

Ruggedized Liquid Cooling Unit (rLCS™)

Aavid, Thermal Division of Boyd Corporation's Ruggedized Liquid Cooling System (rLCS) offer high performance liquid cooling for the most demanding military and aerospace applications. These systems are custom engineered for each application to optimize size, weight, power consumption, and cooling (SWaP-C). COTS or MIL-COTS components are used where practical in order to decrease cost and lead time. Aavid's engineering design, development, validation/qualification testing, and manufacturing capabilities ensure performance and reliability under the most demanding conditions. An example rLCU, shown in Figure 1, will include the following components:

- ▶ Pump(s)
- ▶ Cold Plate(s)
- ▶ Heat Exchanger(s)
- ▶ Fans(s) (if needed)
- ▶ Coolant and Fluid Reservoir
- ▶ Hydraulic Interconnects

The rLCS pumps the chosen coolant through the cold plate(s) to which the heat generating components are mounted. Heat is efficiently transferred into the fluid before flowing through the heat exchanger where the thermal load is rejected.

Key features may include, but are not limited to:

- ▶ Aluminum vacuum brazed heat exchangers
- ▶ Vacuum or dip brazed aluminum cold plates (subsystem shown in Figure 2)
- ▶ Aerospace grade hoses
- ▶ Dripless hydraulic quick disconnect fittings
- ▶ Thermostatic coolant diverter valves
- ▶ Heat spreading or transport via heat pipes, vapor chambers, or k-Core® (subsystem shown in Figure 3)
- ▶ Redundant pumps
- ▶ Power conditioning to handle voltage spikes
- ▶ Vibration isolation of sensitive components

Key Benefits

- ▶ Rugged hardware and vibration isolation allows operation in high G environments
- ▶ rLCS's are designed to minimize system Size, Weight, and Power with improved Cooling (SWaP-C)
- ▶ Modular heat pipe assemblies allow quick removal and replacement of PCB cards (shown in Figure 4)
- ▶ High performance cold plates and heat exchangers allow operation in high ambient environments
- ▶ Elimination of high cost, high maintenance spray cooling or submersion cooling systems
- ▶ Ruggedized designs for MIL-STD-810, MIL-STD-461E, VITA 58 requirements or customized for applications such as military aircraft, ground vehicles, and commercial aircraft.



Figure 1. Example rLCS installed in Chassis

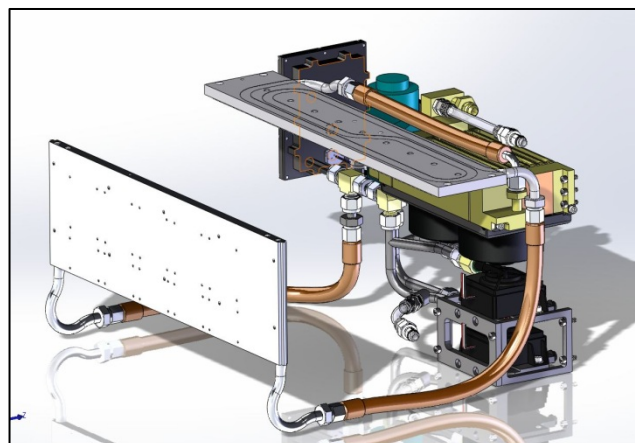


Figure 2. rLCS Liquid Cooling Loop Subsystem

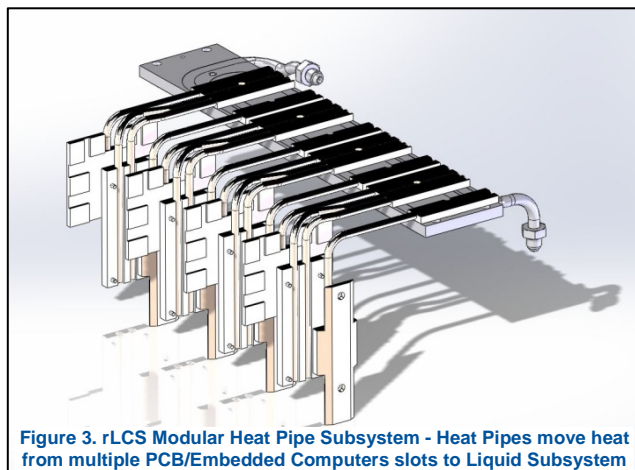


Figure 3. rLCS Modular Heat Pipe Subsystem - Heat Pipes move heat from multiple PCB/Embedded Computers slots to Liquid Subsystem

Options - Ruggedized Liquid Cooled System (rLCS)	
Power / Heat Load (kilowatts)	0.1kW to 20 kW+ Typical
Effective Thermal Resistance	0.02 °C/W typical
Cold Plate Technology	Vacuum Brazed, Dip Brazed, or Tube-in-Plate
Heat Exchanger	Aluminum Vacuum Brazed Liquid-to-Air or Liquid-to-Liquid
Pump	Centrifugal or Positive Displacement Up to 50,000 MTBF Redundancy if needed
Fluid Interconnects	Aerospace Grade AN hoses Aluminum/Stainless hard lines with compression fittings
Reservoir	COTS or custom, as needed
Thermostatic Control Valve	Passive wax cartridge style
Coolant	Ethylene Glycol/Water, PAO, De-ionized water, Fluorinert™ or per specification
Typical System Operating Voltage	12-28 VDC
Typical Input Voltage	28VDC, 120/240VAC, or as specified. If needed, voltage spikes IAW MIL-SPEC-1399
Maximum Operating Temperature	65°C
Minimum Operating temperature	Governed by Coolant/Fluid
Storage Temperature Range	-55°C to +71°C (fluid dependent)
Maximum Operating Altitude	75,000 feet
Maximum Shock (operating/non-operating)	40G / 75G

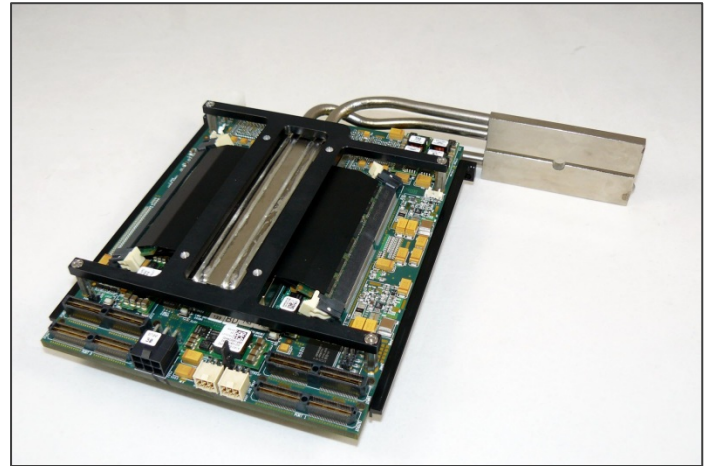


Figure 4. Actual rLCS Modular Heat Pipe Subsystem, from Figure 3 above, installed on Processor Module.

Critical Application Needs

- ▶ Embedded Computing Applications
 - Unmanned Vehicles (UAVs, UGVs, USVs)
 - Military /National Security (Airborne and Ground)
 - Oil & Gas/Seismic Processing,
 - Medical Diagnostic and Imaging Equipment
 - Test Equipment
 - Scientific & Academic Research
- ▶ Harsh, Rugged Environment Computer Cooling
- ▶ Signal, Image, and Radar Processing Applications
- ▶ Microwave/RF, Power Electronics, Military Radars, Power Converters, Laser Diodes Cooling
- ▶ Form Factors & VITA standards include: 3U, 6U, 9U, AdvancedTCA, MicroTCA, Ultra Compact, Ultra Powerful, OpenVPX, VME, VXS

Other Related Technologies

- ▶ Liquid Cooled Cold Plates
- ▶ Intelligent Thermal Management System (iTMS)