Thermal Management Solutions

TX

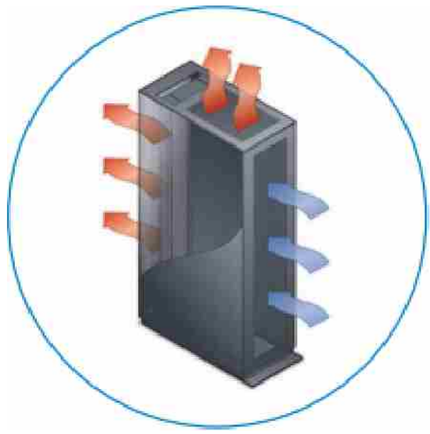
Series

Rack system

Introduction

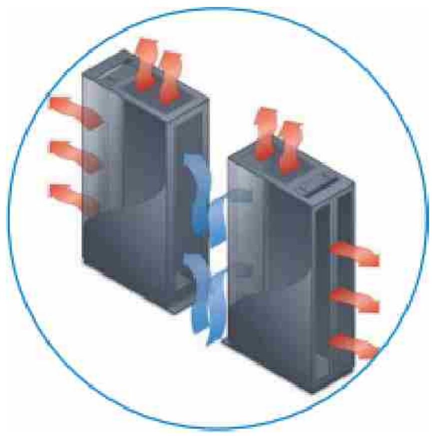
This document explains how the cooling design of the cabinet works, gives some thermal load guidelines and summaries our recommendations on how to best configures equipment inside the TX series for optimize cooling.

In general, any cabinet in a data room environment can be classified into one of the Four categories as described below :



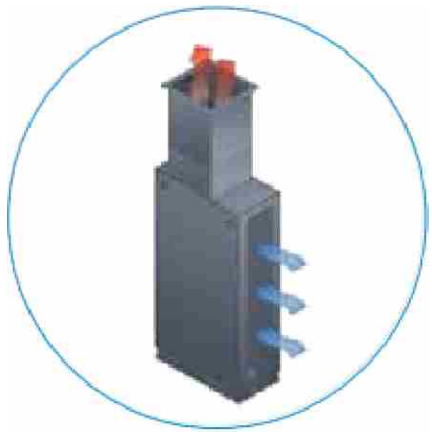
1.. Single Cabinet Environment.

The equipment mounted inside the cabinet creates a low pressure are immediately behind the front door and a high pressure are immediately in the front of the rear door. Cool air is therefore drawn into the cabinet from the front, warmed by equipment, and expelled from the back of the cabinet around the rear door.



2.. Localize Cabinet Environments

This scenario can be found in smaller network installations that have evolved over a period of time. Because the internal cabinet environment relies on local ambient air to provide cooling capacity, other localized influences can impact the cabinet's cooling efficiency. These issues can range from poorly positioned cabinets that are subject to hot air exhausts from other cabinets to cabinets positioned too far from the computer room air conditioning unit (CRAC).

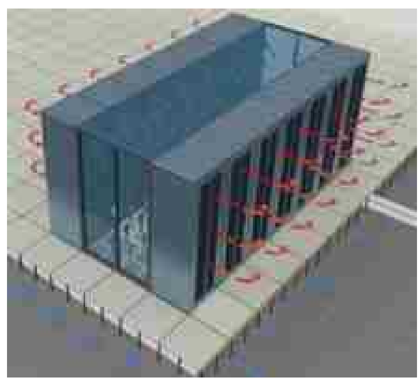


3.. Hot & Cold Aisle installation

Typically found within larger scale data centers, this design usually utilizes a pressurized floor layout where the cold air from the CRAC unit is fed into the under floor void. The cold air is guided over and through the active equipment before begin exhausted as hot air at the rear of the cabinet. In this type of scenario, cold air is fed down one aisle and hot air is returned down another aisle. Issues can still arise from this situation as installations evolve and change over time.

4.. High-Density Containment Applications

In a conventional data room environment configured in a "hot asile" / "cold aisle" layout, the CRAC perform the function of collecting warm air (return air) from the local ambient environment. This return air is then cooled by the CRAC unit before being circulated back into the room environment. Where a raised computer floor is employed in the data room, it is quite usual for the cold air feed from the CRAC unit to be fed under the floor to create a pressurized floor void.



Hot Aisle Containment Solution involves a specialized cabinet with a solid rear door and attachments for ductwork (also called a chimney) and a false ceiling. Attached to the rear of the server cabinets, these ducts catch the exhaust air off the servers and channel it into a false ceiling. The false ceiling serves as a plenum, delivering the hot exhaust air to a perimeter-mounted air conditioner, which may also extend, via ducts, to the ceiling level.

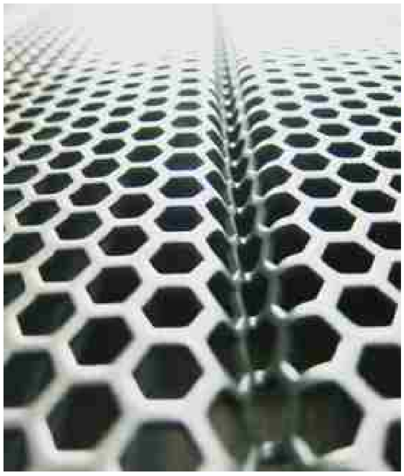
Cold Aisle Containment Solution augments its predecessor's (hot aisle/cold aisle) arrangement by enclosing the cold aisle. The aisle then becomes a room unto itself, sealed with barriers made of metal, plastic, or plexiglass.

Ventilation

This is a key area of differentiation between "standard" equipment cabinets and server racks. A server cabinet must cope with the ventilation demands of many kilowatts worth of electrical equipment. A standard glass-fronted cabinet with fans can only with the cooling demands of less than a kilowatt.

It would appear that suitably ventilated cabinet, supplied with adequate chilled air through a standard floor tile, can cope with about two kilowatts of heat dissipation, where the motive force through the rack is only provided by the fans within the server units themselves.

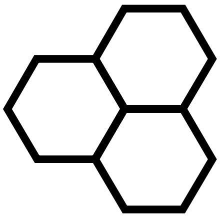
The amount of ventilation required is stated by several sources and is expressed as a ratio of "open" space to overall door area, e.g :
- ... Servers require that the front and back cabinet doors to be at least 63% open for adequate airflow (SUN)
- One method of ensuring proper cooling is to specify rack doors that provide over 830 in2 (0.53m2) of ventilation area or doors that have a perforation pattern that is at least 63% open. (APC)
- Cabinets are a critical part of the overall cooling infrastructure. HP enterpriseclass cabinets provide 65% percent open ventilation using perforated front and rear door assemblies. To support the newer high-performance equipment, glass doors must be removed from the cabinet (HP)
- Ventilation through slots or perforations of front and rear doors to provide a minimum of 50% open space. Increasing the size and area of ventilation openings can increase the level of ventilation. (TIA 942)



TX Series has Hexangular - Hole Perforation Pattern for Front & Rear Door with High Quality Handle Lock

Single Door - 73% Perforation Rated Pattern with Hexangular-Hole Perforation

Double Door - 68% Perforation Rated Pattern with Hexangular-Hole Perforation



Single Door -
73% Perforation Rated Pattern
with Hexangular-Hole Perforation

Double Door -

70% Perforation Rated Pattern
with Hexangular-Hole Perforation

Power IN = Heat OUT

The best way to measure the amount of heat produced in a cabinet is to measure the power being consumed. Every watt of power consumed nearly equals every watt of heat produced. The key to keeping equipment cool is channeling or ducting cool air into the equipment and providing a path for the heated air to escape out of the cabinet.

POWER IN = HEAT OUT
Power in = voltage x current (amps)
Example : 220 vac x 32A = 7,040 watts or 7.04kW

Critical Formulas For Thermal Management

Watts (power) = voltage x current (amperes) = Watts (heat load)

Watts (thermal convection cooling) = .316 x CFM x ΔT° (in °F)

or

CFM = Watts (cooling) / .316 x ΔT° (in °F)

or

ΔT° (in °F) = Watts (cooling) /(.316 x CFM)

This equation can be manipulated to solve any of the three variables: Watts (cooling), CFM or ΔT° (in °F), and is invaluable in the design and operation of a data center.

CFM = cubic feet per minute (quantity of air and its velocity)

ΔT° (in °F) = Delta T (the difference between the coolest air (55°F) and the maximum allowable temperature (95°F).

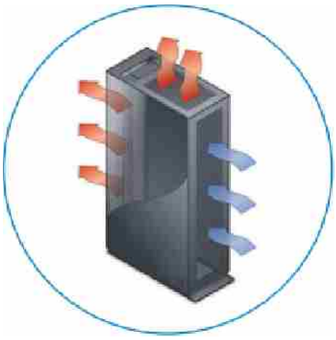
Example:

10 kW of heat load in a typical data center with a (30 ΔT°) will need 1,055 CFM

BTUs (British thermal units) = Watts cooling x 3.413

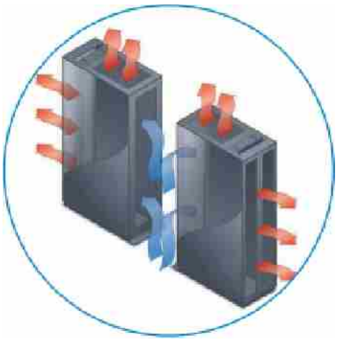
Example: 10 kW cooling = 34,130 BTUs

Thermal Management Strategies



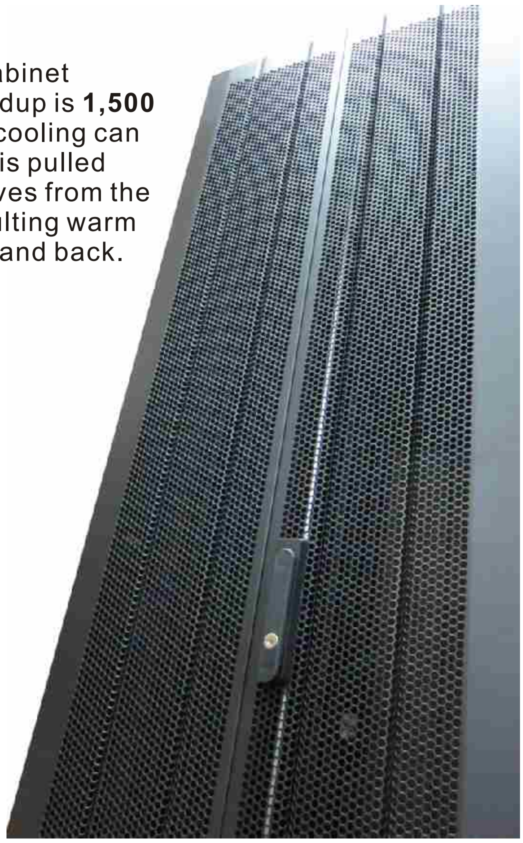
Random Configuration, Passive Cooling

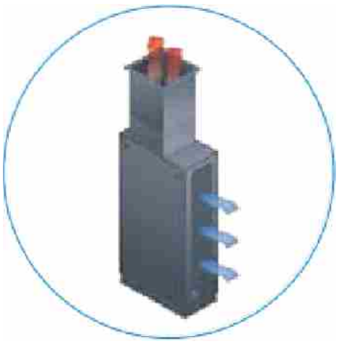
A relatively low heat dispensation volume of **1,000** to **2,000 watts** (**1 kW** to **2kW**) passive cooling will manage heat buildup. TX Series cabinets that have a perforated front, rear and top perform the most efficiently in this type of application.



Hot Aisle / Cold Aisle Configuration, Passive Cooling

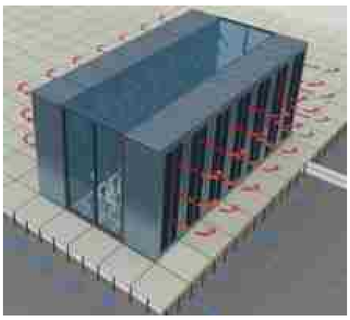
When hot aisle / cold aisle data center cabinet positioning is implemented and heat buildup is **1,500** to **2,000 watts** (**1.5 kW** to **2kW**) passive cooling can be utilized. In this configuration cold air is pulled from the floor to cool equipment as it moves from the front to the back of the cabinet. The resulting warm air is then exhausted out the cabinet top and back.





Chimney Configuration

The TX-Passive Chimney solutions are extremely efficient for appliation up to **12,000 watts** (**12 kW**). Utilizes ducting to remove hot air back to the CRAC unit.



Hot / Cold Aisle Containment

Iracksystem provides ultimate containment sollution for high-density equipment. Flexible and scalable, TX Series cabinets can be deployed and re-deployed into hot or cold aisle configurations, providing passive heat dissipation of up to **20,000 watts** (**20 kW**) per cabinet

Important

As such, the thermal capacities given below must only be considered as guidelines to maximum thermal loading. The thermal capacity for each cabinet is going to be as unique as the selected servers / equipment installed, and influenced by a number of other factor including arrangement, capacity, and the immediate environment.

This information is only a guideline for the systems being constructed and is not intended to be a substitute for system builder verification, validation, and testing on the reliability and effectiveness of a thermal solution

Hot Aisle Containment Solutions

The Hot Aisle containment system works in the same way as a conventional hot aisle / cold aisle layout. Cold air from the local room ambience is drawn through the perforated doors on the front of each cabinet The cold air is drawn over the active equipment where the heat from the equipment transfers to the air.

The now hot air is expelled either out of the rear of side of the equipment collecting in the rear of the cabinet. At this point, it is important that the hot exhaust air is stopped from circulating back to the front of the cabinet as failure to address this issue can lead to the generation of hot spots leading to equipment shut down or premature system failure. Air pressure generated by the internal fans in the active equipment effectively forces the hot air into the hot aisle where it is contained within the hot aisle envelope.

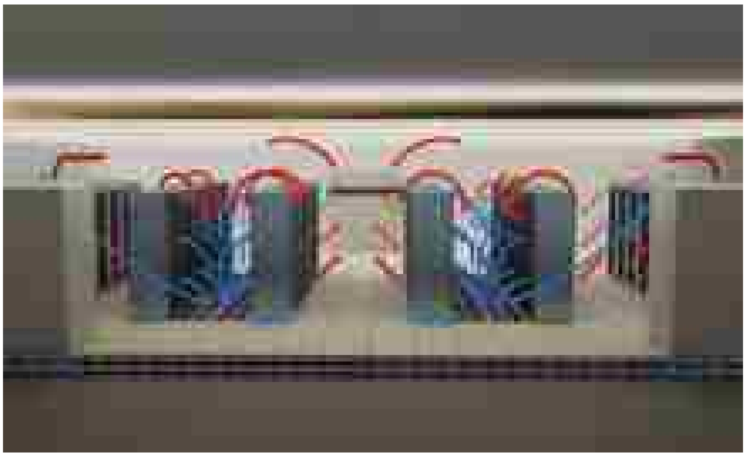
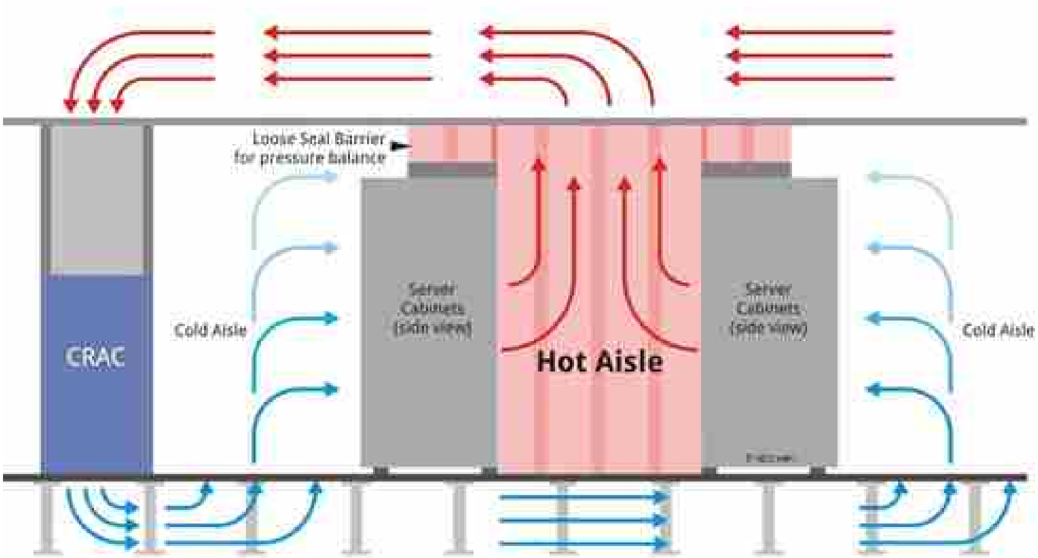
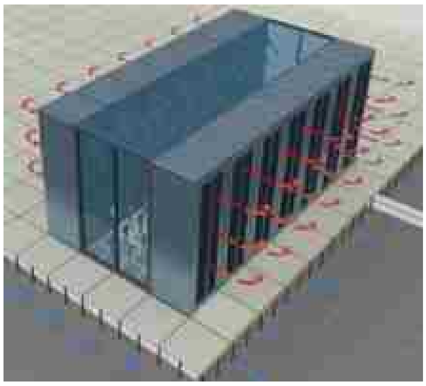


Diagram of a Data Center with Bypass Air problems (mixing of hot and cold air) - a very common cause of power loss.



Hot Aisle Containment reduces energy consumption by exhausting hot air and eliminating bypass air flow

Cold Aisle Containment Solutions



Cold Aisle Containment augments its predecessor's (hot aisle/cold aisle) arrangement by enclosing the cold aisle. The aisle then becomes a room unto itself, sealed with barriers made of metal, plastic, or plexiglass.

As rack densities inevitably climb, the challenges above become more severe. The infrastructure struggles to deliver a sufficient volume of cool air to the equipment and to move exhaust air to the air handlers. As it's forced to deliver colder air at a greater CFM, the cooling scheme consumes more energy from the fans through the pumps, down to the chiller. And even under minimal loads, the efficiency of these systems is suspect. The premise of cold aisle containment, though simple, can improve cooling performance.

Due to the open architecture of the data center room, hot aisle/cold aisle cannot attain complete air separation. With the cold aisle encased, the cold air, delivered from under the floor, stays where it's needed at the server intake. The roof and walls of the containment ensure that the only place this air can exit is through the rackmount equipment. The exhaust air, because of the boundaries, routes back to the air handlers only, eliminating the previous concerns of hot air contamination and hot air recirculation.

If there's adequate capacity in the central plant, cold aisle containment can harness that capacity to support higher density cabinet installations. With mixing out of the equation, the system can focus on cooling the load instead of the entire room. As a result, data center professionals have a more predictable system-a consistent server inlet temperature, within ASHRAE ranges, unaffected by the higher server exhaust temperature.

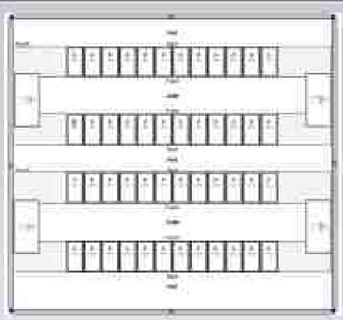
Belows shows depicts a sample data center and compares the volume of air in a contained cold aisle to the volume of air in an uncontained cold aisle. The uncontained cold aisle shows a volume of cold air that is 17 times greater than that of the cold air volume found in the contained cold aisle. This reduced air volume shortens the amount of time (seconds instead of minutes) it would take for the servers to overheat if a failure were to occur.

The current economic climate may delay an organization's ability to build a new data center. As a result, they will demand more uptime and more computing capacity from their existing facilities, while the industry encourages conservation and sustainability. Cold Aisle Containment proves an economical way to achieve both objectives.

Cold Air Volume Sample Calculation

Room Dimensions:

- 36 ft(11m) x 31 ft (9.4M) x 10(3m) ft
- Cold Aisle Width: 4 ft (1.2m)
- Hot Aisle Width: 3 ft (0.9m)
- Rack Height: 42U – 6.5 ft (1.99M)
- Rack Width: 1.97 ft (0.6M)



Contained Cold Aisle Volume =

4ft x (1.97 ft x (12 racks per row)) x 6.5 ft = 614.6 ft^3 (17.2 M^3)

Room Volume (without hot aisles) =

(36 ft x 31ft x 10 ft) – (3 ft x (1.97 x12) x 10) = 10,450.8 ft^3 (3,185.4 M^3)

Uncontained cold air volume is **17 times** greater than cold air in contained cold aisle scenario [614.6 ft^3 (17.2 M^3) x 17 = 10,450.8 ft^3 (3,185.4 M^3)]

Cold Aisle Containment System with door at the front and the end of the row

Rack system

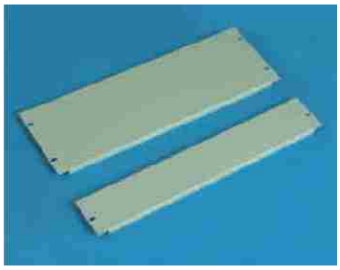
Blanking Panels

When the heat load goes above 2 kW (about 5 average servers) then an escalation policy is required, which can take the form of ;

- increasing floor tile vent size up to 75% open area
- Replacing floor tiles with fan assisted grate tiles.
- Adding specialist fan units to the top and / or bottom of the rack.
- Using cabinets where the entire rear door is a fan unit.

The above solutions will take the heat dissipation capability up to about 6 kW per rack. Above that then more specialized cabinet need to be used where the whole cabinet is fed by a chilled water.

It is also important that the front to back cooling scheme adopt in such cabinets is not compromised by gaps in the rack allowing cooled air to mix with hot air drawn back through the gaps (Thermal Guidelines for Data Processing Environments - ASHRAE). For this reason all gaps in the cabinet must be filled in with blanking plates. Also excessive gaps for cabling at the side of the racks should be sealed with an air dam kit and any cable entry points at the top and bottom of the cabinet should also be sealed with a brush strip.



IRacksystem offers a range of 19 inch blanking panels
Available in 1U, 2U & 5U increments for all applications

Banking Panel Application - Managing Airflow

Unused vertical space in cabinet creates an unrestricted recycling of hot air that causes equipment to heat up unnecessarily. The use of blanking panels can reduce this problem.

Fig. 1 shows the impact of failing to address this issue resulting in the hot air expelled by the active equipment simply recirculating inside the cabinet structure. This scenario can ultimately lead to extreme hot spots, which in turn can cause premature equipment failure and reduced service life.

The use of blanking panels to stop hot air recirculation is a low cost, passive solution that requires no power consumption. Overheating due to air recirculation and the benefits of using blanking panels to avoid it are recognized by IT equipment manufacturers.

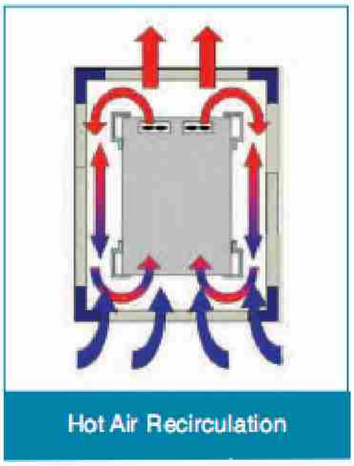
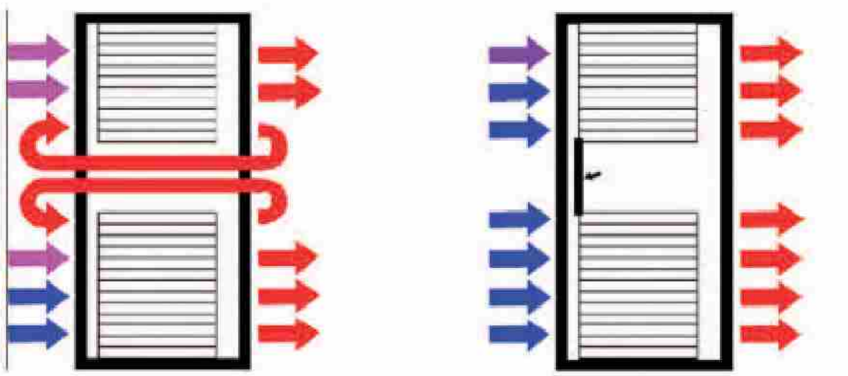
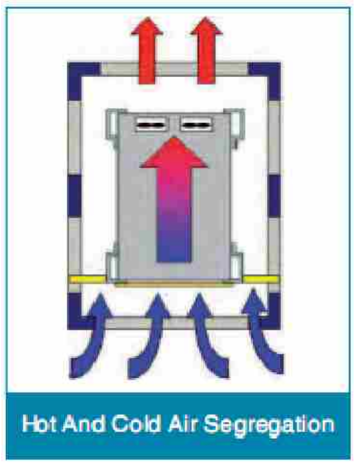


Fig. 1





IRacksystem - TX Series Cabinet

Designed to house servers and manage power / data cables, TX Series rely on optimized passive airflow for thermal management.

Specification :

Frameworks:

Symmetrical Frame construction of rolled and multi-fold vertical & horizontal hollow sections (Max. Static Loading Capacity : 1600 Kg)

Front & Rear - 19" Mtg. Channel with Unit Marking (Fully Adjustable) x 2 sets
Side - Side Supporting Channel (Fully Adjustable) x 1 set

Dimension:

Height : 37U, 42U, 45U, 47U available
Width : 600mm or 800mm
Depth : 1000mm, 1100mm & 1200mm available

Front Door : "Waved" Single Fully Perforated Steel Front Door (73% Perforation Rated Pattern with Hexangular-Hole Perforation) with Advanced Handle Lock

OR

Double Fully Perforated Steel "V" Shape Front Door (68% Perforation Rated Pattern with Hexangular-Hole Perforation) with Advance Handle Lock

Rear Door : Double Fully Perforated Steel "V" Shape Rear Door (68% Perforation Rated Pattern with Hexangular-Hole Perforation) with Advance Handle Lock

Side Door : 2 x Half Height Quick Release Plain Side Door

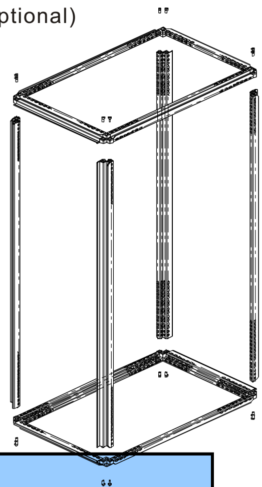
Top : cover Vented Top with 4 x 120mm Diameter Cable Entry with

(With Foamed Edge for Anti-Sketch Protection)

Ventilation :
- Vented Top Cover
- Top Mounted AC Fan Unit x 4 fans (Optional)

Bottom :
- Fully Open Base Design
- With 4 x Large Sized Leveling Feet
- With 4 x Heavy Duty Castors

Cable Tray : Full Height Vertical Cable Tray



Common models

Model	Size (mm) WxDxH	Rack Unit (U)	Notes
TX64210PP	600 x 1000 x 2065	42U	Passive Cooling & Hot Aisle / Cold Aisle
TX64212PP	600 x 1200 x 2065	42U	Passive Cooling & Hot Aisle / Cold Aisle
TX64212PC	600 x 1200 x 2065	42U	Chimney Solution
TX84210PP	800 x 1000 x 2065	42U	Passive Cooling & Hot Aisle / Cold Aisle
TX84212PP	800 x 1200 x 2065	42U	Passive Cooling & Hot Aisle / Cold Aisle
TX84212PC	800 x 1200 x 2065	42U	Chimney Solution

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