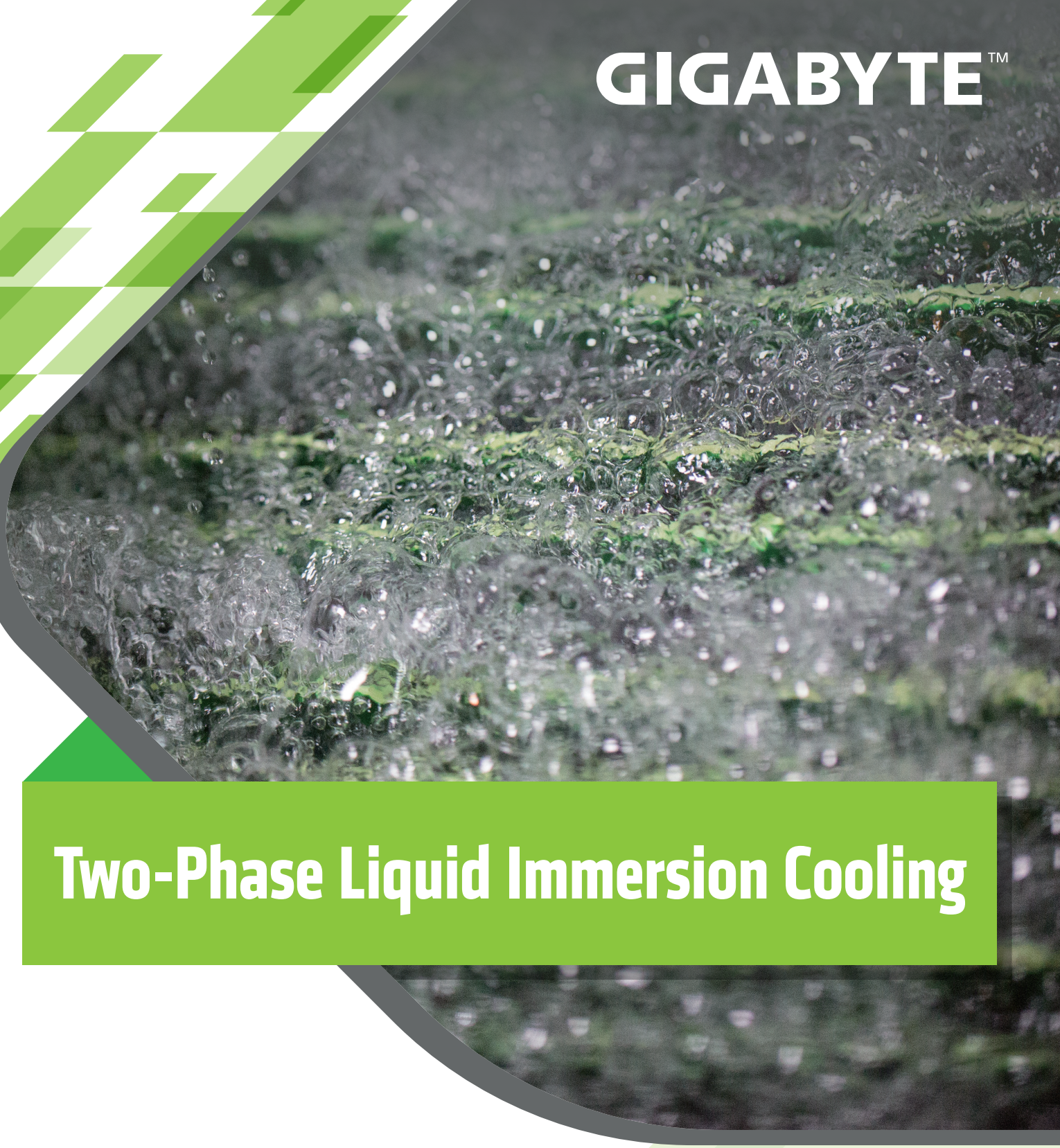
GIGABYTE™



Two-Phase Liquid Immersion Cooling

ALLIED CONTROL
IMMERSION COOLING

3M Science. Applied to Life.™

GIGABYTE has joined forces with Allied Control and 3M to offer a **Two-Phase Liquid Immersion Cooling** solution, allowing customers to drastically reduce their data center energy consumption and improve Power Usage Effectiveness (PUE), radically reducing operating costs and environmental impact.

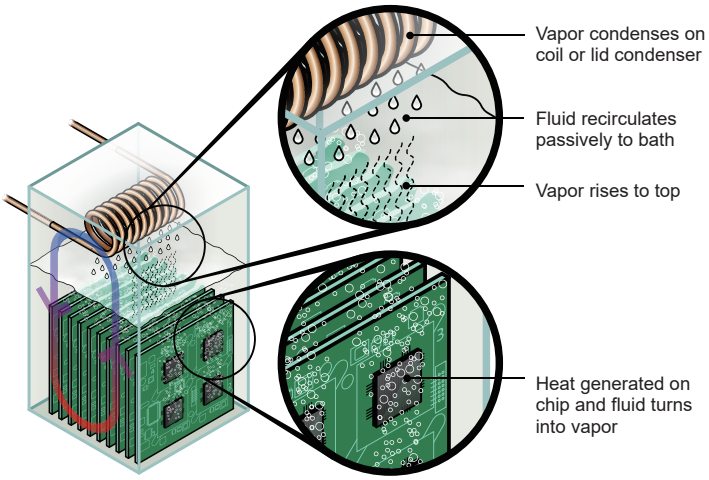
4000x More Efficient at Removing Heat than Air

In a two-phase immersion cooled system, electronic components are submerged into a bath of dielectric heat transfer liquid, which is a much better heat conductor than air, water or oil. With a low boiling point (56°C vs. 100°C in water), the fluid boils on the surface of heat generating components, and rising vapor passively takes care of heat transfer.

In contrast to submersion oil cooling, two-phase immersion cooling liquids are clean, environmentally friendly and non-flammable. No pumps and jets are required to keep hardware cool. Circulation happens passively by the natural process of evaporation and without spending any extra energy. It is this simplicity that eliminates conventional cooling hardware and results in better cooling efficiency. Compared to traditional air, water or oil cooling, this passive process results in the use of much less energy.

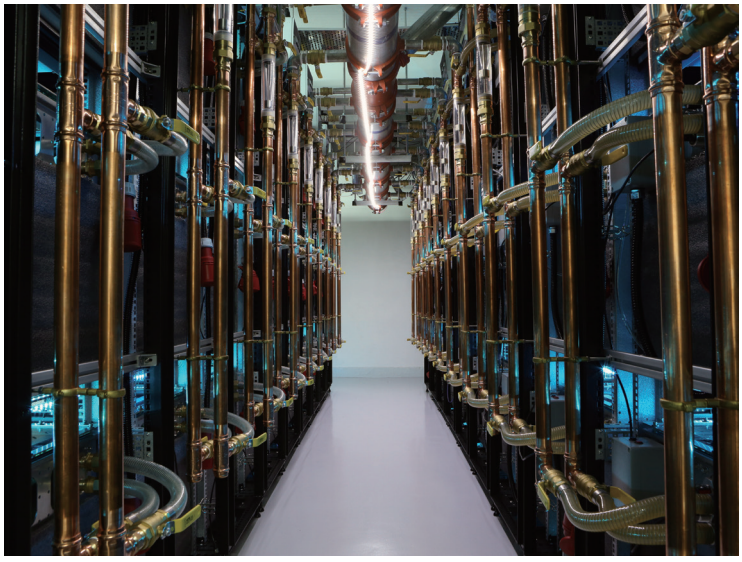
Advantages of Two-Phase Immersion Cooling

- Higher efficiency and energy savings (possible >90% compared to air cooling)
- Reduced capital and operational expenses
- Improved performance & reliability – components not subject to temperature variations, reducing failure potential. And no cooling fans required, eliminating component degradation from vibration.
- Allows higher data center density - as much as 252kW per rack, with less supporting infrastructure
- Works in confined spaces and extreme environments (hot & humid etc).
- Lower maintenance requirement - passive cooling system means no unnecessary parts to build or service, useful especially for remote locations such as edge computing stations
- Extremely clean – airflow, dust and noise are eliminated.
- Reduced environmental impact – environmentally friendly fluid with zero ozone depletion potential
- Inherent fire protection - non-flammable



The Passive 2-Phase Immersion Cooling Cycle

Immersion Cooling Infrastructure – Allied Control



Headquartered in Hong Kong, Allied Control is a pioneer in building the most efficient cooling solutions for high density electronics, and the first to successfully implement liquid immersion technology in commercial operations since 2012. Allied Control have also created the world's largest immersion cooling data centers with 40MW and 120MW IT load capacities. They are an official Technology Partner of 3M for immersion cooling fluids, and have won the both the DCD (Data Center Dynamics) "Future Thinking and Design Concepts" Award and the Best Green ICT Award for the Most Energy Efficient Data Center (PUE 1.01)

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Immersion Cooling Fluid – 3M

3M has a long-held leadership position in immersion cooling fluids, beginning in the 1950s when 3M introduced its first dielectric fluorochemical heat transfer fluids for direct contact cooling for military avionics. Over the past five years, 3M engineered fluids have been used in server cooling and have been recognized by the industry for best in class energy efficiency.

GIGABYTE uses and recommends **3M Fluorinert FC-72 fluid** for a two-phase immersion cooling system. FC-72 is a clear, colorless, non-conductive, non-flammable, residue free, thermally and chemically stable liquid. FC-72 has an extremely narrow boiling range, so its composition will not deviate with time, insuring consistent transport properties.

3M Fluorinert liquids have among the highest dielectric strength and electrical resistivity of all organic fluids, much better in fact than air. And unlike hydrocarbon liquids such as mineral oil, 3M Fluorinert liquids are completely fluorinated. This means they have little or no solvency for hydrocarbons. Components taken out of 3M Fluorinert liquid also dry out easily, and won't be wet, sticky or oily. There is no need to prepare rubber mats, tissues or other materials when taking the servers out of the liquid for maintenance.

Attribute Name	Value
Product Series	FC-72
Application Category	Electronic Testing, Heat Transfer
Applications	Dielectric Bath, Electronic Testing, Heat Transfer, Power Electronic Cooling
Boiling Point	56° C
Boiling Point Range	50-99° C
Brand	Fluorinert
Density	1.68 g/cm³
Dielectric Strength Range	>40 (0.1" gap, kV)
Fluorocarbon Solubility	Very High
GWP (IPCC 2007)	>5000 (100 yr ITH)
GWP Range	High
Hydrocarbon Solubility	Low
Max Use Temp Range	<250° C
Plastic Elastomer Compatibility	Excellent
Pour Point	-90° C

Immersion Cooling Servers with GIGABYTE

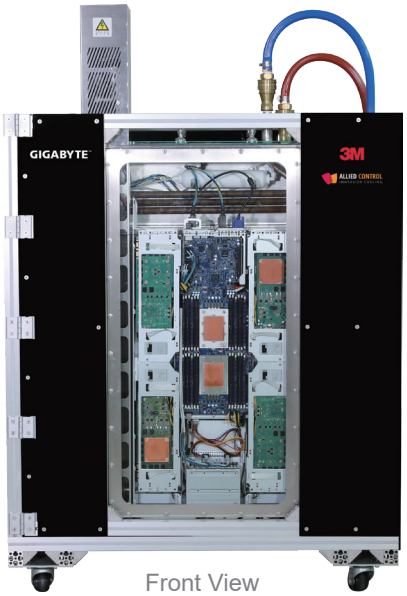
GIGABYTE is an industry leader in server systems for High Performance Computing, an application that is particularly suited to immersion cooling due to the high power consumption and heat generated by high performance processors. GIGABYTE can easily modify our standard server products to make them fully compatible with an immersion cooling system. GIGABYTE has also designed an **Immersion Cooling POC (Proof of Concept) Unit** for testing and validation. This unit is fully compatible with our 2U form factor servers. The unit can also be modified on request to suit our other form factor (1U or 4U) models.

GIGABYTE GPU Server Lineup & Immersion Cooling POC Unit Compatibility

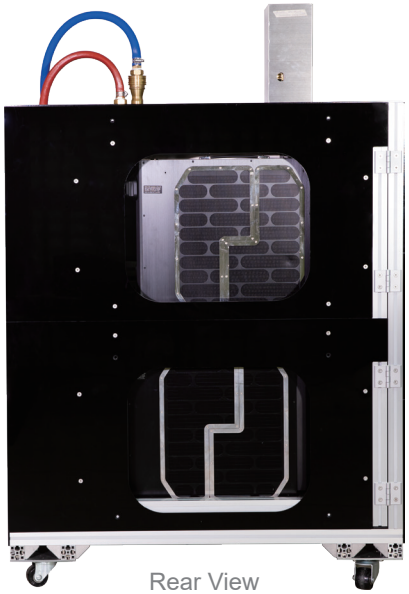
Form Factor	Intel		AMD
2U Compatible with Standard Unit	 G291-280	 G291-281	 G291-Z20
4U Compatible with Customized Unit	 G481-S80	 G481-HA0	-

Immersion Cooling POC (Proof of Concept) Unit

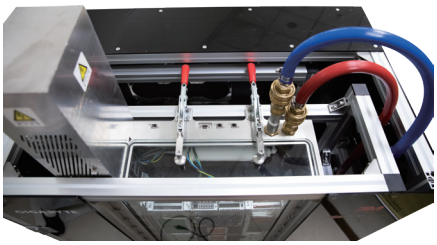
Category	Item	Detail
General	GBT Part Number	25STZ-G25000-ACR
	ACL Model No.	02U-19IN-2PIC-RD-GL-PM Tank Rev.A
	Size HxWxD (mm)	1,540 x 660 x 540 mm
	Weight (kg)	160 kg (Not including fluid and server)
	Power Consumption (W)	190 W (Max)
	Power Source	110/220 VAC, 50-60Hz
	Radiator	2 unit
	Carbon Filter	Yes (pump can be used when re-filling fluid)
	Front Glass	Yes (alternative model: non-glass type)
	Wheel	Yes
Cooling	Cooling Type	Two-phase immersion cooling
	Fluid	3M NOVEC series, 3M Fluorinert series)
	Cooling Capacity (W)	4,000 W (9213BTU/hr) @ 25°C liquid-ambient (25°C dT)
	Max Pressure @ 25°C	2kgf/cm2 (28.5psi)
	Operating Temperature	10 to 35°C
	Display Type	OLED
	Flow Rate	6.8LPM (1.8GPM)
	Radiator	Aluminum, 9 x 120mm fans
	Control	Fan & pump RPM by control display
Management	Monitor	Via WIFI (WIFI system included)
	Measurement Item	Total Facility Energy (KW, KW/h) – Daily, Total
		IT Equipment Energy (KW, KW/h) – Daily, Total
		PUE – Daily, Total
Server support	Input Capacity	2U (open area for system installation = 90 x 450 mm)
	Power Source	110/220 VAC, 50-60Hz
	Power for Server	3,000W (Max)
	Power Plug for server	IEC 320 C13 Type - 2 port
	IO Port	LAN x 4 port (RJ45), USB(2.0) x 2 port
		VGA x 1 port



Front View


Rear View


Inner View


Top View

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