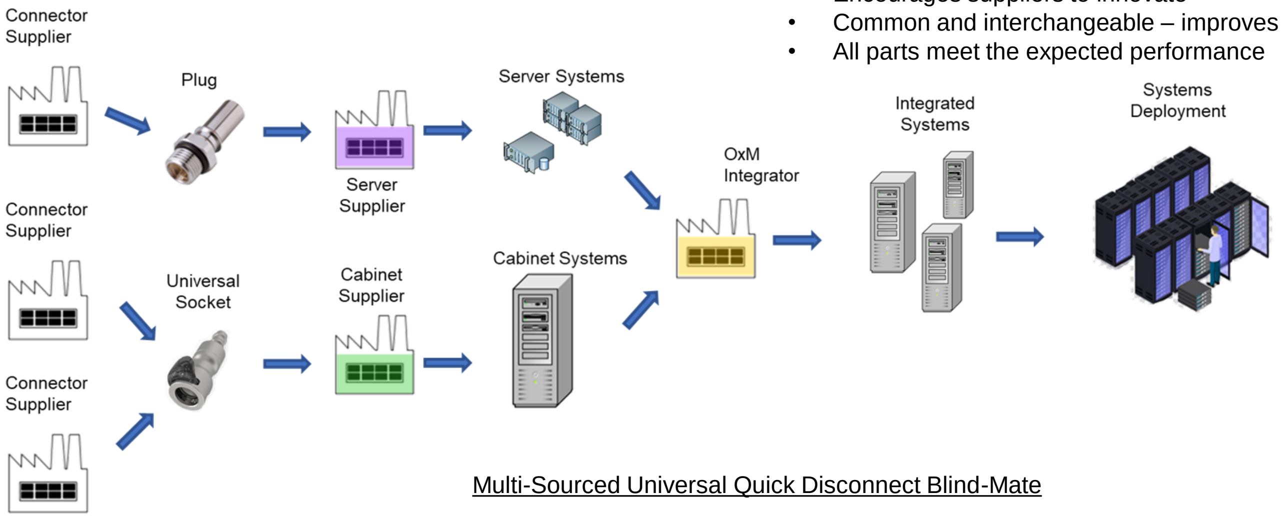
- Cooling Fluid
- Universal Quick Disconnects (UQDs)
- Blind-Mate Universal Quick Disconnects (UQDBs)
- Cooling Distribution Units (CDUs)

UQDB Adds Value to Electronics Cooling Industry

Problem Statement: Currently fluid connectors for electronics cooling are proprietary and non-interchangeable. Servers must be sourced with customized SKU (mfg. part no. connector) to interface with the cabinets.

UQDB Benefits the Electronics Cooling Industry

- Eliminates need for single sourced proprietary parts
- Simplifies the supply chain
- Global availability with sourcing in, Europe, US, China
- Refresh simplified
- New components can easily be added to the liquid circuit
- Encourages suppliers to innovate
- Common and interchangeable – improves adoptability
- All parts meet the expected performance



Multi-Sourced Universal Quick Disconnect Blind-Mate

UQDB Dimensions

- Minimum set of prescribed dimensions
- Each supplier can differentiate on self-alignment mechanism and internal flow geometry
- Geometry allows multiple self-alignment features, enabling design flexibility for suppliers to differentiate

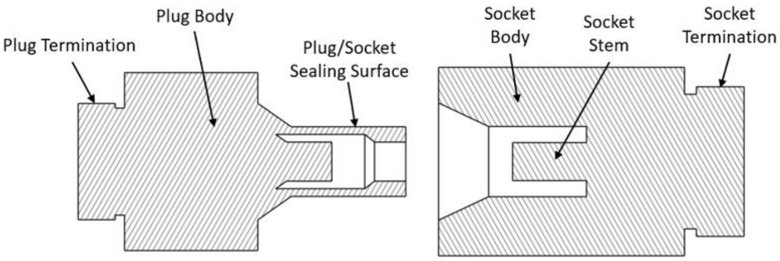


Figure 1 Universal Quick Disconnect Plug and Socket

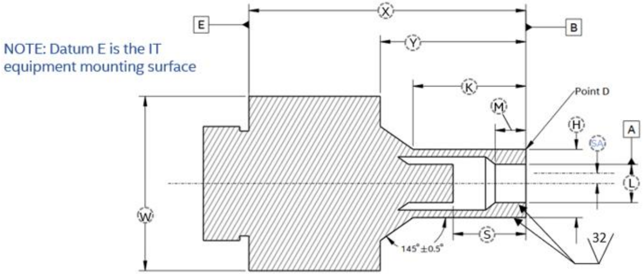


Figure 4 UQD Plug Dimensions

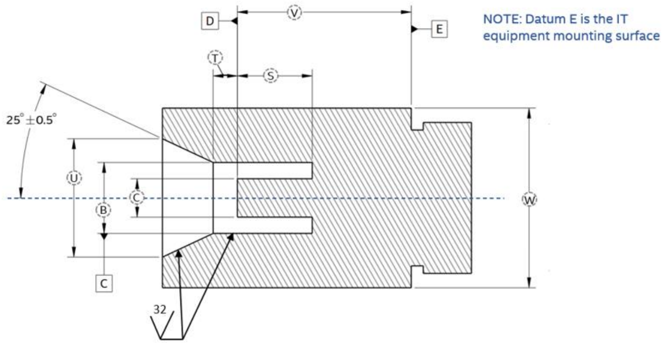


Figure 3 UQDB Socket Dimensions

UQDB Requirements & Performance Testing

Table 10 Flow and Temperature Requirements

Parameter	UQDB02	UQDB04	UQDB06	UQDB08	Priority
Maximum operating pressure	100 psi				Required
Minimum burst pressure	300 psi				Required
Minimum Cv[3] at minimum engagement	0.25	0.80	1.55	2.40	Required
Flow Rating[4]	At least 0.55 GPM	At least 1.7 GPM	At least 3.0 GPM	At Least 4.7 GPM	Recommended Manufacturer discretion (ratings shall be published by supplier)
Operating temperature range[5]	17°C - 65°C				Required
Shipping temperature range[6]	-40°C – 75°C				Required

[1] Cv are reported for water.

[2] Flow rating is for water.

[3] Support for higher temperature range is desirable as an option as there are known solutions that may operate in the range 17°C - 75°C. It is expected that rating would be published by supplier.

[4] Shipping may include charged systems.

- Performance requirements specifically derived for the electronics cooling industry
- The specified requirements address performance criteria for Pressure, Flow Rate, Temperature, Cv (Flow Coefficient), Durability, and life

To verify interchangeability among suppliers:

- Cv correlates pressure drop to flow rate

$$C_v = Q\sqrt{\frac{SG}{\Delta P}}$$

$$Q = C_v\sqrt{\Delta P}$$

- Measure: flow rate, pressure drop

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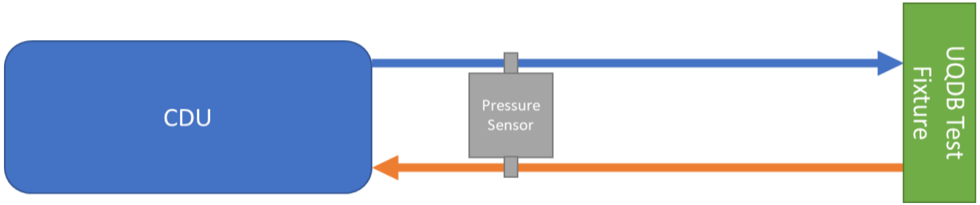
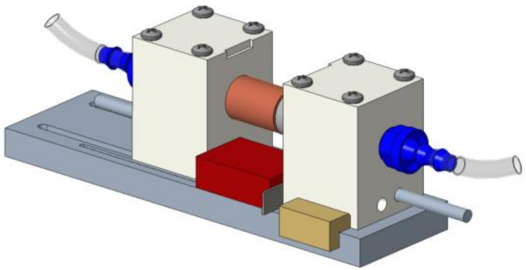
Test Setup



- Hose length calculated for uniform flow at UQDB: 12 inches
- Test: 3 flowrates
- Record pressure delta values

Test Matrix 4 Suppliers, run 4 iterations					
		Socket			
		A	B	C	D
Plug	A	X	✔	✔	✔
	B	✔	X	✔	✔
	C	✔	✔	X	✔
	D	✔	✔	✔	X

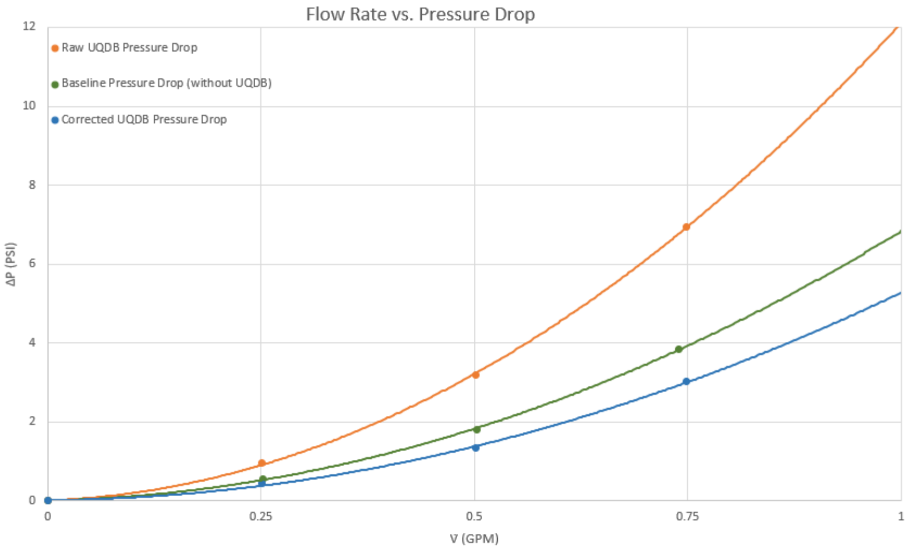


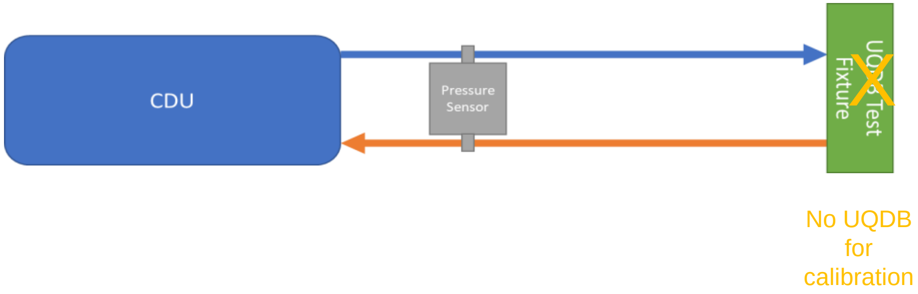
Test fixture to test in varying mating conditions

- Nominal vs minimum engagement
- Radially aligned vs full 1mm of radial misalignment
- Flow direction through UQDB pair (Socket to Plug vs Plug to Socket)

Baseline – Calibration

- Establish baseline pressure drop without UQDB





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Post-Processing Example

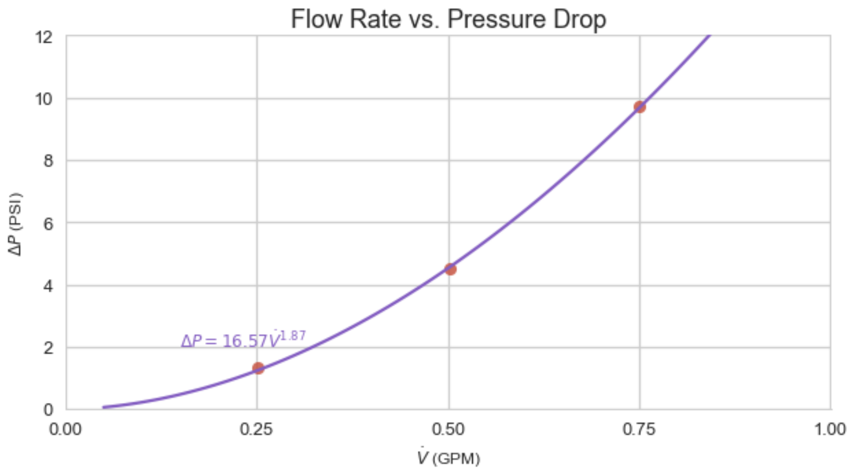
Sample Pressure Drop

Pressure drop through UQDs –Subtract baseline pressure drop

Solve for Cv

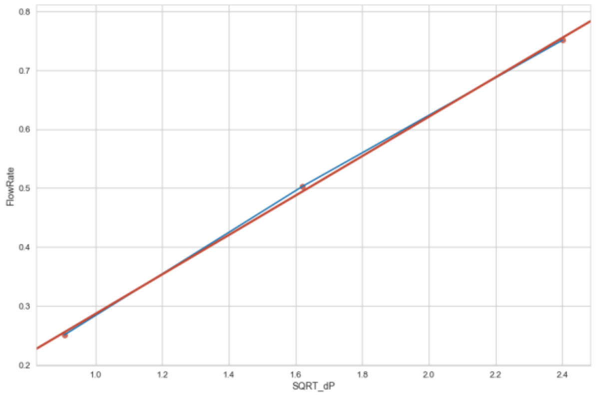
Linear fit using

$$Q = C_v\sqrt{\Delta P}$$




```
CV =
[0.3088751]

R_squared value =
0.9924795159192091
```



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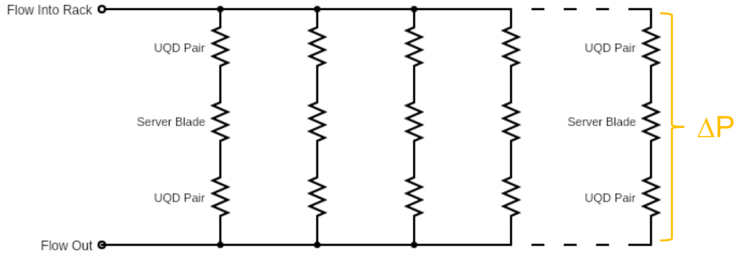
Network Impact Calculation

UQDB impact on server flow rate

$$Q = C_v\sqrt{\Delta P} \rightarrow \Delta P = \left(\frac{Q}{Cv}\right)^2$$



Low Cv relates to a high resistance

As Cv decreases in single blade, flow decreases. Total flow distributed through rack, potentially negative impact on single-blade cooling.

UQDB Impact Solver

Vary flow rate through each blade so that pressure drop is equal. Sum of blade flowrates equal to system flowrate.

Previous Results: pressure drop through servers/racks outweighs affect of varying pressure drop through UQDBs.

Takeaway: Little to no risk in using UQDBs from various suppliers

Call to Action

Review the UQD hand-mate and UQDB specifications and UQDB whitepaper for more information

- https://www.opencompute.org/contributions

Get involved in the ACS Coldplate sub-project group

- Monthly meetings 11-12 AM ET
- https://www.opencompute.org/projects/acs-cold-plate

Thank you!