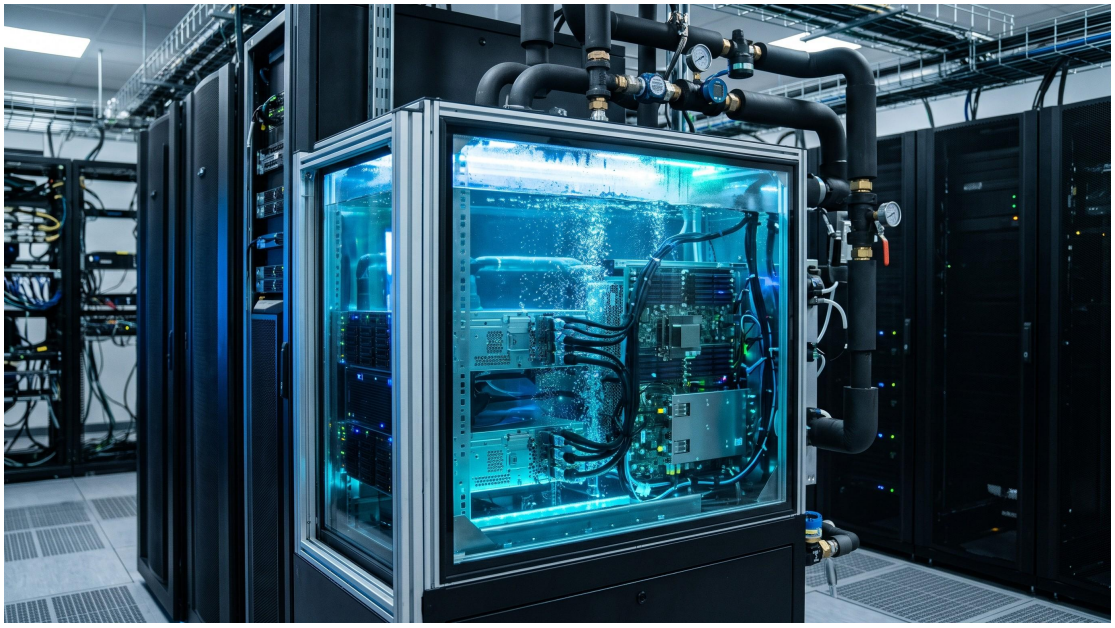
Two-Phase Phase-Change Immersion Cooling Module Thermal Flux Limits - Official Technical Overview & Hardware Datasheet

EXECUTIVE SUMMARY

This document defines the certified thermal flux boundaries, operational envelopes, and systems-engineering constraints for the Two-Phase Phase-Change Immersion Cooling Module. The module is a hermetically sealed, passive-circulation heat-rejection assembly engineered to interface with dielectric phase-change fluids operating under saturated pool-boiling conditions. Its purpose is to extend the effective critical heat flux (CHF) margin of immersion-cooled telecom and datacenter compute payloads while maintaining dielectric integrity, pressure containment, and long-term fluid compatibility.

The module is characterized by a multi-layer boiling-enhancement surface, a vapor-dominant headspace management architecture, and a condensing interface that supports both facility-water and refrigerant-loop heat rejection. Certified operation spans a thermal flux range from 8 W/cm2 to 145 W/cm2 at the die-level interface, with a design burst margin exceeding 2.5x the rated pressure envelope. All figures in this datasheet are derived from OEM-validated bench testing under IEC 60529 and Telcordia GR-63-CORE environmental profiles.



ARCHITECTURE & CHASSIS DESIGN

The module is built around a sealed two-phase enclosure with an integrated vapor riser, a liquid return manifold, and a condensing heat exchanger. The base plate features a graded micro-cavity and sintered-wick boiling surface that promotes nucleation-site density and delays film-boiling onset. Vapor generated at the die interface rises through a low-pressure-drop headspace and condenses against a finned cold plate, returning to the pool by gravity. The chassis is a 2RU sealed enclosure with a welded 316L stainless steel shell, dielectric-compatible elastomer seals, and a pressure-relief valve rated at 1.6 MPa.

Internal geometry is optimized for a 3.2 mm liquid subcooling target at nominal

load and a maximum vapor-space pressure of 0.85 MPa at 65 degrees C condensing temperature. The module supports front-to-rear serviceability of the condensing loop and top-side access to the fill and pressure-test ports. All wetted surfaces are passivated and compatible with HFE and hydrofluoroolefin dielectric fluids.

HARDWARE FEATURES

Key hardware attributes include a boiling-enhanced base plate, a low-pressure-drop vapor riser, a condensing heat exchanger with 12 mm OD tube connections, a redundant pressure-relief assembly, and integrated temperature and pressure sensor ports. The module provides a fill-level sight glass, a dielectric-compatible fill valve, and a leak-detection channel at the base perimeter. The condensing interface supports both facility chilled water and low-GWP refrigerant loops. The enclosure is rated for indoor operation and includes mounting brackets for standard 19-inch racks.

COMPLIANCE & STANDARDS

The module is designed to meet Telcordia GR-63-CORE and GR-1089-CORE environmental and EMI profiles, IEC 60529 IP54 sealing, IEC 61010-1 safety requirements for electrical equipment, and ASHRAE 34 fluid classification

requirements for A1 refrigerants. Pressure containment is verified to ASME BPVC Section VIII Division 1 principles where applicable, and dielectric compatibility is validated per ASTM D877 and D1816. RoHS and REACH declarations are available on request.

TECHNICAL SPECIFICATIONS

The following parameters define the certified thermal flux and operating envelope. Values are nominal at 25 degrees C ambient and 1 atm unless otherwise stated. Thermal flux limits are specified at the die-level interface with a 10 mm x 10 mm reference heater and a 3.2 mm subcooling margin.

Parameter	Specification
Form Factor	2RU sealed enclosure, 19-inch rack mount
Certified Thermal Flux Range	8 W/cm2 to 145 W/cm2 (die-level reference)
Critical Heat Flux Margin	Greater than 25% above rated maximum flux
Boiling Surface Enhancement	Graded micro-cavity with sintered wick
Working Fluid Compatibility	HFE and hydrofluoroolefin dielectrics

	(A1 class)
Condensing Interface	Facility water or low-GWP refrigerant loop, 12 mm OD
Maximum Vapor Space Pressure	0.85 MPa at 65 degrees C condensing temperature
Pressure Relief Valve Rating	1.6 MPa
Liquid Subcooling Target	3.2 mm at nominal load
Sealing Rating	IP54 per IEC 60529
Shell Material	Welded 316L stainless steel, passivated
Sensor Ports	Temperature and pressure, integrated
Leak Detection	Base-perimeter detection channel
Operating Ambient	5 to 40 degrees C indoor
Compliance	Telcordia GR-63-CORE, GR-1089-CORE, IEC 61010-1, RoHS, REACH

ORDERING OPTIONS

Standard configurations include the ICM-2P-2RU-W (water-cooled condensing loop, 2RU), ICM-2P-2RU-R (refrigerant condensing loop, 2RU), and

ICM-2P-2RU-D (dual-interface condensing loop, 2RU). Optional accessories include a pressure-test kit, a dielectric fill service kit, a leak-detection sensor harness, and a rack-mount slide rail set. Factory acceptance testing and fluid compatibility certification are available as orderable services.

