RITTAL THERMAL MANAGEMENT SERIES

RITTAL TOP—THERM

Thermal Management Solutions

Air Conditioners

RITTAL®

What is Air Conditioning?

Air conditioning by definition is a means to cool and remove humidity from an environment, such as an enclosure, through use of a refrigerant cooling cycle. Air conditioners currently are the only practical stand-alone device in the market that can cool an environment below ambient temperatures. There are other devices in the marketplace that can cool below ambient (e.g. air to water heat exchangers), but these devices require a secondary coolant source supply to the unit, such as a chiller.

The impact of increasing temperatures

As technology in electronic packaging has advanced, so has the impact of thermal loading and temperature rise to these electronics. Smaller electronic components and increasingly dense packaging in enclosures have made these systems much more sensitive to external influences such as temperature, dust, oil and humidity.

This can be problematic because the failure of just one electronic component may lead to the complete shutdown of an entire production line. Resulting costs add up quickly.

Heat is the number one enemy of electrical and electronic equipment!
Looking at Figure 1, you will see that 57% of all component failures are heat related, followed by vibration, humidity and dust respectively. The use of air conditioners can help you eliminate three of these potential system failures. (Temperature, Humidity, and Dust)

As a rule of thumb it is said that the average life span of semi-conductors is reduced by 50% every time the operating temperature rises 20°F (10°C) over its maximum operating temperature. (*See Figure 2*)

Yet, high temperatures in enclosures can hardly be avoided because electronic equipment such as transformers, power distribution components, drives, PLC's and PC's all generate heat ~ known as heat loss.

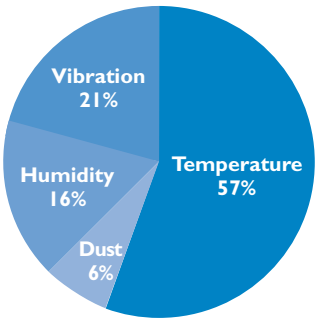


Fig 1

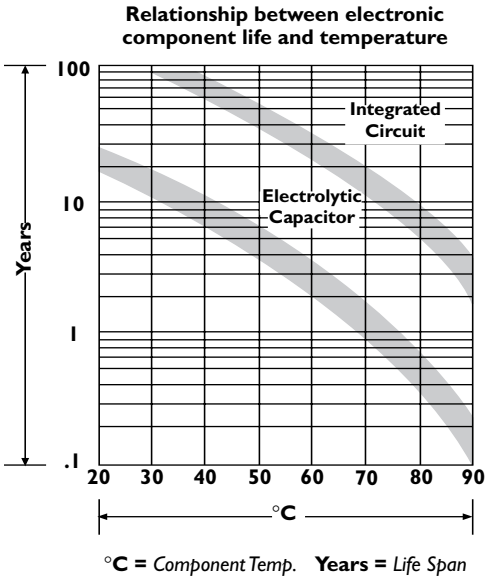


Fig. 2

Sizing the Air Conditioning unit for your application

To properly determine the specifications for climate control components, a few simple calculations have to be made, but first, lets review the required terminology:

- $\dot{Q}_V$[Watts or BTU]: total power loss (heat loss) of all the electrical and electronic components installed in the enclosure.
- $\dot{Q}_S$[Watts or BTU]: heat dissipation absorbed or radiated, through the outside surfaces of the enclosures. When the temperature inside the enclosures is higher than the ambient outside, ($T_i > T_u$), heat will be radiated to the outside environment ($\dot{Q}_S > 0$). When the temperature inside the enclosure is lower than ambient, ($T_i < T_u$), the enclosure absorbs heat from the environment ($\dot{Q}_S < 0$).
- $\dot{Q}_E$[Watts or BTU]: required cooling capacity of the air conditioner. This is the amount of heat the air conditioner must remove from the enclosure.
- Required Cooling Capacity: $\dot{Q}_E = \dot{Q}_V - \dot{Q}_S = \dot{Q}_V - k * A * \Delta T$
- T_i[°C or °F]: maximum allowable temperature inside the enclosure per the components manufacturers' specifications. This value should be rated to the components with the lowest allowable steady state operating temperature inside the enclosure. Depending on the component, this range can run anywhere from 35-45°C (95-113°F), Typically 40°C (104°F).

- Tu[ºC or ºF]: maximum ambient temperature that can occur in the environment in which the enclosure is installed.
- Temperature Differential: $\Delta T = Ti - Tu[°C\ (°F)]$
- A[m^2 or ft^2]: exposed enclosure surface. In other words, any flat side of the enclosure that is not up against another surface, such as a wall. If a surface is against a wall, then heat transfer to the environment through that surface will be negligible.
- k[W/m_K]: heat transfer coefficient of an enclosure
  - Stainless Steel 6.5(W/m^2ºC) [1.2 BTU/hr ft^2ºF]
  - Sheet Steel 5.5(W/m^2ºC) [1.0 BTU/hr ft^2ºF]
  - Plastic 3.5(W/m^2ºC) [0.65 BTU/hr ft^2ºF]

Helpful Conversions

1 Watt = 3.413 BTU/hr
1m^2 = 10.76 ft^2
ºF = 1.8 * (ºC) + 32ºF

Terms

Heat Conduction: Heat is transported by matter, without the matter itself being moved. The energy is passed from particle to particle.

Convection: Energy flows with the matter. The transport medium, e.g. a liquid or gas, takes up energy in the form of heat and dissipates energy as heat.

Radiation: Heat is passed from one body to another in the form of radiation energy, without a medium material.

Conduction and convection play an important role in enclosures. An important criteria for heat removal from an enclosure is whether the enclosure is an "open" (air can freely move through the enclosure) or a "closed" (air tight) system. While heat naturally dissipates from the inside of an "open" enclosure, heat from a "closed" enclosure can only be dissipated through the surfaces (walls, doors, roof).

Calculation of exposed enclosure surface: (Per VDE 0660 part 500)

Special attention should be paid to the total exposed enclosure surface area (A), because heat loss dissipated from the enclosure depends not only on its actual value, but also the enclosure location. An enclosure located in the middle of a room naturally dissipates more heat than an enclosure located against a wall or in the corner. This is due to the fact that all surfaces are exposed.

For that reason, careful attention should be given to the location of your enclosure for the heat dissipation calculations. *(See Figure 6)*

Enclosure installation type according to VDE 0660 Part 500 with formula to calculate A [m^2]

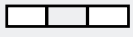
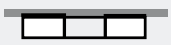
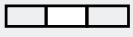
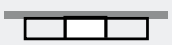
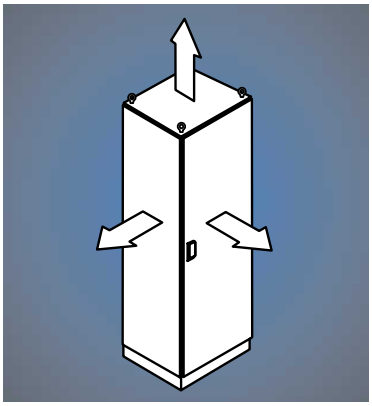
	Single enclosure free-standing on all sides: A = 1.8 • H • (W+D) + 1.4 • W • D
	Single enclosure for wall-installation: A = 1.4 • W • (H+D) + 1.8 • D • H
	End enclosure of a free-standing row: A = 1.4 • D • (H+W) + 1.8 • W • H
	End enclosure for wall-installation: A = 1.4 • H • (W+D) + 1.4 • W • D
	Center enclosure of a free-standing row: A = 1.8 • W • H + 1.4 • D • W + D • H
	Center enclosure for wall-installation: A = 1.4 • W • (H+D) + D • H
	Center enclosure for wall-installation, covered roof surfaces: A = 1.4 • W • H + 0.7 • W • D + D • H

Fig. 6

Heat Conduction

Convection



Radiation

Heat Loss

When the heat loss within an enclosure is unknown, but the actual ambient temperature, Tu, and the temperature inside the enclosure, Ti, can be determined, the heat loss can be calculated using the following formula. (This is very useful on equipment already in service):

Q_V (measured) = A * k * ΔT_{max} (Watts)

This measurement must be taken with all components operating, excluding fans, heat exchangers, or A/C's and the enclosure must be sealed.

Example

You have a single stand alone carbon steel enclosure with the following dimensions H=2000mm (79"), W= 600mm (24"), D=500mm (20"). The enclosure is not mounted against any surfaces. The ambient temperature in the environment is 50°C (122°F). You have calculated, from your analysis of the equipment inside the enclosure, that the heat dissipation based on manufacturer's equipment efficiencies is about 600W(2050 BTU/hr).

Q: What is the amount of cooling capacity required for this system?

First: Calculate surface area (See Figure 6)

$\dot{A}$ = 1.8 * H * (W + D) + 1.4 * W * D

A = 1.8 * (2m) * (0.6m + 0.5m) + 1.4 * (0.6m) * (0.5m)

$\dot{A}$ = 4.4m² or 4.4m² * 10.76ft²/m² = 47.3ft²

Second: Calculate the temperature difference ΔT [°C (°F)]

ΔT = Ti - Tu

ΔT = 35°C - 50°C = -15°C (-27°C)

Finally: Calculate the Required Air Conditioner Capacity

$Q_E = Q_V - Q_S$

$Q_E = Q_V - k * A * \Delta T$

$Q_E = 600W - 5.5(\frac{W}{m^2C}) * (4.4m^2) * (-15°C)$

Q_E = 600W + 363W = 963W (3290 BTU/hr)

Performance Diagram [DIN 3168 (60Hz)]

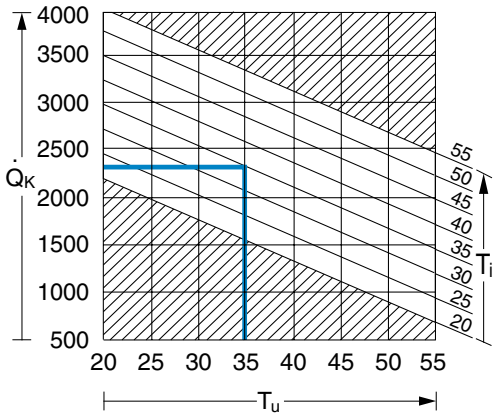


Fig. 7

How to read a Performance Chart – and what does it mean

Fundamentally, an air conditioner performance chart is the functional cooling capacity of a particular unit. Much as you would desire when purchasing a high performance car, you would want to know the performance characteristics such as horsepower, torque, rpm, etc. The same philosophy holds true with air conditioners. All Rittal Air Conditioners are tested to the international standard — DIN 3168. This testing assures that the resultant data is determined from a standardized series of tests. This is the best basis upon which air conditioner performance can be tested under the same conditions. This criteria is DIN 3168. Ultimately, know the basis upon which you are comparing manufacturers.

For Example: Rittal TopTherm 3328110.

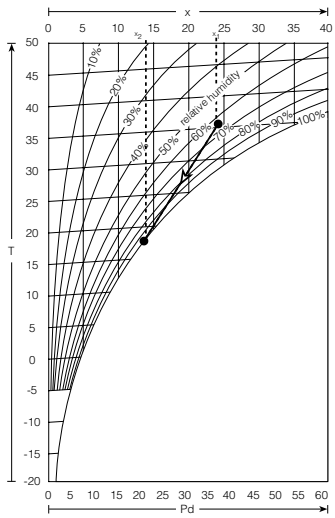
DIN 3168 testing is performed at L35/L35, or in other words, L35 located before the backslash is the internal temperature of the enclosure (35°C) and the second L35 is the ambient. If you look at the performance chart below, the horizontal axis is the outside temperature and the vertical being the cooling capacity. The diagonal lines are the internal temperature intersects. To read the chart, select your outside temperature, draw a line up to the desired internal temperature and draw a line horizontally to the Y-axis. You will see that the cooling capacity of this particular unit at L35/L35 is 2350Watts (8000 BTU/hr).

The importance of DIN 3168

Buyer Beware!

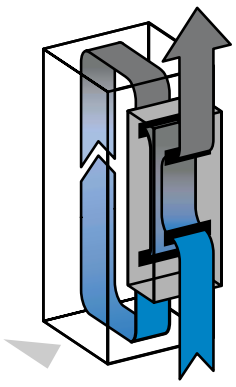
When stating the cooling capacity, many manufacturers will rate their unit at L50/L50. This information is often noted as a footnote rather than up front. L50/50 is not nearly as difficult to achieve cooling effectiveness inside an enclosure and will provide the user a misleadingly higher number when comparing A/C's. In other words, an 8000BTU unit from one manufacturer might not be as good as an 8000BTU unit from another manufacturer. Lets go back to the car analogy, If you were comparing 2 cars only on horsepower, and they both were 200HP each, you still better know the basis of the specification. One car could be rated at 200HP at the output of the engine, and the other 200HP at the rear wheels. The second car would have more overall power as the engine must be larger to take into account transmission and shaft losses.

Always know the basis upon which you are evaluating A/C's. This is why DIN 3168 is so important: it defines the common criteria upon which units may be evaluated.



The impact of humidity

An unavoidable side-effect of using air conditioners is the dehumidification of the enclosure's interior air. As it cools down, part of the humidity contained in the air condenses on the evaporator coil. This condensate must be discharged reliably from the enclosure. The amount of condensate occurring depends on relative humidity, the air temperature in the enclosure and on the evaporator coil, and the air volume present in the enclosure. The Mollier h-x diagram shows the water content of air depending on its temperature and relative air humidity.



Introducing TopTherm

As with any Rittal innovation, or product improvement, the design team sets forth top-level design criteria that must be achieved to meet the desired results in the marketplace. The same held true for TopTherm, the latest in enclosure air conditioner solutions. Since 1985, Rittal has been the market leader in thermal management solutions for the enclosure industry and again is setting forth with the latest of designs. Combining the available technology advancements and customer feedback, Rittal has set 4 performance criteria:

1. Optimize and minimize the number of mechanical form factors
2. Modular design to reduce the number of required spare parts with cross platform spares
3. Develop an easy to service and assemble products manufactured in a new state-of-the-art facility
4. Develop the latest in contemporary sleek designed units

And TopTherm is the result!

Features and Benefits

Roofmounted Units

- Only 3 standard form factors with a cooling capacity of 1740 BTU - 14,300 BTU resulting in only three cutout variations across the entire cooling range
- All three-phase units are dual voltage 400/460V, 50/60Hz thereby eliminating the need for costly transformers and wiring
- The electronics are located in an environmentally protected internal cool air cycle free from oil, dirt and conductive dust
- Ingenious intake and exhaust air routing system with intake through the front, exhaust through the sides, rear and optionally through the top., resulting in easy installation with no restrictions when mounting units next to one another
- Patented air routing for internal air circuit with a central air intake and corner outlets, allowing for air flow options suited for any installation along with ducting options for directed cooling
- Variable positioning Positive Pressure Condensate discharge system eliminates need for checkvalve and increases your installation options
- Simple to install via a singular rectangular cutout

Wallmounted Units

- Only 5 basic form factors with a cooling capacity of 1090 BTU 15,000 BTU resulting in only five cutout variations across the entire cooling range
- All three-phase units are dual voltage 400/460V, 50/60Hz thereby eliminating the need for costly transformers and wiring.
- Versatile mounting options, allowing the ultimate in installation flexibility if external space is at a premium, all with the same unit!

External mounting

Partial internal mounting

Internal mounting

- The electronics are located in an environmentally protected internal cool air cycle free from oil, dirt and conductive dust.
- Optimized air routing in the enclosure due to generous separation of air intake and exhaust thereby eliminating the need for costly air diverting baffles
- Simplified fan replacement, for quick exchange and only 4 filter sizes for all types of units

The New Control Concept

Comfort controller

- Two types of control
  - — Comfort Controller
  - — Basic Controller
- Highest possible quality standards through use of surface mount devices compliant with EMC safety and high performance relays/contactors with MTBF of 10 years

The Basic Controller

- Integrated door limit switch and delayed start up function
- Red and Green fault and status LED's
- Integrated icing sensor temporarily shuts down compressor and external fan if icing risk exists
- Two floating fault contacts for over-temperature indication and other alarms
- Motor Monitoring
- Phase loss detection on all 3 phase units
- Setpoint adjustable from outside via potentiometer

The Comfort Controller

- Master-Slave control for up to 10 units
- Two programmable floating fault signal contacts
- Data logging and upload/download capability with RiDiag II software
- Over-Temperature alarms
- Icing alarm and cooling loss signal
- Condensate warning with roof mounted units
- Integrated door limit switch
- Motor monitoring
- Phase loss detection on all 3 phase units
- Digital temperature display
- Fault code display
- Programming via keypad or RiDiag II software

Applications and Applicable Markets

As with all Rittal Industrial products, TopTherm has been designed to endure the rugged environment presented by the most challenging industrial applications. Anywhere dust, dirt, air borne cutting fluids, or similar exist, a Rittal TopTherm air conditioner can be installed. Rittal services many industries, including:

- Machine Tool
- Converting
- Transportation
- Automotive
- Food and Beverage
- Printing
- Process Control
- Packaging and Handling
- And many more.....

TopTherm units meet all international certifications and requirements including:

- UL
- cUL
- CE

Thereby providing international compatibility and acceptance. No other supplier can offer international acceptance and the most advanced product in the marketplace along with a host of services and technical support anywhere in the world.

If you would like more information on TopTherm and your application, please contact your local Rittal representative, or technical support person for help with our TopTherm products or any thermal management needs.

Main Customer Service: 800-357-4722

Technical Hotline: 800-637-4425

www.rittal-corp.com/toptherm

Feature/Benefit Comparison

Feature/Benefit Comparison	TopTherm	Old Rittal A/C	Competitors A/C
Design			
Flexible depth mounting - exterior, partial, fully recessed	●	●	○
Flexible mounting locations - top or side panels	●	●	O
Physical size commonality - only 8 form factors	●	○	○
Easy access panels - no dismantling required for servicing wallmount units	●	O	O
Domestically available spare parts	●	O	●
Clean, elegant design	●	O	○
Installation			
Easy to install	●	O	O
Standard mounting cutout sizes	●	○	○
Plug and Play quick connector	●	O	○
Performance			
Full product sizes: 1090 - 15000 BTU's (Roof and Wallmount)	●	●	O
400/460 VAC, 50/60 Hz 3 phase solutions	●	○	○
Flexible air routing	●	O	○
Master slave for up to 10 units	●	●	○
Roof mount units - positive pressure condensate lines	●	○	○
Electrical controls protected from heat and dust within cold air cycle - eliminates component failures	●	○	○
Monitoring/Safety			
Real time remote diagnostic capabilities - data logging, trending	●	O	○
Full diagnostic control - in Comfort Control	●	●	○
Diagnostic software - RiDiag II and RiDiag	●	●	○
Coil ice warning, protection and auto shutoff	●	O	○
Simple condensation management	●	○	○
Optional integrated condensation evaporator	●	O	○
2 Floating fault signal contacts - standard	●	O	○
Fault monitoring for - phase loss and motor functions	●	○	○
Door switch interlock available on all units	●	O	O
Restart time delay - standard	●	O	○
Testing			
UL, cUL,CE Certifications	●	●	●
All units tested to international performance standard DIN 3168	●	●	○

Key: ● = Excellent O = Fair ○ = Poor/Not available

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Switch to perfection

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