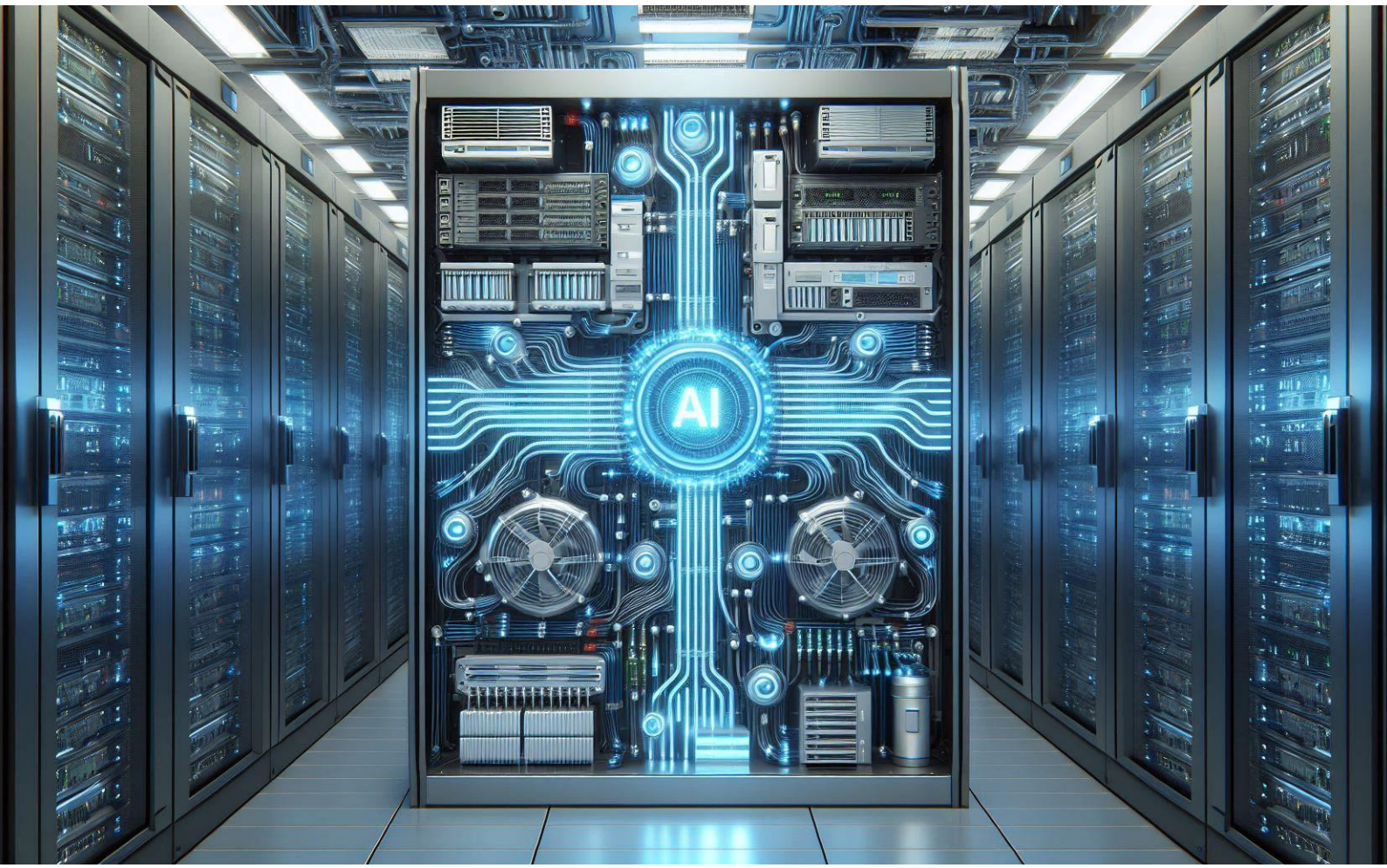

ABOVE
THE
STANDARD
ABRA

The world depends on data, we power and cool. From a simple swipe, to life-changing medicines. From push notifications to generative AI.

Where there's data, there's ABRA. Powering its potential. From pioneering precision cooling, to ABRA's leadership in critical infrastructure.

And the more data created, the more ABRA technology is needed. From supercomputers powering artificial intelligence, to modular data centers enabling fast-track deployment.

We're powering the potential for tomorrow's breakthroughs. ABRA's scale and innovation is accelerating the industry. From empowering what data needs now, to cooling where data goes next. As AI heats up, leading chip makers turn to us to keep them cool. What's next?



A sustainable digital future enabled by ABRA. Join us at the edge of innovation, supercharging data's next move.

Because the best way to predict the future, is to power it.

Introduction

Proper cooling is crucial to the operation of IT equipment, including servers, storage, and networking devices. As more companies undergo digital transformation, they need edge data centers that include robust, reliable compute resources located close to where data is being generated and processed. Edge computing is the concept of having compute and storage capacity close to where users are generating, consuming and manipulating data. Internet of Things (IoT) applications, for example, involve devices and sensors generating significant amounts of data at the network edge that must then be processed. Legal requirements, the need for local data consolidation and, above all, the high network costs, latency and network security lead to an enormous growth in decentralized IT, the edge applications. The latency involved in sending it to a centralized or cloud data center is too long, driving the need for localized processing capabilities. Healthcare, factory floor machine control and "smart city" applications including autonomous vehicles are just a few examples of applications driving demand for edge computing and, hence, edge data centers.

Office Environments and Comfort Cooling

The typical office environment uses room-based cooling systems provided by building heating, ventilation and air conditioning (HVAC) systems or de-centralized mini-split cooling systems. In centralized building HVAC systems, the cool air enters the space through vents in the ceiling or floor, while warm air is funneled back to the cooling system through a separate return duct. In de-centralized cooling systems extensive ductwork is not needed because the air conditioner is located in the cooled space on or near an outside wall. While this setup works fine in general, as any office worker knows, some areas may be warmer or cooler than others, especially with the centralized HVAC systems. That's a function of the way such systems work, having a single thermometer setting the desired temperature for what may be a fairly large area, such as an entire floor or multiple rooms. But the building's configuration, and the direction that different windows face, may mean some areas warm up more so than others. These differences, however, are not usually large enough to make for uncomfortable, comfort cooling temperatures one way or the other. Putting IT equipment into such a space can change that equation; looking at cooling requirements for office buildings versus data centers helps illustrate why. Cooling capacity is calculated based on the heat load the cooling system needs to handle, typically measured in watts (W) or kilowatts (kW). A typical office HVAC system should have cooling capacity to deal with a heat load in the range of 50 to 150 W per square meter. But a single rack of IT equipment may produce a heat load of up to 7500 watt per square meter.

That is likely to have several repercussions:

- Employees may be uncomfortable as the system struggles to maintain a target temperature, especially in the areas closest to where the IT rack sits
- IT equipment such as servers often have thermal protection systems that trigger a shutdown if the temperature rises too high, causing disruptive downtime and raising the potential for lost and corrupted data
- Continually taxing the HVAC system to operate above its rated cooling capacity will drive up operating costs, over the long-term

Another issue with typical office buildings is humidity. Office HVAC systems aren't designed to hold a constant level of humidity. With doors and potentially windows opening and closing all the time, humidity levels can constantly change depending on conditions outside. The HVAC system will only keep humidity in check at a general level, as a function of providing comfortable heating and cooling, not at exact levels. That may not be good enough for IT equipment, which is highly susceptible to changes in humidity. High humidity can cause condensation and water droplets to form on metal surfaces, eventually leading to corrosion. On the other hand, low humidity can cause static discharge from IT equipment, which may result in damage to electronics such as hard drives. Similarly, dust is the enemy of IT gear. That's why purpose-built data centers have air filtration systems that remove dust and other particulates from the air. In an office environment, dust will naturally accumulate on any surface that's not at least occasionally cleaned, including inside servers and other IT equipment. Over time, this accumulation could impede proper functioning of the equipment.

IT Cooling Options for Office Environments

Companies have two general options for overcoming these obstacles and providing proper cooling for IT equipment installed in an office environment:

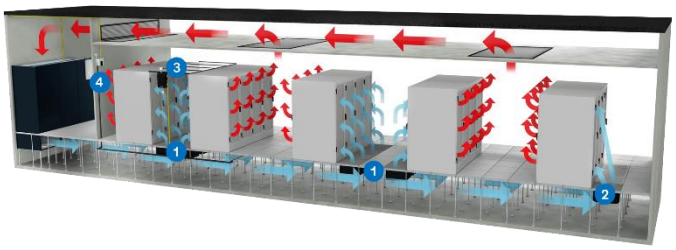
- Dedicated room cooling
- Spot-cooling
- Rack-cooling
- Row-cooling

In either case, a key consideration is the equipment footprint.

Companies typically have limited space to dedicate to IT equipment in the first place, often carving it out of space previously dedicated to another purpose. Air cooling systems for such spaces need to be designed to take up as little floor space as possible.

Dedicated Room Cooling

One option is to take a defined amount of space and turn it into a room dedicated to IT equipment, often called a server room. You can then install a cooling system dedicated to the sole purpose of cooling the IT equipment in that room.



Such a system can address the shortcomings of the building HVAC system, including humidity control and particulate filtration. Multiple options exist, enabling companies to choose one that best fits their exact situation.

For cooling the entire room, the two main options are floor-mounted and ceiling-mounted cooling units. In either case, these are typically split systems provided by DX or chilled water that mounted in the IT facility, which are called In-Room systems.

Spot Cooling

However, in edge facilities especially, it's not always possible or practical to create a dedicated server room and some users need to install the IT equipment directly in the office space. In such cases, spot cooling is a good option, with options falling into two general categories: rack- and row-based cooling.

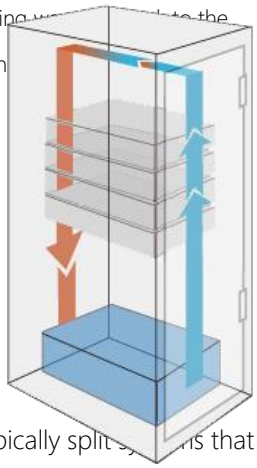
Rack cooling systems can be installed in a perforated door rack or a two-post rack without a door. Such systems also provide some room cooling, making them more suitable for dedicated server rooms or network closets. The systems typically have cooling capacity of about 2-4 kW per rack.

Rack-based Cooling

Rack-based cooling is good for smaller installations of just one or two racks of IT equipment. It involves a cooling system that's integrated directly into the rack and cools only that rack.

The racks can be enclosed, or contained, such that the cool air doesn't get dispersed into the room. This is a good option in office installations because it separates IT cooling from office cooling, so they do not impact each other. IT cooling won't make it uncomfortably cool for people in the office, and the warmer office air won't hinder the effectiveness of the IT cooling system.

A rack-based system has a self-contained unit that disperses cool air to the IT load, then circulates the resulting w[illegible] to the cooling unit. Enclosed Rack Cooling Does not require dedicated server room. It can be installed in office or in

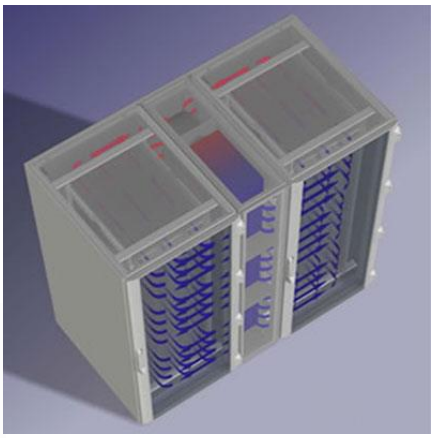


Row-based Cooling

For applications with more than one rack, another option is row-based cooling. These are typically split s[illegible]ns that use an outdoor condenser unit and an indoor evaporating unit. The indoor component comes in a form factor that enables it to fit seamlessly into an IT rack, with the ability to cool several racks in the row.

Row systems can also be contained, similar to enclosed rack systems so that the IT cooling air is circulated only inside of the racks and not discharged into the room. This configuration is ideal for users that don't have a dedicated server room but need to have more than two racks installed in an office space.

Here again, an open version with perforated rack doors is available as well and is used mainly in dedicated server rooms.



Row-based systems disperse cool air through the front of server rows and send warm air out the back, typically to an outdoor condenser unit where it is cooled again. They can be configured as fully contained systems or with perforated doors for room cooling.

One of the benefits of row-based cooling is it's installed close to the IT equipment, which allows for short air paths and quick system reactions to changing heat loads. The system continuously adjusts its cooling capacity and airflow to match the actual server load at any given time. This helps to keep operating costs low by giving the IT equipment only the cooling capacity it needs. Some systems can monitor temperatures of up to 10 different racks and adjust their cooling performance to make sure each rack is getting enough cold air. Such a capability makes these systems a good fit for applications with varying levels of server density.

Heat Rejection Options

As the cooling system cools the room, it removes the heat from that space, and this heat has to go somewhere. There are several options available for how the heat can be rejected, and each application may require different heat rejection types, like the popular methods of air, water, and refrigerant. This may dictate which cooling system is the best match for a given space.

One simple way of heat rejection is through the existing duct system in a building. This is a viable option for smaller rack-based cooling systems that generally produce a relatively small amount of warm air if a building duct system is available and suitable for it. Unfortunately, in many situations this is not the case.

Row- and room-based systems require a different approach since their cooling capacities are bigger, and consequently, they also remove more heat from the room. The existing building duct system would not have the capacity to absorb all this rejected heat. Therefore, these systems always consist of an indoor and outdoor unit connected with two pipes. Depending on heat rejection type, there can be either refrigerant or water flowing in these pipes between indoor and outdoor units.

Direct expansion (DX) systems use refrigerant to transport the heat removed by the indoor unit into the outdoor unit called the condenser, where it is rejected into the ambient air. A DX System is a practice used most commonly with home air conditioning systems.

Chilled water systems use water to transport the heat removed by the indoor unit. The chilled water type of indoor unit is connected to an outdoor chiller plant. The Chiller plant removes the heat from the water, cools it, and sends it back into the indoor unit, which uses it to cool the room. Chilled water systems are typically used in applications with higher heat loads because a single chilled water row-based indoor unit can provide from 30 to 60kW of cooling capacity. In practice, most companies would not build a chiller plant for small sites since it's quite expensive. Therefore, for smaller locations, DX systems are typically preferred.

Uncontrolled Environments

Aside from office environments, many companies need to install edge data centers on factory floors, in manufacturing facilities, and in warehouses that have widely varying environmental characteristics.

Any warehouse faces challenges in maintaining a constant temperature since they aren't usually well-insulated. Depending on geographic region, that can lead to excessive heat or cold inside the facility. Facilities located in regions with changing seasons will see wide fluctuations in terms of temperature from hot to cold and back again. Humidity is likewise an issue for all the same reasons, especially in facilities with no ambient air control system in place.

Uncontrolled environments are also likely to be far dustier than offices, and less likely to have any particulate filtration system in place. Dust combined with high humidity can be quite harmful to IT equipment, as the humidity will make particles stick to IT equipment and potentially clog up the filters meant to protect gear such as servers and data storage systems.

Cooling Options

Theoretically, all the same cooling systems that apply in an office environment can also be used in uncontrolled environments, but most customers favor an approach that involves a sealed rack, which means rack- or row-based cooling.

The reason is simple: such self-contained systems essentially seal off the IT equipment from the outside air. That protects the equipment from dust and humidity, while enabling the company to tightly control the temperature of the racks.

The key is to look for a system with a high Ingress Protection (IP) rating as defined in the International Electrotechnical Commission (IEC) 60529 specification, which covers mechanical and electrical enclosures intended to protect against intrusion, dust and water. An IP54 rating, for example, means an enclosure offers strong protection against dirt, dust, oil, and splashing water, all enemies of IT equipment.

With such an enclosure, the IT equipment is isolated from the environment in which it's installed. Combined with a rack- or row-based cooling system, companies can tightly control the temperature of the IT equipment while also protecting it from its potentially harsh surroundings.

Such a setup can also be highly efficient since IT equipment can withstand far higher temperatures than what is comfortable for humans. For example, the latest guidance from the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) says 87 percent of server models are safe to operate at 35 degrees Celsius (95 degree Fahrenheit). Operating the IT cooling system at or near that level would save significant sums on cooling costs versus using a temperature closer to the comfort level for humans.

In-Row Cooling System

Direct Expansion (DX) In-Row Cooling Systems

The DX Type In-Row Cooling Machine is a cutting-edge solution designed for precision cooling in data centers and computer rooms. Leveraging advanced Direct Expansion (DX) technology with an Inverter BLDC (Brushless Direct Current) condensing unit, this cooling machine delivers high efficiency, superior temperature and humidity control, and flexible operation. Its innovative design, featuring a variable speed evaporator fan, ensures optimal performance and energy savings, making it an ideal choice for modern data center environments.

Applications:

- Data Centers: Ideal for high-density server environments, ensuring precise and reliable cooling.
- Telecommunications Facilities: Provides consistent cooling for critical telecom infrastructure.
- IT Rooms and Server Farms: Ensures optimal operating conditions for IT equipment, preventing downtime and equipment failure.

Benefits:

- Enhanced Energy Efficiency: Inverter BLDC technology and variable speed fans significantly reduce energy consumption, leading to lower operational costs.
- Superior Temperature and Humidity Control: Maintains stable conditions to protect sensitive IT equipment and ensure peak performance.
- Space Optimization: The In-row design maximizes floor space utilization, crucial for high-density data centers.
- Scalability and Flexibility: Easily scalable to meet evolving data center needs, providing a future-proof cooling solution.
- Reduced Noise Levels: Quieter operation creates a more pleasant working environment in data centers.

Features

Inverter BLDC Condensing Unit:

- Enhanced Efficiency: The BLDC condensing unit offers superior energy efficiency and performance compared to traditional systems. Its inverter technology allows for precise control of cooling capacity, so reducing energy consumption achieved.
- Quiet Operation: BLDC motors operate more quietly, creating a less disruptive environment in the data center.

Variable Speed Evaporator Fan

- Energy Savings: The variable speed fan adjusts its speed based on real-time cooling demands, ensuring efficient airflow and reducing power consumption.
- Optimal Cooling: Provides consistent temperature and humidity control, protecting sensitive IT equipment from overheating and humidity-related issues.

Precision Temperature and Humidity Control

- Stable Environment: Maintains precise control over temperature and humidity levels, ensuring the optimal operating conditions for data center equipment.
- Advanced Sensors: Equipped with high-accuracy sensors for real-time monitoring and adjustments.

Compact In-Row Design

- Space-Saving: The In-row configuration fits seamlessly between server racks, maximizing floor space and delivering targeted cooling where it's needed most.
- Modular and Scalable: Easy to scale up or down to match the changing cooling requirements of the data center.

Energy-Efficient Operation

- Adaptive Control Algorithms: Advanced control algorithms dynamically adjust cooling output to match the data center's load conditions, optimizing energy use.
- Reduced Operating Costs: Lower energy consumption translates to significant cost savings over time.

Intelligent Monitoring and Control

- Real-Time Data: Continuous monitoring of system performance, temperature, and humidity, with data accessible remotely for proactive management.
- User-Friendly Interface: Intuitive controls and interface for easy operation and configuration.

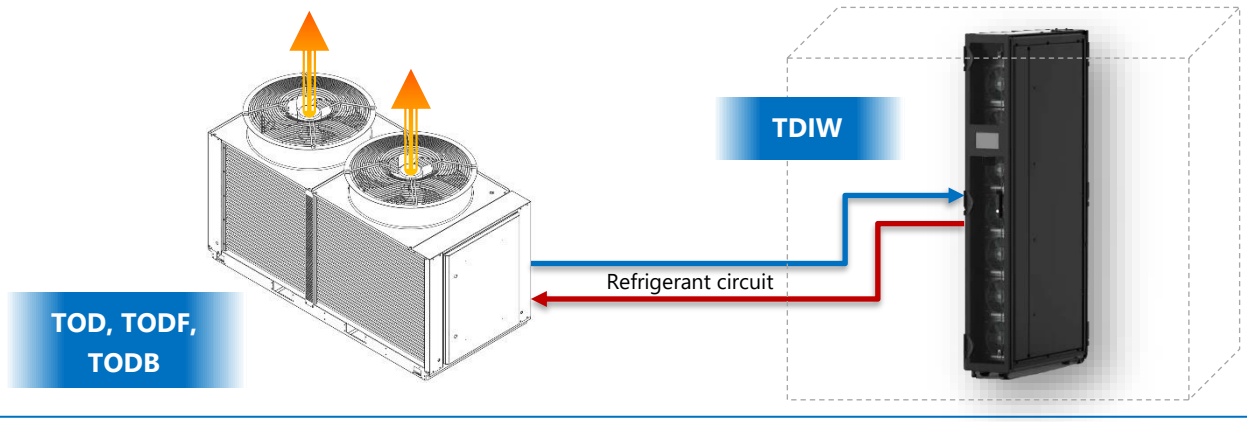
High Reliability and Redundancy

- Robust Design: Built to withstand the demanding conditions of data center environments, ensuring reliable performance.
- Redundancy Options: Can be integrated with other cooling systems to provide redundancy and ensure continuous operation.

Eco-Friendly Refrigerant

- Sustainability: Uses environmentally friendly refrigerants, contributing to lower global warming potential (GWP) and compliance with environmental regulations.

DX In-Row Cooling Systems Operation Diagram



Optional Add-on

1. Multi-Indoor Unit Connection

- Redundancy and Cost Efficiency: Multiple indoor in-row units can be connected to a single outdoor unit, providing enhanced redundancy and reducing overall costs. This setup ensures continuous cooling operation even if one unit requires maintenance, offering a reliable and cost-effective solution for data centers.

2. Built-In Humidifier

- Enhanced Environmental Control: The system can be ordered with a built-in humidifier, allowing for precise control over humidity levels. This feature helps maintain optimal conditions, protecting sensitive IT equipment from humidity-related issues and ensuring consistent performance.

3. Drain Pump

- Convenient Drainage: For installations where gravity drainage is not feasible, the system can be equipped with a built-in drain pump. This option facilitates efficient removal of con1densate water, ensuring smooth and hassle-free operation.

Technical Data Table

Model no.			TDIWDF30SSD	TDIWDF60SSD
Cooling capacity	Db 27 °C Wb 23 °C	KW	23	41
	Db 30 °C Wb 23 °C	KW	27	49
	Db 35 °C Wb 26.5 °C	KW	31	54
SHR		-	> 0.95	
Input power		KW	3	8
Heating capacity		KW	2	4
Air flow rate		m^3/h	4200	7400
Fan		Type	Variable speed backward curved plug fan	
Remote monitoring		-	SNMP / Modbus TCP / Modbus RTU / BACnet / CAN-FD	
Refrigerant		Type	R410a	
Expansion Valve		Type	EEV	
Pipe connection	Inlet	inch	3/8	5/8
	Outlet	inch	7/8	1 1/8
Air filter		Type	G4	
Power supply		-	230 V ±10% – 50 HZ	400 V – 50 Hz Dual Power
Dual power		-	Included	
Dimension	W× H × L	mm	300 × 2000 × 1200	600 × 2000 × 1200
Net weight		kg	150	250

Chilled Water In-Row Cooling Systems

The Water Chilled Type In-Row Cooling Machine is an advanced cooling solution designed specifically for computer room air conditioning applications. Utilizing chilled water supplied from a central chiller or dry cooler, this in-row cooling machine ensures precise temperature and humidity control while maximizing energy efficiency. The integration of variable speed evaporator fans further enhances its performance, making it an ideal choice for modern data centers and IT environments.

Applications

- Data Centers: Ideal for high-density server environments, ensuring precise and reliable cooling.
- Telecommunications Facilities: Provides consistent cooling for critical telecom infrastructure.
- IT Rooms and Server Farms: Ensures optimal operating conditions for IT equipment, preventing downtime and equipment failure.

Benefits:

- Enhanced Energy Efficiency: Variable speed evaporator fans and chilled water cooling significantly reduce energy consumption, leading to lower operational costs.
- Superior Temperature and Humidity Control: Maintains stable conditions to protect sensitive IT equipment and ensure peak performance.
- Space Optimization: The In-row design maximizes floor space utilization, crucial for high-density data centers.
- Scalability and Flexibility: Easily scalable to meet evolving data center needs, providing a future-proof cooling solution.
- Eco-Friendly Operation: Utilizes chilled water, reducing the reliance on refrigerants and contributing to lower global warming potential.

Features

Chilled Water Cooling

- Efficient Heat Removal: Uses chilled water from a central chiller or dry cooler to efficiently remove heat from the data center environment.
- Eco-Friendly: Reduces reliance on refrigerants, offering a more environmentally friendly cooling solution.

Variable Speed Evaporator Fan

- Maximized Efficiency: Adjusts fan speed based on real-time cooling demands, optimizing airflow and reducing power consumption.
- Enhanced Control: Provides precise temperature and humidity regulation, ensuring optimal conditions for IT equipment.

Compact In-Row Design

- Space-Saving: Fits seamlessly between server racks, maximizing floor space and delivering targeted cooling directly to heat-generating equipment.
- Scalability: Easily scalable to meet the growing cooling needs of expanding data centers.

Intelligent Monitoring and Control

- Real-Time Data: Continuous monitoring of temperature, humidity, and system performance with remote management capabilities.
- User-Friendly Interface: Intuitive controls and interface for easy operation and configuration.

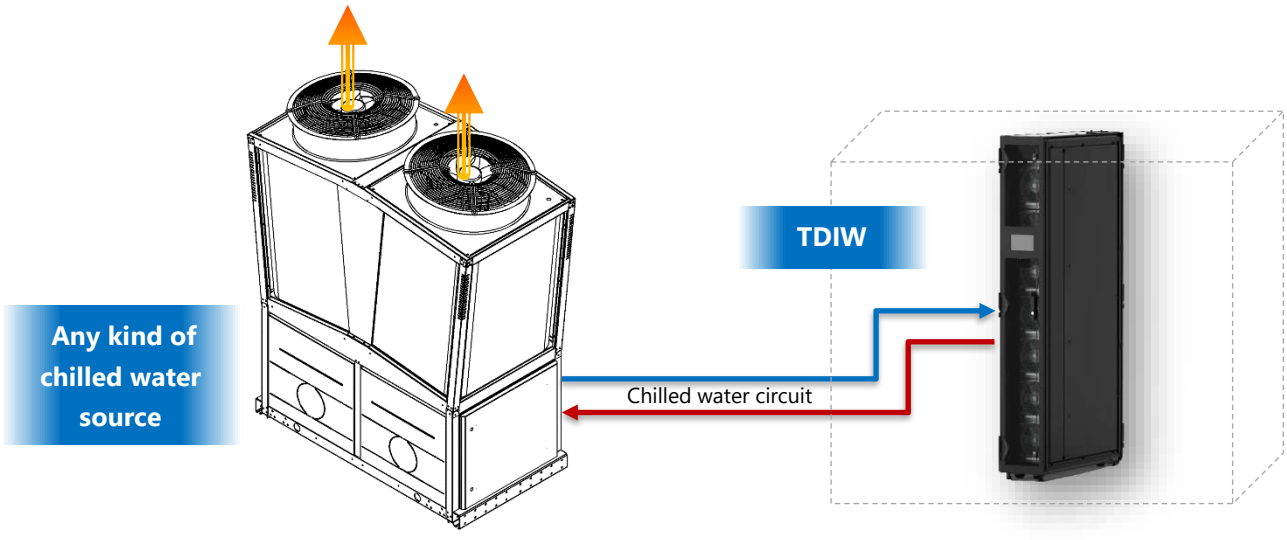
Energy-Efficient Operation

- Adaptive Control Algorithms: Dynamically adjusts cooling output to match the data center's load conditions, ensuring energy-efficient operation.
- Reduced Operating Costs: Lower energy consumption leads to significant cost savings over time.

High Reliability and Redundancy

- Robust Design: Built to withstand demanding data center environments, ensuring reliable and continuous operation.
- Redundancy Options: Can be integrated with other cooling systems to provide redundancy and ensure uninterrupted cooling.

Water Chilled In-Row Cooling Systems Operation Diagram



Optional Add-on

1. Dew Point Control Kit

- Maximized Sensible Heat Removal: This kit includes a PWM controlled variable speed pump that adjusts the flow in the coil, optimizing dew point control for maximum sensible heat removal without latent heat removal. This ensures efficient cooling and enhanced environmental control.

2. Built-In Humidifier

- Enhanced Environmental Control: The system can be ordered with a built-in humidifier, providing precise humidity control to maintain optimal conditions and protect sensitive IT equipment from humidity-related issues.

3. Drain Pump Options

- Standard Drain Pump: Ensures efficient removal of condensate water, suitable for installations where gravity drainage is not feasible.
- Dual Drain Pump: Offers extra redundancy with dual drain pumps, ensuring continuous and reliable condensate removal for uninterrupted operation.

Technical Data Table

Model no.			TDIWLWA/B30SDD	TDIWLWA/B60SDD
Cooling capacity	Db 27 °C Wb 23 °C	KW	23	41
	Db 30 °C Wb 23 °C	KW	27	49
	Db 35 °C Wb 26.5 °C	KW	31	54
SHR		-	> 0.95	
Input power		KW	3	8
Heating capacity		KW	2	4
Air flow rate		m^3/h	4200	7400
Fan		Type	Variable speed backward curved plug fan	
Remote monitoring		-	SNMP / Modbus TCP / Modbus RTU / BACnet / CAN-FD	
Coolant		Type	Water / Water-Glycol 30%	
Water flow rate	max	m^3/h	5.5	12
Pipe connection	Inlet	inch	1 1/4	2
	Outlet	inch	1 1/4	2
Air filter		Type	G4	
Power supply		-	230 V ±10% – 50 HZ	400 V – 50 Hz Dual Power
Dual power		-	Included	
Dimension	W × H × L	mm	300 × 2000 × 1200	600 × 2000 × 1200
Net weight		kg	150	250

Hybrid In-Row Cooling Systems

The Hybrid In-Row Cooling Machine is an advanced and versatile solution designed to meet the dynamic cooling needs of modern data centers. This innovative product seamlessly integrates with computer room air conditioning systems to ensure optimal temperature control, enhanced energy efficiency, and reliable performance. The hybrid design allows it to utilize both Direct Expansion (DX) and chilled water as sources for cooling, offering unparalleled flexibility and adaptability to varying cooling demands and infrastructure setups.

Applications:

- Data Centers: Optimized for high-density server environments, ensuring consistent cooling performance even under peak load conditions.
- Telecom Facilities: Provides reliable cooling for critical telecommunication infrastructure, ensuring uninterrupted service.
- Edge Computing Sites: Ideal for remote or small-scale data centers where space and resources are limited.

Features

- Dual Cooling Sources

- DX Cooling: Utilizes refrigerant to directly cool the Heat Exchanger. Ideal for environments where chilled water is not readily available or where direct cooling is more efficient.
- Chilled Water Cooling: Uses a chilled water loop, leveraging existing chilled water infrastructure for efficient heat removal. Perfect for large-scale data centers with established water-cooled systems.
- DX Cooling + Water Cooling: Benefits of Simultaneous DX Cooling + Water-Free Cooling;

Enhanced Efficiency

Combining DX and chilled water cooling optimizes energy use, leading to significant energy savings and lower operational costs.

Increased Reliability

Redundant cooling paths ensure continuous operation even if one system experiences issues.

Operational Flexibility

The ability to dynamically switch between cooling methods allows for adaptability to changing conditions and load demands.

Cost-Effective Maintenance

The ability to perform maintenance on one system without shutting down the cooling ensures continuous protection of critical IT equipment.

In summary, the simultaneous use of DX and water-free cooling in the Hybrid In-Row Cooling Machine provides a robust, efficient, and flexible solution for data center cooling, ensuring optimal performance and reliability.

- DX Cooling + Free Cooling: Free cooling, also known as economizer cooling, leverages the cooler outdoor air during winter months to assist in cooling data center environments. When integrated with a DX (Direct Expansion) cooling system in the Hybrid In-Row Cooling Machine, it offers several significant benefits:

Energy Savings

- Reduced Compressor Usage: During winter, the need for mechanical refrigeration is minimized because the colder outdoor air can be used to cool the data center. This reduces the runtime of compressors in the DX system, leading to substantial energy savings.
- Lower Power Consumption: By utilizing free cooling, the overall power consumption of the cooling system decreases, resulting in lower energy bills and improved energy efficiency.

Extended Equipment Life

- Reduced Wear and Tear: With less reliance on compressors and other mechanical components during cooler months, the wear and tear on the DX system is reduced. This can extend the lifespan of the cooling equipment, lowering maintenance costs and increasing reliability.

- Balanced Load Distribution: By alternating between free cooling and DX cooling, the load is more evenly distributed, reducing the strain on any single system.

Enhanced Cooling Efficiency

- Optimal Use of Resources: The system can intelligently switch between free cooling and DX cooling based on real-time temperature and load conditions, ensuring that the most efficient cooling method is used at all times.
- Higher Cooling Capacity: The combination of free cooling and DX cooling can handle higher cooling loads more effectively, ensuring that the data center maintains optimal temperatures even during peak operation.

Environmental Benefits

- Reduced Carbon Footprint: Utilizing free cooling reduces the need for energy-intensive mechanical cooling, lowering the data center's overall carbon footprint. This contributes to sustainability goals and can enhance the company's environmental credentials.
- Sustainable Operations: By maximizing the use of natural cooling resources, data centers can operate in a more environmentally friendly manner, supporting green initiatives.

Cost Saving

- Lower Operational Costs: Reduced energy consumption directly translates to lower operational costs. Free cooling can significantly decrease the cooling costs during winter months, providing financial benefits to the data center operations.
- Deferred Capital Expenditure: The extended lifespan of the cooling equipment due to reduced mechanical stress can defer the need for capital expenditure on replacement or upgrades.

Improved Redundancy and Reliability

- Backup Cooling Option: Free cooling acts as an additional cooling method that can provide backup in case the DX system experiences a failure or requires maintenance.
- Consistent Performance: By incorporating multiple cooling methods, the system ensures consistent and reliable cooling performance, critical for maintaining the uptime and stability of data center operations.

Regulatory and Compliance Benefits

- Energy Efficiency Standards: Many regions have regulations and standards aimed at improving energy efficiency in data centers. Utilizing free cooling can help data centers meet these standards and potentially qualify for energy efficiency incentives or rebates.
- Compliance with Environmental Regulations: Reducing the reliance on mechanical cooling can help data centers comply with environmental regulations aimed at reducing energy consumption and greenhouse gas emissions.

Scalability and Flexibility

- Designed to integrate seamlessly between server racks, the in-row configuration provides targeted cooling directly at the source of heat generation. This modularity allows for scalable expansion as data center needs grow.

Energy Efficiency

- Advanced control algorithms optimize the use of DX and chilled water systems Simultaneously, to maximize energy efficiency. By dynamically switching between cooling modes based on real-time load conditions, the hybrid system minimizes energy consumption and reduces operational costs.

High Precision Cooling

- Equipped with precise temperature and humidity control, the Hybrid In-Row Cooling Machine ensures stable conditions, safeguarding critical IT equipment from overheating and maintaining optimal performance.

Smart Monitoring and Control

- Integrated with intelligent monitoring systems, the cooling machine provides real-time data on temperature, humidity, and system performance. Remote management capabilities allow for proactive maintenance and quick response to potential issues.

Compact and Space-Saving Design

- The in-row configuration maximizes floor space utilization by fitting directly within server aisles. This design minimizes airflow obstructions and enhances cooling efficiency compared to traditional perimeter cooling solutions.

- Multi Cooling Sources

- DX Cooling: Uses refrigerant for direct air cooling.
- Chilled Water Cooling: Utilizes chilled water loops for efficient heat removal.
- Free-cooling with Dry Cooler: Uses Cooling Water From water sources such as cooling towers in summer or closed-circuit dry cooler in winter.

Energy-Efficient Operation

- Dynamic Switching: Automatically switches between DX and chilled water cooling based on real-time conditions to optimize energy use.

Compact In-Row Design

- Space-Saving: Fits between server racks, maximizing floor space and providing targeted cooling.
- Intelligent Monitoring and Control:
- Real-Time Data: Provides continuous monitoring of temperature, humidity, and system performance with remote management capabilities. Using Protocols Such as SNMP, Modbus TCP or Modbus RTU

Enhanced Redundancy

- Backup Cooling: Ensures continuous operation by having dual cooling sources, providing redundancy in case of system failures and reduces the need for having a redundant unit.

Advanced Control Algorithms

- Optimal Performance: Utilizes advanced algorithms to manage cooling modes and improve efficiency in both full load operation and part load operation.

Free Cooling Integration

- Winter Optimization: Leverages cooler outdoor air during winter to reduce energy consumption and enhance cooling power efficiency.

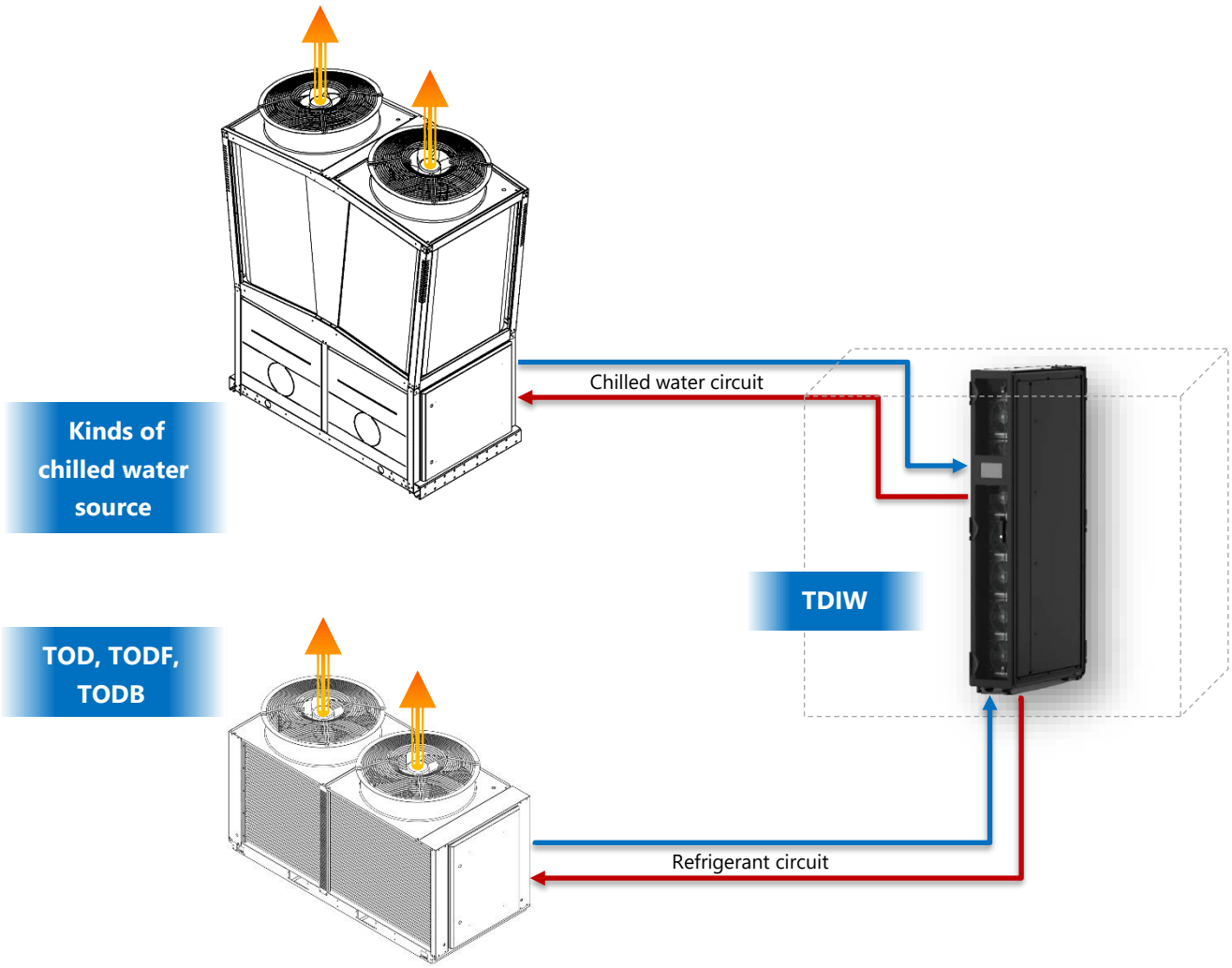
Precise Temperature and Humidity Control

- Stable Environment: Maintains consistent conditions to protect sensitive IT equipment from overheating.

Reduced Maintenance Costs

- Lower Wear and Tear: By distributing the load between DX and chilled water systems, maintenance requirements and costs are minimized.

Hybrid In-Row Cooling Systems Operation Diagram



Technical Data Table

Model no.				TDIWHN30SDD	TDIWHN60SDD
Cooling capacity	Db 27 °C Wb 23 °C		KW	23	42
	Db 30 °C Wb 23 °C		KW	27	51
	Db 35 °C Wb 26.5 °C		KW	31	58
SHR			-	> 0.95	
Input power			KW	6	9
Heating capacity			KW	2	4
Air flow rate			m^3/h	4200	7400
Fan			Type	Variable speed backward curved plug fan	
Remote monitoring			-	SNMP / Modbus TCP / Modbus RTU / BACnet / CAN-FD	
Coolant	DX coil		Type	R410a	
	Primary circuit		Type	FroGen 30 (30% water 70% Glycol)	
	Water coil		Type	Water / Water-Glycol 30%	
Expansion Valve			Type	EEV	
Water flow rate	max		m^3/h	7.5	15
Cooling water supply temp range			°C	5 – 15	
Cooling water return temp range			°C	10 – 20	
Cooling water side pressure drop			kPa	22	28
Pipe connection	DX coil	Inlet	inch	3/8	5/8
		Outlet	inch	7/8	1 1/8
	Water coil	Inlet	inch	1 1/4	2
		Outlet	inch	1 1/4	2
Air filter			Type	G4	
Power supply			-	230 V ±10% – 50 HZ 1 Ph + PE	400 V – 50 Hz 3 Ph + N + PE
Dual power			-	Included	
Dimension	W × H × L		mm	300 × 2000 × 1200	600 × 2000 × 1200
Net weight			kg	300	450

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