VERTIV APPLICATION PAPER

Vertiv™ Liebert® XD System

Flexible, Energy-Saving High Density Cooling Application

V/TM-126

Executive Summary

As high performance computing applications, artificial intelligence, quantum computing, machine learning, deep learning, and other computing intensive application process huge amounts of data, therefore the need for an efficient, scalable, and reliable IT infrastructure is paramount. Apparently, the legacy perimeter cooling is insufficient to take care of these high heat density applications. Therefore to address the extreme heat in data centers it requires an X-treme density cooling solution, packed with the optimum configuration and right architecture.

This technical note explains the fundamentals of Vertiv™ Liebert® XD technology, its components, working architecture, and system design. It also describes key features, benefits, and product positioning tricks based on the different applications scenarios.

Introduction

Growing adoption of high-performance computing systems and higher rack revenue potential for colocation space are just a couple of reasons where high-density racks are growing in popularity. However, transitioning to higher rack density environment requires enormous efforts. Every operational aspect must be assessed to ensure seamless operational continuity along with superior data center efficiency, scalability, and space demands. Liebert XD mission-critical cooling systems are specifically designed to eliminate high heat loads that are generated by tightly packed electronic rack enclosures in association with different configurations of cooling modules - Liebert XDV, Liebert XDO & Liebert XDH.

The Liebert XD family delivers efficient and sensible cooling to high heat environments. Vertiv™ Liebert® XD systems are designed to cool the spot where the heat is accumulated. This Liebert XD technology uses pumped refrigerant that is ideal for use in the data centers. The use of water-less cooling removes the chance of electrical hazards. It operates at low pressure and produces gas at room temperature, making it ideal for use around electronic equipment.

Higher Watt, Higher Heat Densities

Today's data center technologies have compound conventional cooling problems. Blade servers, communications switches, and other electronics essentials are being packed into tighter and tighter spaces. Computing capacity that once filled an entire room is now contained in a single rack — creating extreme power and heat densities. This increased capacity is fueled by rapid growth in processing capacity. More compact capacity means higher heat densities. What was a 1 kW rack, now may exceed 10 kW. This requires a shift in focus from a room-based solution of cooling to a rack-based solution. As processor capabilities increase, so do computer room power densities— from 50 Watt per square foot (540 W/m^2) to over 300 Watt per square foot (320 W/m^2); the whole data center just keeps getting hotter.

Figure 1 chart* explains major technology sector with current technology trend that demands for high performance and high-speed computing.

Vertiv continues to align its product portfolio as per the future business needs

Responding to expanding demands for data centers, Vertiv has launched a thermal management waterless design solution for high-density IT applications, such as computing applications and enterprise data centers. This solution is ideal for use around electrical equipment, thus reducing hazards and supporting sustainability targets for businesses working to eliminate water usage in the data center.

The Liebert XD can be implemented as a hybrid approach, using a combination of floor mount mission-critical cooling units and cooling from the Liebert XD as supplemental or primary.

Its compact design allows for targeted cooling closer to the heat source, allowing for potential energy savings of up to 70% when deployed as primary cooling and up to 30% savings as supplemental cooling, compared to traditional data center cooling solutions.

Figure 1. Industrial and Technology Trends

Tech Trend	Healthcare		Enabler Sector		Mobility		Industry 4.0	
	Pharma	Health	Information	Tele-communication	Automotive	Logistics	Electronics	Advance Industry
Next Level Process Automation								
Applied AI								
Future of Connectivity								
Next Generation Computing								
Future Programming								
Bio Revolution								

Moderate/Limited Influence Major Influence

Source : Based on the average impact across different industries. By Expert Interviews; McKinsey Analysis.

Vertiv™ Liebert® XD Fundamentals

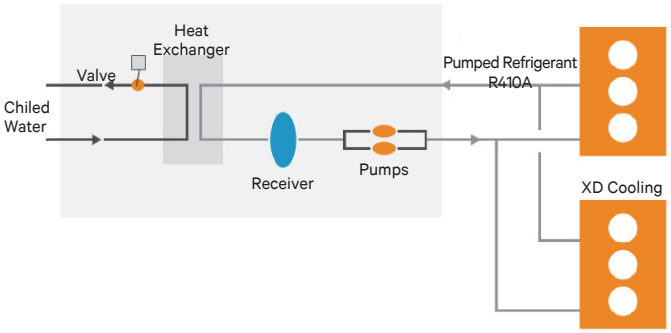
Vertiv™ Liebert® XD solutions are modular and expandable to meet the needs of growing and changing data centers. The Liebert XDC or Liebert XDP pumping units support various configurations of Liebert XD cooling modules that cool high-density rack loads. Simply mix and match the Liebert XD modules that best suit the room layout and heat load. The cooling modules require little or no additional floor space.

When Building Chilled Water is Available

The Liebert XDP pumping unit serves as an isolating interface between the building chilled water system and the pumped refrigerant circuit. It circulates refrigerant to the XD cooling modules at a temperature always above the actual dew point to prevent condensation.

Liebert XD systems consist of two cooling loops, primary loop uses chilled water and the secondary loop uses pumped refrigerant R410A/R134a, as illustrated in Figure 2. The fluid in the primary loop is always used to maintain the temperature of the refrigerant in the secondary loop above the actual dew point of the conditioned space, preventing the formation of condensation on the piping. In this configuration, available cooling module is row-based which is placed between two high-density racks.

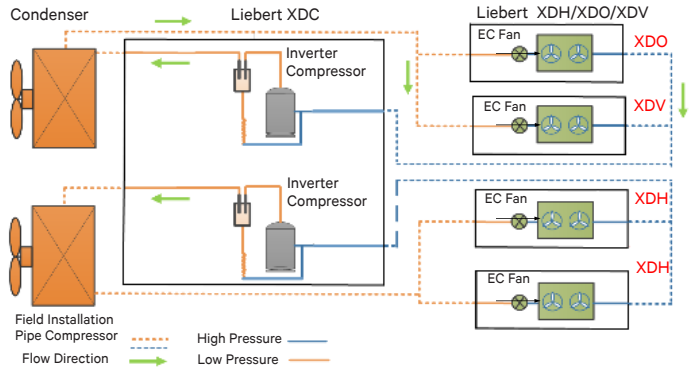
Figure 2. Liebert XD & the Cooling Modules



When Building Chilled Water is Unavailable

If the adequate building chilled water is not available and site condition demands “zero” footprint* based cooling modules, Liebert XDC coupled with the associated cooling modules is a perfect solution for such site conditions.

Figure 3. Liebert XDC & the Cooling Modules



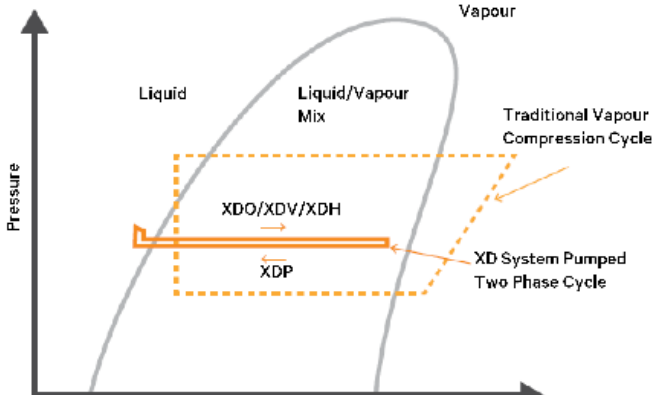
Refer Figure 3, Liebert XDC units are equipped with high efficiency, variable speed compressors unit; whereas the combination of cooling modules (Vertiv™ Liebert® XDH or Vertiv™ Liebert® XDV or Vertiv™ Liebert® XDO) are installed close to the heat source i.e. server racks. Energy-efficient refrigerant (coolant) R410A is used for heat transfer. For more accurate refrigerant flow control EEV (electronic expansion valve) is deployed. For heat rejection, an air-cooled condenser is used (for better performance Vertiv™ Liebert® LVC, V-type centralized air-cooled condenser is recommended).

Advantages of Refrigerant Based Waterless System

- There are no water lines in the conditioned space and no condensation is formed on the coils or the refrigerant lines.
- It does not interfere with the electronic equipment in case of a leak, it is more space-efficient, and energy-efficient than water-based cooling technologies.

Let us take a deeper view on working principle of Liebert XDP system. It is explained in the below Pumped Refrigerant, Pressure – Enthalpy chart.

Figure 4. Liebert XDP System Working Principle



Refrigerant is pumped as a liquid, becomes a gas within the heat exchangers of the cooling modules, and then is returned to the pumping unit where it condenses back to a liquid, see Figure 4.

System Design Highlights

Vertiv™ Liebert® XDC and the Cooling Modules

When chilled water is not available, the Liebert XDC is the solution. Primary cooling is provided by two inverter-driven scroll compressors. The combination of variable speed control augmented by electronic expansion valves provides a smooth linear output for precision control at the end of the cooling modules.

Vertiv™ Liebert® XDC130			
Cooling Capacity (Entering air temperature for cooling modules)	35 °C DB 26% RH	Total Cooling Capacity	130 kW
	40 °C DB 20% RH		150 kW
Minimum Heat Load	Minimum heat load required is 30% of Liebert XDC capacity. For each DX circuit of Liebert XDC130 the minimum heat load is about 18 kW.		

Number of XD Cooling Units Connected

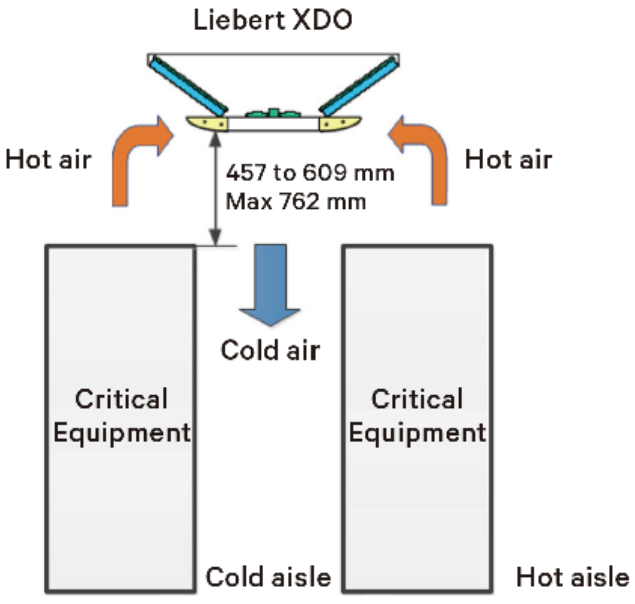
Cooling Module Type	Vertiv™ Liebert® XDV	Vertiv™ Liebert® XDO	Vertiv™ Liebert® XDH
Number for Each Liebert DX Circuit [Maximum (Minimum)]	8 (3)	4 (2)	3 (1)
Number for Liebert XDC [Maximum (Minimum)]	16 (6)	8 (4)	6 (2)

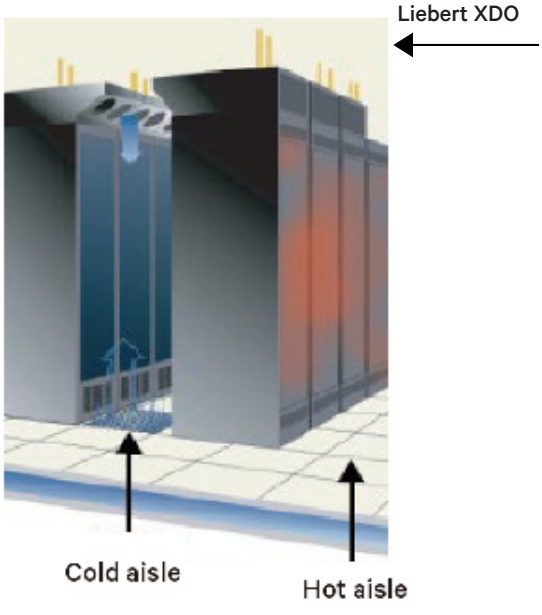
Each of the Liebert XDC dual DX circuits could be installed with different types of cooling module to meet the minimum cooling modules configuration rate of 50%.

Cooling modules configuration rate = (Liebert XDV rated capacity x quantity) + (Liebert XDO rated cooling capacity x quantity) + (Liebert XDH rated cooling capacity x quantity) ÷ (Circuit rated cooling capacity).

- For Liebert XDC 130 with dual circuits, circuit rated capacity is 65 kW
- One of the circuits is installed with 2 # Liebert XDV10 & 1 # Liebert XDO20
- Cooling modules configuration rate = (10 x 2 + 20 x 1) ÷ 65 = 61.5% > 50%.

Figure 5. Different Configurations of Cooling Modules and their Placement in High Density Data Center





Vertiv™ Liebert® XDP - XDH Combination

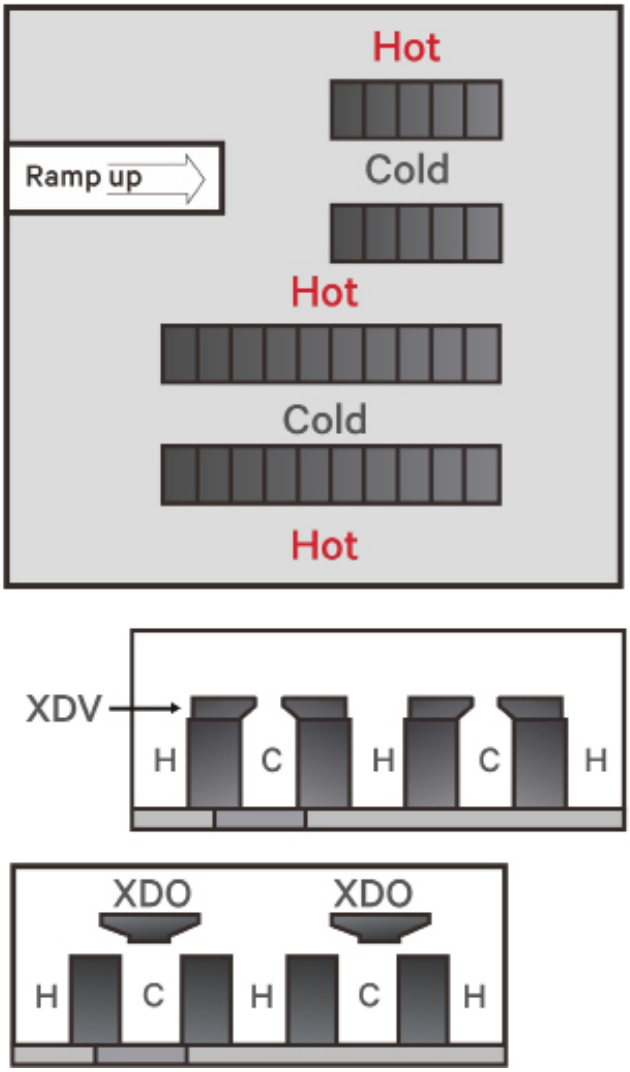
When building chilled water is adequate and easily available for data center, high-density cooling solution by Vertiv™ Liebert® XD architecture is achieved through Liebert XDP and Liebert XDH arrangement.

- Each Liebert XDP unit can deliver 160 kW to 200 kW (depending on parameter).
- Each Liebert XDH module can deliver 27 kW to 32 kW (depending on parameter).
- Max 6 and Min 2 units of the Liebert XDH can be coupled with 1 Liebert XDP unit.
- Variable load in high density cooling is easily managed by this architecture as Liebert XDP has inverter-driven pump set

Liebert XD Deployment Architecture

As explained, there are two types of central units (Liebert XDC and Liebert XDP) and three types of cooling modules (Liebert XDH, Liebert XDO, Liebert XDV) with different capacities are available and are selected based on the application.

Figure 6. Liebert XDV & the Cooling Modules



Generally, data center cooling arrangement follows hot & cold aisle arrangement but when load density increases, proper cooling is not achieved by this configuration.

If load density occurs more than 150-200W/Sqft; it is better to go for "close to source" cooling configuration like XD technology where cooling modules are either at overhead or besides racks.

If the data center does have enough height (i.e. > 15 ft) overhead solution with Liebert XDV or Liebert XDO can be deployed.

While we need to place cooling modules at right on the top of racks, Liebert XDV is an ideal one. It can cool 10 kW. Even if the hot and cold aisles are reversed, we can simply turn around Liebert XDV cooling modules or we can go for Liebert XDO units.

Liebert XDO cooling modules are ceiling mounted and they can cool 20 kW. It is used to place at top of the cold aisle. Hot return air will be taken by two sides of cooling modules from hot aisles.

Figure 7. Liebert XD System Double Stack

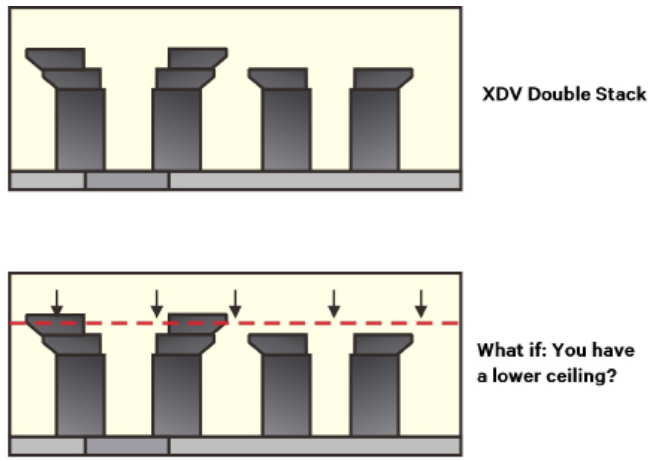


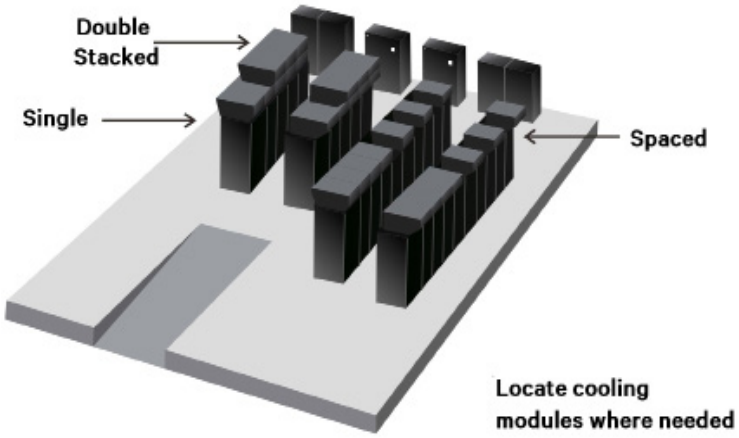
Figure 7 shows the elevation view with the double stacked Liebert XDV that solves 20 kW or more per rack. But what if the ceiling is too low to double-stack the modules? That problem is solved by keeping the single Liebert XDV modules, and adding a few Liebert XDH cooling modules between racks to pick up the added heat from those 20 kW heat load racks.

The Liebert XDH is placed in line with rack enclosures and air is directly drawn from the hot aisle through the rear side of the unit, cooled and discharged into the cold aisle where the electronic equipment air inlets are located. Thus, allowing the unit to take advantage of higher heat transfer efficiency from the hot aisle.

Liebert XDH is being deployed where per rack load is up to 30 kW; the cooling modules can be placed in a row along with heat sources.

Liebert XDH cooling modules can go with both Liebert XDP & XDC solution. Min 2 nos. of and max 6 nos. of Liebert XDH can be deployed as cooling modules with a single Liebert XDC or a single Liebert XDP.

Figure 8. The Cooling Modules Arrnagement



Uneven load is easily solved by Liebert XD technology. If load density is high but different across data centers, Liebert XD cooling modules provide the perfect solution. In lower high-density single stack Liebert XDV, for higher heat load density double stack Liebert XDV or Liebert XDO systems are deployed. If there is any height issue floor-mounted Liebert XDH system can be configured. It really provides very flexible architecture.

Configuration Challenges and Vertiv™ Liebert® XD Solution

Sr. No.	Challenges	Solution
1	High density presence at few sections of entire data center	Along with perimeter/row cooling, XD solution is deployed in that high-density section.
2	Chilled water available but not adequate	Liebert XDP & XDC solution can be deployed as hybrid solution in high density segment.
3	Uneven heat load distributed in high density segment	With Liebert XDC, choose suitable cooling module (XDO/XDV/XDH).
4	Double stack Liebert XDV can be deployed to take care such condition	Liebert XDP can be placed within or adjacent to the data center; Liebert XDC is available in both room & row type configuration; it is easily placed within the data center.
5	Challenge in placing of Liebert XDP Or Liebert XDC unit at DC	Liebert XDP can be placed within or adjacent to the data center; XDC is available both room & row type configuration.
6	Ceiling height issue	In case of low ceiling height, installation of Liebert XDV or XDO is challenging; so row-based cooling module (XDH) can be placed close to the heat source.
7	If hot aisle/cold aisle reversed for some reason	In case of Liebert XDV, we can turn it on the opposite side on the racks and in case of Liebert XDO we can place it in the cold alley.

Positioning Statement

Parameter	For	Product is	Ideal for	Better than	Remarks
High Density	AI, HPC, HFT, GPU enabled servers	Vertiv™ Liebert® XD technology (XDC)	Support high-density load > 15 kW/rack to 30 kW/rack	Zero footprint configuration available compared to standard row cooling system	• It can cool more than 15 kW/rack to 30 kW/rack with different kinds of cooling module architecture. • This solution can be independent of chilled water availability. • With this system, complex chilled water system architecture, maintenance will be avoided, and Capex is saved to good extent.
Flexible Solution	Any medium or large extreme density data center switch room	Liebert XD technology	Ideal for existing & new high-density segment	Conventional & Row type for high density application	• Cooling modules are available in 10 kW to 30 kW per each range. • Wide range of connected cooling modules enable flexible and modular cooling infrastructure design in the high-density application.
Space Utilization	All kind high heat density data centers	Vertiv™ Liebert® XDO, Vertiv™ Liebert® XDV, Vertiv™ Liebert® XDH	High-density data center	Standard row/aisle containment arrangement	• Liebert XDO and Liebert XDV do not consume white space in the data center, while the Liebert XDP and Liebert XDC main unit and Liebert XDH, row type cooling module consume minimum space.

Conclusion

The Vertiv™ Liebert® XD family of thermal management units deliver efficient and sensible cooling to high-heat density environments. The Liebert XD systems are designed to provide high density cooling where the heat is accumulated. These units are best suited for cooling - computer racks, hot zones in a data center, or computer rooms. It provides energy efficiency and without using expensive floor space for cooling components.

In summary, the following points are critical to configure a Liebert® XD system properly.

Flexibility

- The floor-mount, rack-mount, and ceiling-mount modules, plus a choice of cooling capacities, which cover any application requirements.
- The plug & play facility for initial installation that can expand in the future. Can cool more than 30 kW per rack.

Higher Availability

- The Liebert® XD solution assures continuous operation of critical IT systems under extreme heat conditions.
- The units are designed to work with the hot aisle/cold aisle design of raised floor applications. It efficiently draws the hot air out of equipment racks and circulates cool air into the cold aisle, thus lowers the total cost of ownership.
- Vertiv™ Liebert® XD targeted cooling solution is more cost-effective than increasing the overall room air conditioning capacity using floor-mounted cooling units only.
- The total energy savings potential achieved with the Liebert XD solution is 30% to 40%. Thus, the overall data center efficiency increases.
- The minimal floor space requirements allow more room for the IT equipment.

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