Control Panel Technical Guide

How to reduce damage to components through effective thermal management
To find out more about thermal management solutions for control enclosures, please consult our catalogue or visit our website at www.schneider-electric.com
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Many of our customers, including design and engineering departments, panel builders, integrators or even OEMs, ask us to help them optimise the performance of their electrical installations, while complying with environmental constraints and avoiding thermal problems.

Schneider Electric, as a leading international specialist in energy-efficiency management, has drawn up this expert's operating guide for these customers (and any others).

Through this overall fully practical and comprehensive document, Schneider Electric wants to share all its experience in thermal management of electric enclosures with its customers.
Reasons why installations shut down or malfunction

In the vast majority of cases, when electric installations and devices housed in control enclosures shut down or malfunction, the problem is thermal: excessively high or low temperature of electrical and, especially, electronic equipment.

Consequences

Even the slightest shut-down or malfunction of the electrical installation can have major – even catastrophic – financial repercussions for a company, regardless of its business sector.

Here are some examples of business sectors in which 1 hour of down time can be very expensive:

- **€ 50,000** Metalworking (foundry)
- **€ 40,000** Glassworks
- **€ 10,000** Motor industry
- **€ 6,000** Agri-business industry
- **€ 35,600,000** Microprocessor industry
- **€ 2,940,000** Banking transaction services
- **€ 90,000** Airline ticket-booking services
- **€ 47,000** Mobile telephone operators
- **€ 350** SMEs

NB.: Total financial losses depend on the size of the affected manufacturing process.
Thermal management issues inside and outside your enclosures

Avoiding
down-time and malfunctions caused by overheating of electrical and electronic devices

Extending
the service life of the internal components

Reducing
• costs associated with the manufacturing processes
• maintenance cycles and costs for the installation

Guaranteeing
continuity of service
The ideal combination for an installation, with no breakdown risk

Choose the right IP
(according to the harshness of the environment)

Choose the right thermal solution
AND correct installation

Knowledge of losses of power in the installation (in W)

Installation with no breakdown risk and suitable protection
Analysis of thermal conditions
Analysis of thermal conditions

It is essential to calculate a complete, reliable heat balance before considering any management solutions. A heat balance consists of measuring and analysing thermal conditions inside AND outside the enclosure. Based on these measurements, the ProClima v5.0 software will help you identify the solutions that best suit your control enclosure and the environment in which it is installed.

Internal analyses
- Analysis of thermal conditions inside the enclosure

External analyses
- Analysis of weather conditions
- Analysis of pollution and difficult or harsh environmental conditions

Zoom on
Your heat balance with ProClima v5.0 software

How does it work? Nothing could be easier!
Simply enter the collected thermal data in the software. ProClima v5.0 will then suggest the solutions that best suit the features of your installation. And only these solutions!
**Thermal analysis inside the enclosure**

First of all, it is essential to identify the most delicate devices or functions: the ones that should be given protection priority.

Delicate devices can be the cause of shut-downs or malfunctions of the installation.

**Important to know**

- Critical temperature for each device
- Critical humidity level for each device

<table>
<thead>
<tr>
<th>Device</th>
<th>Recommended operating temperature</th>
<th>Maximum temperature with the risk of malfunction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable speed drives</td>
<td>35°C</td>
<td>50°C</td>
</tr>
<tr>
<td>Programmable logic controller</td>
<td>35°C</td>
<td>40 - 45°C</td>
</tr>
<tr>
<td>Contactors</td>
<td>45°C</td>
<td>50°C</td>
</tr>
<tr>
<td>Circuit breakers</td>
<td>45°C</td>
<td>50°C</td>
</tr>
<tr>
<td>Fuses</td>
<td>50°C</td>
<td>50°C</td>
</tr>
<tr>
<td>Power supply</td>
<td>35°C</td>
<td>40°C</td>
</tr>
<tr>
<td>Printed Circuit Board (PCBs)</td>
<td>30°C</td>
<td>40°C</td>
</tr>
<tr>
<td>Electric batteries (accumulators)</td>
<td>20 - 25°C</td>
<td>30°C</td>
</tr>
<tr>
<td>Telecommunications equipment</td>
<td>40 - 50°C</td>
<td>55°C</td>
</tr>
<tr>
<td>PFC capacitors</td>
<td>50°C</td>
<td>55°C</td>
</tr>
</tbody>
</table>

**Case study: Cranes with electro-magnetic lifting systems for handling**

**Example 1:**

The concentration of variable speed drives can push the inner temperature up to 70°C or higher (with no thermal solution installed).

**Example 2:**

Batteries are highly sensitive to temperature changes. They should not exceed 25-30°C.

Batteries:

- 10 years lifetime

**Expert’s tip**

- The thermal management solution must be sized according to the critical temperature of the most delicate element of the enclosure. This temperature should never be exceeded.

- The mean working temperature recommended for the inside of the enclosure is 35°C. This is the reference temperature for the control equipment integrated in the thermal solution.
1. Measuring the air temperature

The measurement of air temperature inside the enclosure, must be taken over a complete period (e.g.: one production cycle, 24 hours, 1 week, etc.).

This data will be used:
- To complete the overall thermal analysis
- To avoid exceeding the critical temperature of each device
- To calculate the loss of power (W) of each device

Expert's tip

The temperature measurement inside the enclosure should be taken in three separate areas (T1, T2 and T3). Avoid the ventilated hot-air outlet.

The hot-air ventilation flows affect the temperature in the various areas. Also, each case must be studied separately and in detail.

Mean temp. of the enclosure = (T1 + T2 + T3) / 3.

2. Measuring losses of power (W)

Before performing the thermal calculation, it is important to have detailed information of the dissipation value of each component. Generally speaking, this value is not easy to find.

Expert's tip

Use the ProClima v5.0 software to find out the dissipation value of the components in your enclosure. ProClima v5.0 offers the loss values for all the most common devices on the market.
Analysis of weather conditions

1. Measuring the air temperature
   To ensure reliable calculations, the external temperature measurement should be taken over a complete period (e.g.: one production cycle, 24 hours, 1 week, etc.).

   **What to measure**
   - Max. mean temperature
   - Min. mean temperature

2. Measuring the humidity level (%)
   This consists of determining whether the environment is:
   - **Dry**: Humidity level < 60%
   - **Humid**: Humidity level between 60% and 90%
   - **Very humid**: Humidity level > 90%
   Temperature variations detected in the environment will let you know whether or not there is condensation.

- Heat balance calculated using reliable values
- Specific calculations in the ProClima v5.0 software
- Optimisation of the thermal management solution: minimises under- or over-sizing errors
Analysis of pollution and difficult or harsh environmental conditions

It is essential to measure and analyse air quality in the installation area of the control enclosure.

A prior inspection of the installation site is generally enough to identify the constraints to which the electrical and electronic devices will be exposed.

Difficult or harsh environments

- Sites with presence of oils, solvents and aggressive substances
- Saline, corrosive or sugary environments
- Dusty atmospheres: cemeteries, flour mills, ceramic and wood processing plants, rubber factories, etc.
- Nuclear, chemical, petrochemical sites, etc.
- Bottling plants (high humidity levels)
- Metalworking sites
- Textile plants (fibres tend to block the air intakes)

Example 1:
Plant manufacturing car parts. The presence of oil in the environment reduces the service life of the components.

Example 2:
Fan not working due to the presence of sugar in the plant (beer production).

Example 3:
Busbar installed in a water treatment site. The humid, corrosive atmosphere has damaged the copper.

Find out whether the temperature and the quality of the external air can help cool the enclosure (*Passive* solution).

Knowing the installation site well helps optimise the protection level of the thermal solution (e.g.: filter thickness) and the protection level of the enclosure (e.g.: IP degree according to EN 60529).
Thermal optimisation solutions
There are two main families of thermal management solutions: so-called "Passive" solutions (inexpensive and natural, defined upstream from the installation, etc.) and so-called "Active" solutions (corrective solutions, requiring specific sizing, possibly expensive, etc.).

"Passive" solutions

- Choice of material
- Size of the enclosure
- Location of the enclosure
- Wall insulation
- Power load arrangement
- Moving passive electric loads to the outside
- Cable layout
- Air-flow management
- Natural airing or convection
- Natural dissipation and air circulating

"Active" solutions

- Thermal control device
- Forced convection
- Forced ventilation
- Temperature management with air-conditioners
- Temperature management with air-water exchangers
- Temperature management with air-air exchangers
- Resistance heaters

Expert's tip

Maximise the use of "Passive" solutions before choosing an "Active" solution.
"Passive" solutions

Choice of material

The choice of material for the enclosure (steel, polyester) is essential for ensuring the natural dissipation of calories released by the electrical or electronic devices.

Mean values of K

For iron: 5.0 to 5.5

For aluminium: 12.0

For polyester: 3.5

Zoom on...

the phenomenon of natural dissipation of calories

Natural dissipation of calories depends on the total heat-transmission coefficient: K.

- Total heat transmission = All processes that contribute to heat transmission:
  \[ Q = K \times S \times (T_e - T_i) \]

Where,

- \( K \) = Heat flow when stationary, divided by the surface area and the temperature difference between the equipment on either side of the system.

It is measured in W/m² x °K.

The three forms of heat transfer are included: conduction, convection and transmission.

Example of calculating natural dissipation

<table>
<thead>
<tr>
<th>Enclosure specifications:</th>
<th>Calculation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>CASE No. 1</td>
<td></td>
</tr>
<tr>
<td>Dimensions: 1800 x 600 x 500 mm</td>
<td>Ti = Te + Pd/(Se x K)</td>
</tr>
<tr>
<td>Material: painted sheet steel, 1.5 mm</td>
<td>S = 3.55 m²</td>
</tr>
<tr>
<td>Position: back to the wall</td>
<td>Ti = 27 + (500/5.5 x 3.55)</td>
</tr>
<tr>
<td>Loss of power (Pd): 500 W</td>
<td>= 27 + (500/19.525)</td>
</tr>
<tr>
<td>External temp (Te): 27°C</td>
<td>= 27 + 25.6 = 53</td>
</tr>
<tr>
<td></td>
<td>Ti = 53°C</td>
</tr>
<tr>
<td>CASE No. 2</td>
<td></td>
</tr>
<tr>
<td>Dimensions: 2000 x 800 x 600 mm</td>
<td>Ti = Te + Pd/(Se x K)</td>
</tr>
<tr>
<td>Material: painted sheet steel, 1.5 mm</td>
<td>S = 5.07 m³</td>
</tr>
<tr>
<td>Position: back to the wall</td>
<td>Ti = 27 + (500/5.5 x 5.07)</td>
</tr>
<tr>
<td>Loss of power (Pd): 500 W</td>
<td>= 27 + (500/27.885)</td>
</tr>
<tr>
<td>External temp (Te): 27°C</td>
<td>= 27 + 17.9 = 45</td>
</tr>
<tr>
<td></td>
<td>Ti = 45°C</td>
</tr>
</tbody>
</table>

Expert's tip

When the external temperature is favourable (< 35°C), increasing the size of the enclosure makes it possible to reduce the internal operating temperature and slow down a possible temperature rise.
Increasing the size of the enclosure

As with the material, the size of the enclosure (useful occupied surface area in m²) affects the inner temperature level.

If the external temperature is favourable (< 35°C), the energy savings can be substantial:
- Up to 50% for steel enclosures
- Up to 65% for polyester enclosures

- Avoids problems of condensation on the most delicate devices (electronic)
- Avoids corrosion on metal parts

Location of the enclosure

The position of the installed enclosure is a factor which should not be neglected, since the walls of the enclosure affect the heat transfer process.

For example, if the enclosure is installed in an equipment room where the temperature is favourable (< 35°C), all the walls should be left accessible such as to facilitate the dissipation of calories.
Insulation of the enclosure

When the external temperature is high (> 35°C, for example 45°C), the calorie intake through the surfaces of the enclosure increases the internal temperature.

If a high external temperature (> 40°C) is permanently recorded and a source of radiation is detected, the solution will be to thermally insulate the walls of the enclosure.

Expert's tip
In the latter case, extraction must be carried out in an "Active" manner, using an air-conditioner or an air-water exchanger.

The energy saving (measured by the cooling capacity gain) is around 25% for metal enclosures and 12% for polyester enclosures.

Without insulation
Cooling power required: 2200 W

1 Irradiated heat source (furnace for glass, ceramic, molten metal, etc.)
2 Air-conditioner

With insulation
Cooling power required: 1630 W

1 2 3
1 2 3

Expert's tip
Insulation can also be used as a "Passive" solution when the external temperature is very low and permanently exceeds the critical temperature of the installed devices.
E.g.: installations in cold storage rooms, outdoors (–20°C), etc.
Power load arrangement

The distribution of power loads in various groups of enclosures is very important. Beyond the potential energy savings, load distribution has many advantages:

- Avoiding unwanted hot spots inside the enclosure
- Lowering the mean temperature of the enclosure
- Better adaptation of the thermal solution

Consequences of not distributing the loads = The weakest loads will receive the impact of the highest loads.

Expert's tip

- A thermal partition can be used to separate loads and optimise the solution and its overall cost.
- It is preferable to separate the control enclosures and the power enclosures.

Example of an enclosure initially provided with several loads

Case No. 1:
More powerful thermal solution (example: air-conditioner)

Case No. 2:
Weaker and efficient thermal solution (example: ventilation)

Expert's tip

The highest loads must be installed as low down as possible. In this way, the amount of air inside the enclosure can cool the dissipated heat and favour internal air convection.
Rules to be observed concerning the layout of devices inside the enclosure

- Respect the air gap distances inside the enclosure.
- Create an air column covering the entire height of the enclosure (100 to 200 mm wide), between the air intake and outlet. This will avoid overheating and losses of thermal efficiency.

For easier circulation of air inside the enclosure: leave at least 100-200 mm

1. Outlet grilles
2. Fan
3. Drives
Moving passive electric loads to the outside

In most production sites, the enclosures have electric loads installed in them that give off vast amounts of heat. This is the case, for example, with the braking resistances of the variable speed drives (around 500 W to 3.5 kW).

These calories must be extracted using cooling units ("Active" solutions), unless this type of equipment is installed outside of the enclosure.

17%
Increased energy efficiency

Expert's tip

Moving passive electric loads outside of the control enclosures reduces the power of thermal solutions and its consumption.

Cable layout

The wiring of the devices can be a source of heating. Also, there should be good habits:
- The cables should not rest on the devices
- The ventilation grilles should not be obstructed
- Screw/snap-fit the locking elements
Air-flow management

Free space above and below for ventilation

Expert's tip
Avoid blocking the air outlets of the electronic equipment.
Always leave a ventilation space of at least 100 mm at the top and bottom (= extended service life for the devices).

Natural airing or convection

The emission of calories inside the enclosure creates a natural convection force (hot-air evacuation flow).
In this case, the flow rate is low unless the internal equipment is ventilated (photo on the left).
Natural dissipation and air circulating

Several parameters are involved in the phenomenon of natural (or passive) dissipation of calories:

- **Installation site** of the enclosure (quality of the surrounding air).
- **Usable surface** taken up by the enclosure (in m²).
- **Type of material** (steel, polyester).
- **Other parameters**: load arrangement, wiring, external temp., etc.

It is essential to mix the air inside the enclosures in order to:

- **Equalise and lower the temperature** by distributing the calories.
- **Cool a localised hot spot**.
- **Distribute the cold air** released by the cooling units (air-conditioner, exchangers). This extraction solution should be considered for aggressive environments when the mixing flow rate is not sufficient.

**Expert's tip**

- Use the **ProClima v5.0 software** to calculate the natural dissipation capacity of your enclosures.
- It is advisable to be able to direct the flow from the air circulating fans (e.g.: towards delicate devices, recurring hot spots, etc.).
- The greater the mixing flow, the quicker dissipation will take place.
Natural dissipation and air circulating (continued)

Air circulating architecture for a single enclosure

Without an air circulating solution, the temperature can reach 50°C or higher at the top of the enclosure.

With an air circulating solution, the temperature is equalised throughout the enclosure. It is lower than the maximum value without convection.

Air circulating helps extract calories. It can be enough (without other "Active" solutions) if the external temperature is favourable.
Thermal optimisation solutions • “Passive” solutions

Air circulating architecture for coupled enclosures

This consists of creating internal air circulation, with no turbulence.

Architecture for an air-conditioner & air circulating combination

Expert's tip

• Leave an additional air-circulation space of at least 150-200 mm deep.
Air circulating solutions by Schneider Electric

The **ClimaSys range of air circulating fans** will allow you to create your own architectures: for single enclosures, coupled enclosures or combined architecture.

**Air circulating fans**
- User protection according to DIN31001.
- Power: 17 W.
- Dimensions:
  - Fan: 119 x 119 x 38 mm.
  - Collar: length 140 mm, fixing centre-to-centre distance : 130 mm.
- Installation on ball-bearing.
"Active" solutions

- Thermal control device
- Forced convection
- Forced ventilation
- Temperature management with air-conditioners
- Temperature management with air-water exchangers
- Temperature management with air-air exchangers
- Resistance heaters
Thermal control devices

The use of thermal controllers such as thermostats or hygrostats helps stabilise the temperature and humidity conditions inside the enclosure.

It also helps optimise the power consumption required to maintain good thermal conditions.
Where should the thermostat be placed in the enclosure?

**Example 1:**

At the top (the hottest part of the enclosure)

Two fans + one thermostat equipped with two relays provide two flow levels according to the inner temperature:
- Fan 1 active if $T_i = 45^\circ C$
- Fan 2 providing support if $T_i = 55^\circ C$

**Example 2:**

Next to the most delicate devices

One fan + one resistor + one thermostat equipped with two probes ($S_1, S_2$) make it possible to control two local temperature levels:
- Fan active if temperature of $S_1 T_i = 45^\circ C$
- Resistor active if temperature of $S_1 T_i = 10^\circ C$

Probe $S_2$ located outside (outdoor applications).

**Expert’s tip**

- Two additional probes can be used to optimise the measurement.

Up to 58% Energy savings (compared with a solution without thermal control)
Thermal control solutions by Schneider Electric

The **ClimaSys range of thermal controllers** is made up of mechanical and electronic thermostats and electronic hygrostats and hygrometers.

**Adjustable thermostats**
- NO (blue button) with normally open contact to control the starting of a fan when the temperature exceeds the displayed maximum value.
- NC (red button) with normally closed contact to control the stopping of a resistance heater when the temperature exceeds the displayed value.
- Large range of temperature control.
- Small dimensions.

**Electronic thermostat with LCD screen**
- Operating temperature: 0 °C…+ 50 °C.
- Simple programming.
- Option of installing an external sensor, for remotely reading the temperature (operating temperature: – 30 °C…+ 80 °C).
- Ventilation and heating function (2 separate relays).

**Electronic hygrotherm**
- Operating temperature: 0 °C…+ 50 °C.
- Option of installing an external sensor, for remotely reading the temperature (operating temperature: – 30 °C…+ 80 °C).

**Expert's tip**
- Electronic thermostats and hygrostats are more accurate than mechanical models.
- A TH, HY or HYT controller can be used to reduce the consumption of the thermal solution.
- Install the thermostats in the top of the enclosure: this is the hottest part.
- As for the hygrostats, the best location is the bottom of the enclosure: this is the most humid part.
Thermal optimisation solutions • “Active” solutions

2

Forced convection (through the appliance) with grilles

Passive convection solutions:
• Side grilles
• Roof grilles
• Roof elevators

Exemple:
The use of outlet grilles to extract the calories from the variable speed drive prevents the temperature rising inside the enclosure.

In which circumstances is the filter not required?
The natural dissipation flow rate is better with no filter. However, this is only possible under certain conditions:
• Very clean external air (e.g.: clean rooms)
• Air-conditioned installation area
• Good filtering of the air

Expert's tip
• Select the filter type according to the environment in which the enclosure is installed (difficult, harsh, polluted, etc. or good air quality).
• Service the filter on a regular basis to avoid clogging and loss of flow.
Forced convection solutions with grilles by Schneider Electric

The ClimaSys range of airing systems includes plastic and metal grilles.

Selection of plastic materials
ASA / PC material chosen to manufacture the ventilation system:
- Improved resistance (longer service life) to UV.
- Excellent mechanical operation.
- Standard grille colours: RAL 7035 and RAL 7032 (replacement accessory).
Other colours are available on demand (contact us).
ASA / PC plastic material, self-extinguishing according to standard UL94 V0.

Outlet grille
- Delivered with G2 M1 synthetic standard filter.
- Material: injected thermoplastic (ASA PC), self-extinguishing according to UL94 V0.
Forced ventilation

When combined with a thermal control device, forced ventilation is one of the best solutions in terms of energy efficiency.

The performance of the forced ventilation depends greatly on external temperature conditions and air cleanliness. Also, measurements and analyses must be performed before installation.

Expert's tip

- The external environment must be favourable: amount of dust, temperature level and humidity level.
- The delta $T (T_i - T_e)$ should always be $\geq 5^\circ C$.
- Measure the external temperature before validating the solution.
- The thermal controller is very useful for adapting the power of the "Active" solution to the required charge level. For example, you can use two fans and only activate one or two according to the temperature.

If the enclosure is properly sized and the loads are properly distributed:

> Ventilation direction pointing inwards
> If the enclosure heats up too much (Temp. > 60°C), use a centrifugal fan (ventilation with roof extraction).

Service life of the fans

- Increased pressure thanks to the air pulse: no dust enters through the openings
Side-mounted pulsing ventilation architecture (with thermal control)

To avoid the formation of air locks, check that the flow rate from the fan of the enclosure 1 is ≥ the flow rate of the drive 2 to be protected.

The air intake is particularly sensitive to loss of flow.

To avoid dust and air intakes: leave a distance of 100 mm from the floor.

150 mm

Side-mounted ventilation solutions by Schneider Electric

The ClimaSys forced ventilation range fulfils most cooling needs, with energy savings and high performance levels.
Where should the thermal controller be placed?

**Example 1:**
At the top (the hottest part of the enclosure)

Two fans + one thermostat equipped with two relays provide two flow levels according to the inner temperature:
- Fan 1 active if $T_i = 45\,^\circ C$
- Fan 2 providing support if $T_i = 55\,^\circ C$

**Example 2:**
Next to the most delicate devices

One fan + one resistor + one thermostat equipped with two probes (S1, S2) make it possible to control two local temperature levels:
- Fan active if temperature of S1 $T_i = 45\,^\circ C$
- Resistor active if temperature of S1 $T_i = 10\,^\circ C$

Probe S2 located outside (outdoor applications).
Top-mounted extraction ventilation architecture (with thermal control)

The air inlet is particularly sensitive to loss of flow

To avoid dust and air intakes: leave a distance of 100 mm from the floor

Expert's tip

• If the enclosure heats up too much (Temp. ≥ 60ºC), use the top-mounted extraction ventilation, with high-speed centrifugal fan (from 500 m³/h)
• It is essential to use filter-clogging and thermal control elements.

• High cooling speed (extraction power)
• Energy efficiency (with an accurate electronic controller)
Roof fan or side fan?

The centrifugal fan (roof) has greater resistance to losses of load than the axial fan (side).

Centrifuge

Axial

Top-mounted ventilation solutions by Schneider Electric

The ClimaSys top-mounted ventilation range is a natural airing device for coupling to the top of metal floor-standing enclosures. Ideal solution for combining with the ventilation slots.

• Natural airing device for coupling to the top of metal floor-standing enclosures.
• Solution for combining with the ventilation slots.
• Fixing to the top by means of caged nuts and special screws.
• Material: steel.
• Finish: painted with epoxy-polyester resin, textured RAL7035 grey.
• Protection rating: IP54.
4 Temperature management with air-conditioners

Air-conditioners or cooling units are widely used for cooling enclosures which contain devices that give off a lot of heat. They dehumidify the total volume of the enclosure by extracting condensation water.

In what cases should an air-conditioner be used?

- When the external temperature is too high to ventilate (Temp. > 35°C).
- When the atmosphere is highly polluted, but it is possible to use a filter to protect the external part of the air-conditioner.

Pay attention to the air flow direction!

Cold air must be directed downwards (not direct), observing a distance of at least 200 mm between the cold air outlet and the air intake of the drive.

Expert's tip

- Use deflectors to avoid heat shocks.
  If the hot-air emitted by the air-conditioner is in direct contact with the air outlet of the drives, a heat shock may occur (condensation forming in the enclosure).
- Make sure the drives are correctly centred relative to the thermal solution.
- Have the filters replaced regularly by the maintenance team (e.g.: every four weeks for critical workshops).
- Avoid the typical mistake of blocking the air-conditioner air outlet. Consequences of the blockage: reduced performance and/or appearance of heat shocks.
Thermal optimisation solutions • “Active” solutions

Drive-cooling architecture with side-mounted air-conditioner

* Installation at the rear of the enclosure

- Effective distribution of cold/hot-air
- The solid plate is cooled and the ventilation plug of the variable speed drive is closed (convection & conduction)
How to interpret the technical data sheet of a Cooling Unit?

- Cooling capacity required under real conditions to extract the calories from the loss of power of the drives.
- This area is very important, it tells us how much the compressor can withstand (55°C)!
- Only performing cooling units withstand such high temperatures!
- Mean outside temperature
- Temperature desired in the inside Tint

Expert's tip

- Save time by using the ProClima v5.0 software and selecting the cooling unit that is best suited to the demands of your installation.
Thermal optimisation solutions • “Active” solutions

Drive cooling architecture with roof cooling unit

Pay attention the pipe cross-section and the number of bends in order to avoid flow losses at the drive inlet.

Expert's tip

• Leave enough space to guarantee correct convection, from the roof to the bottom of the enclosure.
• Leave a minimum lateral depth of 150 mm, and avoid any obstacles (risk of loss of load and performance).
1. The hot-air (output) enters the second group.
   • Loss of performance or shutdown if Te > 55°C.

2. Special care must be taken to make sure the groups are totally upright.
   • A deviation of more than 3° may cause a malfunction.

3. The cold air outputs from inside the enclosure should be free of obstacles.
   • The circuit closes and the enclosure does not cool.
   • Possible condensation problems.

The two air outputs “crash”, and this reduced output impairs performance.

Pay special attention to minimum clearances.
Thermal optimisation solutions • “Active” solutions

Expert’s tip

• Save time by using the ProClima v5.0 software and selecting the cooling unit best suited to the demands of your installation.
Useful information!

> Check that the cable entries are perfectly sealed

The most common mistake with the enclosure + air-conditioner solution is leaving the cable-entry open, and not providing a sealing system (foam, etc.).

> Side-mounted or top-mounted?

• Top-mounting should be considered when the site does not allow the installation of a side-mounted air-conditioner.
  > Reduced accessibility (compared with a side-mounted solution)
  > Importance of respecting internal air circulation in order to ensure correct convection
  > Installation generally used for high-power enclosures (> 3 kW): it makes the device heavy.

• Side-mounting is more commonly used.
  > Maximum accessibility (easier maintenance)
  > The cold unit is near the devices that emit most heat (variable speed drives).

> Cooling unit with electronic control: Advantages that should not be ignored!

• High adjustment precision (+/- 1°C).
• Since its contacts are built into the doors, the electronic controller waits 2-3 min before resuming operation. Result: the cooling fluids return to their original state.
• Indication of the internal temperature value.
> Interpretation of air-conditioner faults in the K2 contact

All the ClimaSys cooling units are equipped with a fault signalling system.

This signal can indicate:
- A sudden disconnection
- An incorrect three-phase connection
- A clogged filter
- Excessively high compressor temp.
- Excessively low compressor temp

> Filter types and filter replacement frequency

There are different types of filter to suit the installation environment (difficult, harsh, etc.).

For example:
- **Polyurethane filter**: for extremely dusty environments.
- **Stainless-steel filter**: for oily environments
- Special filters are available for environments with a high concentration of textile fibres: do not hesitate to consult us.
- For extremely aggressive environments, the condensing battery (external) can be protected by a coating.

The filter replacement frequency depends on the level of pollution of the installation site.

It is essential to be able to **assess this level of pollution** in order to select the correct filter quality and anticipate its replacement.

---

**Expert's tip**

If the environment is pollutant-free, you can do without the filter. In this case, the cooling unit will gain performance (around 5% to 10% higher).
Useful information! (continued)

> Evacuating condensation water (condensates)

There are several ways to evacuate condensation water:

"Passive" solutions:
- With a pipe, connected to the water outlet of the plant
- With a container, intended for recovering the water

"Active" solutions:
- With an external dissipation system

Warning! Permanent contact between the condensation water and the walls of the enclosure can speed up the corrosion phenomenon.

• ClimaSys cooling units have an evaporation temperature between 8 and 12°C. This is generally enough to obtain a temperature of 35°C (in the enclosure). Furthermore, ClimaSys solutions do not generate much condensation water.
• ClimaSys roof units also include a built-in evaporation system. No additional energy required for evaporating the water.

"Passive" solutions

"Active" solutions: Condensate evaporation kit

Expert's tip

Before installing an active water-evacuation solution:
- Check the amount of water generated by the air conditioning.
  **NB.** for a dry environment, this should be low or even very low.
- Check whether it is possible to use an external water outlet.
- Check for proper water circulation: downwards (no curves on the initial level)
- Use a transparent pipe in order easily to identify any clogging or plugs in the pipe.
Cooling unit solutions by Schneider Electric

ClimaSys cooling units offer complete solutions from 240 W to 4 kW, in all installation versions: side and roof.

- High efficiency
- Withstands extreme temperature conditions (up to 55 °C)
- Guaranteed protection rating: IP 54 and IP 55 (range SLIM)
- Built-in adjustable thermostat
- Automatic evaporation system (roof-mounting installation)
- Maximum security
- Easy maintenance (access to the condensers)
- Environmentally friendly: R134a (HFC) eco-friendly gas
Temperature management with air-water exchangers

Air-water exchangers are used mainly for cooling or heating enclosures installed in difficult or harsh environments: cemeteries, paint production chains, oily workshops, etc. Places where filters clog very quickly.

This solution is completely sealed (up to IP 54). The air-water exchanger is capable of extracting a large number of calories from the enclosure (by fluid exchange). These calories are then released outside the plant (chiller-type cooling unit).

This means that the water can come from other sources.

- Completely sealed assembly (up to IP 55). Ideal solution for highly-polluted environments and/or those with a high level of humidity (e.g.: water-treatment plants, bottling plants, wastewater plants, etc.).
- Calories dissipated to the outside.
- Water temperature can be checked at any time. The same goes for cooling power.

Example 1: Printing machines
Constraints: High evacuation of calories + high seal

Example 2: Paint production chain
Constraints: Level of dust (filters blocking) + humidity/condensation

Expert's tip

- Save time by using the ProClima v5.0 software, selecting the air-water exchanger that is best suited to the demands of your installation.
Thermal optimisation solutions • "Active" solutions

Drive cooling architecture with a side-mounted air-water exchanger

> Composants

- Thermostat
- Terminal box
- Pressure switch
- Side grill filter (prevents the penetration of water into the enclosure in case of leakage)
- Electro-valve reel
- Fan condenser
- Fan
- Exchange cassette
- Side grill filter (prevents the penetration of water into the enclosure in case of leakage)
- Anti-return valve
- Electro-valve

> Expert's tip

- Please consult our catalogues to find performance curves according to the water flow rate, water temperature and the desired working temperature inside the enclosure.
Air-water exchanger solutions by Schneider Electric

ClimaSys air-water exchangers are sealed solutions capable of extracting a large amount of calories from the enclosure.

- Side installation or roof installation
- Easy maintenance (access to the batteries for easy cleaning)
- Internal temperature control (built-in thermostat)
- Guaranteed protection rating: IP 54
- Maximum security (anti-leak system)
Temperature management with air-air exchangers

The use of air-air exchangers requires a temperature difference between the inside of the enclosure and the outside of at least 10°C ($T_i > T_e$).

- Inner temperature ($T_i$) always higher than the outer temperature ($T_e$)
- Protection rating maintained: IP54
- Much lower maintenance frequency than fans.
- Works without a filter: the inner and outer air circuits are kept separate by the exchanger.
- Ideal solution for:
  > Equipment rooms (mean temp. of 25 ºC)
  > Already air-conditioned sites
  > Agri-business industries
  (good temperature but corrosive environment)

Expert's tip

- **Save time** by using the **ProClima v5.0 software**, selecting the air-air exchanger that is best suited to the demands of your installation.
- **Perform regular preventive maintenance of the battery** of the exchanger.
Drive-cooling architecture with a side-mounted air-air exchanger

Ti > Te

Parts

- Exchange cassette
- Two Fans. For the inside circuit (permanent operation) and for the outside circuit (driven by the thermostat)
- They are of the centrifugal type, with good behaviour in case of pressure losses
- Thermostat installed as standard. It controls the operation of the outside fan
Air-air exchanger solutions by Schneider Electric

ClimaSys air-air exchangers are sealed solutions, designed for relatively cool environments (around 25°C), and for installations with medium losses of power (1000 W per enclosure).

- Side installation or roof installation
- Power from 15 W/°K to 70 W/°K
- Easy cartridge maintenance and replacement (special configuration)
- Built-in thermostat
- No filter required (reduced maintenance and costs)
- Guaranteed protection rating: IP 54
Resistance heaters

External temperature changes (outdoor installations) or extreme temperature levels (< 5°C), can create a phenomenon of condensation (on electronic devices located inside the enclosure) or even cause malfunctions during the starting cycle.

- Avoids high levels of humidity
- Controls the condensation phenomenon
- Allows the electronic devices to be started up conveniently in cold or very cold atmospheres

By modifying internal temperature of sealed enclosure (IP 54 or +), the relative humidity is modified and the quantity of water vapour in suspension is maintained.

Expert's tip

- Check that the resistance heater is correctly installed using a hygrostat (checking the relative humidity: RH as a %) or a thermostat (checking the temperature in °C or °F)
- The enclosure must be sealed to prevent humid air from entering the hot areas of the enclosure.

Where should the resistance heaters be installed?

The resistance heaters should be installed at the very bottom of the enclosure. As low as possible. Also consider the internal convection that the heat they produce will generate. This is why it is important to leave a distance of at least 150 mm between the roof of the resistor and the first device.

**NB.** For large enclosures, leave a free column of air. For example, leave the space between two coupled enclosures free.
Resistence heater solutions by Schneider Electric

ClimaSys resistance heaters are the best way to prevent the formation of condensation or humidity inside the enclosure or even to protect the installation against cold or very cold environments.

Insulated or ventilated-insulated resistors
- Two extraction modes: by natural convection or with a fan
- Seven power levels from 10 W to 550 W
- Innovating design (plastic enclosure)
- Maximum security (PTC-type heater)
- Easy installation and connection (direct clipping on 35-mm DIN rail)
- CE marking and UL and VDE conformity

Aluminium resistors
- Equipped with a PTC-type detector
- Eight power levels from 10 W to 400 W
- Improved convection
- Quick fixing (clipping on 35-mm DIN rail)
- Connection terminal board (heaters > 20 W)
ProClima v5.0 software: The

Your thermal study in seven steps

1. Enter the project and customer details (optional)

2. Enter the internal and external temperature data

3. Enter the electrical specifications of the installation (voltage, power, etc.)

4. Determine the power dissipated by the equipment.
   If this value is not known, ProClima v5.0 can calculated it:
   • According to the number and type of electric and electronic devices installed in the enclosure
   • According to a temperature reading
5 Select the enclosure and the installation type

6 Select the thermal management system

7 View and print the study summary

- Reliable and accurate thermal study
- Optimised solution
- Saves time
- User friendliness and ergonomics
- Thermal values provided for all the most common devices on the market
Practical summary
Good reflexes for thermal management of enclosures

- Previously visit the site and the area where the enclosure will be installed. This will allow you to assess the external thermal conditions (before measuring them and analysing them closely).

- Select the material that is best suited for the installation environment and its natural thermal regulation features (e.g.: ventilated area, external air suitable for use in passive cooling, etc.).

- Always analyse the thermal conditions inside and outside the enclosure, over a complete period and in different areas.

- Strictly observe the manufacturer's installation instructions: installation area, mounting, wiring, dimensions of the airing spaces, etc.

- Give priority to "Passive" thermal management solutions before considering any "Active" solutions.

**Expert's tip**

Plan thermal management (before installing the enclosure).
Key figures for thermal management

"Passive" Solutions

Increasing the size of the enclosure

- **Steel:**
  - 52% Energy savings
  - 38°C Temp. savings

- **Polyester:**
  - 64% Energy savings
  - 60°C Temp. savings

Insulation of a steel enclosure

- 26% Energy savings

Moving loads to the outside

- 52% Energy savings

Load distribution

- 52% Energy savings
- 25°C Temp. savings
"Active" Solutions

- Insulation of a polyester enclosure: 12% Energy savings
- Ventilation of an enclosure: 58% Energy savings
- Temp. savings: 20°C

Good thermal management can extend the service life of components and avoid expensive breakdowns.
Choosing
the best thermal management solution
### System

| Natural convection causes the temperature to drop inside the enclosure. Simple solutions for this case include installing grilles (without filter) or lifting the top. | Fans with filters are designed to evacuate a large amount of heat economically. | Air-air exchangers are equipped with an aluminium exchange cassette which separates the internal and external air circuits and prevents the entry of dust. |

### When should it be used?

| This solution can only be used when the power to be dissipated is low, in an environment with small amounts of dust. | When larger amounts of heat need to be evacuated in a polluted environment. | The air-air exchangers are used in highly polluted environments or when it is necessary to evacuate large amounts of heat while guaranteeing the independence of the internal and external air circuits. |

### Ta: Ambient temperature

| Ta < Td |

### Td: Desired temperature

| Ta < Td |

### Advantages

- Economic solution.
- No maintenance.
- Quick and easy installation.
- Economic solution.
- Easy maintenance.
- Quick and easy installation.
- Even temperature inside the enclosure.
- High protection rating: IP 54 or IP 55.
- The internal and external air circuits are independent.
- Easy maintenance.
- High protection rating: IP 54.

### Disadvantages

- Small amount of heat evacuated.
- Reduction of the IP protection rating.
- Entry of dust particles.
- The temperature inside the enclosure is always higher than the external temperature.
- The internal and external air circuits are in contact.
- Maintenance required: filter replacement.
- The temperature inside the enclosure is always higher than the external temperature.

### Solutions

- Ventilation devices
- Fans and outlet grilles
- Air-air exchangers
**Air-air exchangers**

Natural convection causes the temperature to drop inside the enclosure. Simple solutions for this case include installing grilles (without filter) or lifting the top. Fans with filters are designed to evacuate a large amount of heat economically.

Air-air exchangers are equipped with an aluminium exchange cassette which separates the internal and external air circuits and prevents the entry of dust.

- **When should it be used?**
  - This solution can only be used when the power to be dissipated is low, in an environment with small amounts of dust.
  - When larger amounts of heat need to be evacuated in a polluted environment.
  - The air-air exchangers are used in highly polluted environments or when it is necessary to evacuate large amounts of heat while guaranteeing the independence of the internal and external air circuits.

- **Ta**: Ambient temperature
- **Td**: Desired temperature

- **Ta < Td**
  - NO
  - YES

**Advantages**

- Economic solution.
- No maintenance.
- Quick and easy installation.
- Economic solution.
- Easy maintenance.
- Quick and easy installation.
- Even temperature inside the enclosure.
- High protection rating: IP 54 or IP 55.
- The internal and external air circuits are independent.
- Easy maintenance.
- High protection rating: IP 54.

**Disadvantages**

- Small amount of heat evacuated.
- Reduction of the IP protection rating.
- Entry of dust particles.
- The temperature inside the enclosure is always higher than the external temperature.
- The internal and external air circuits are in contact.
- Maintenance required: filter replacement.
- The temperature inside the enclosure is always higher than the external temperature.

---

**Air-water exchangers**

Air-water exchangers reduce the temperature inside the enclosure by means of a water-cooled exchange cassette. Temperature control inside the enclosure is performed by a thermostat which opens and closes an electro-valve.

The air-water exchangers are used to evacuate large amounts of heat. They require a cold-water circuit with stable temperature and flow rate. They are specially recommended in difficult, highly polluted environments where there is no external air circuit.

- **Solutions**
  - Ventilation devices
  - Fans and outlet grilles
  - Air-air exchangers

**Cooling**

Air-conditioning device providing efficient cooling of the enclosure, regardless of the outside air, and prevention against hot spots.

The cooling units can be used in the harshest environments, where the temperature can reach up to 55 ºC. These devices control the temperature inside the enclosure and include an alarm function for signalling operational anomalies.

- **Ta > Td**
  - NO
  - YES

**Advantages**

- The temperature inside the enclosure does not depend on the external temperature.
- The internal and external air circuits are independent.
- Security device against possible leaks.
- Even temperature inside the enclosure.
- High protection rating: IP 54.
- Use of an environmentally friendly gas.
- Small dimensions.
- Equipped with a PTC-type heating system, which stabilises the surface temperature of the aluminium profile.
- Available in two versions: insulated with low surface temperature or in aluminium when the surface temperature is limited to 75 ºC.
- The fan-equipped resistances guarantee an even temperature inside the enclosure.
- A cold-water supply source is required.
- Specific pumping installation.
- Installation of a drain is recommended.
- Maintenance required: filter replacement.

**Heating**

The resistance heaters prevent the formation of condensation and guarantee the ideal temperature for the correct operation of the electronic components.

The resistance heaters are used to reheat the electrical switchboard when the ambient temperature is too low or to prevent the formation of condensation.

- **Ta < Td**
  - YES

**Advantages**

- The internal and external air circuits are independent.
- Security device against possible leaks.
- Even temperature inside the enclosure.
- High protection rating: IP 54.
- Use of an environmentally friendly gas.
- Small dimensions.
- Equipped with a PTC-type heating system, which stabilises the surface temperature of the aluminium profile.
- Available in two versions: insulated with low surface temperature or in aluminium when the surface temperature is limited to 75 ºC.
- The fan-equipped resistances guarantee an even temperature inside the enclosure.
- A cold-water supply source is required.
- Specific pumping installation.
- Installation of a drain is recommended.
- Maintenance required: filter replacement.
### Ventilation systems with filters

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Reference</th>
<th>Fan with filter</th>
<th>Outlet grille</th>
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### Air-air exchanger

#### Dimensions (mm)

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<tr>
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### Air-water exchanger

#### Dimensions (mm)

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<td>310</td>
<td>600</td>
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### Cooling unit

#### Side-mounting models

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<tr>
<th>External dimensions (mm)</th>
<th>Control</th>
<th>Reference</th>
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<tr>
<td>450 X 350 X 140</td>
<td>Thermostat</td>
<td>NSYCUC40W230VL</td>
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<td>620 X 300 X 170</td>
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<td>NSYCUC160W230VL</td>
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<td>1010 X 400 X 240</td>
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<td>NSYCUE140W400L</td>
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<td>1010 X 400 X 240</td>
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#### Top-mounting models

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<tr>
<th>External dimensions (mm)</th>
<th>Control</th>
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<tr>
<td>415 X 750 X 412</td>
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<td>Thermostat</td>
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<tr>
<td>470 X 800 X 450</td>
<td>Thermostat</td>
<td>NSYCUCU200W400VL</td>
</tr>
</tbody>
</table>

### SLIM electronic control models (modular)

- 1,100 W
  - NSYCUB1100W230S
  - NSYCUB1500W230S
  - NSYCUB2200W230S
  - NSYCUB2700W230S
- 1,500 W
  - NSYCUB1100W400S
  - NSYCUB1500W400S
  - NSYCUB2200W400S
  - NSYCUB2700W400S
- 2,200 W
  - NSYCUB1100W115S
  - NSYCUB1500W115S
  - NSYCUB2200W115S
- 2,700 W
  - NSYCUB1100W230S
  - NSYCUB1500W230S
  - NSYCUB2200W230S

### Covers

<table>
<thead>
<tr>
<th>Type</th>
<th>Reference</th>
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<tbody>
<tr>
<td>Surface-mounting</td>
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<tr>
<td>Partial flush-mounting</td>
<td>NSYCUCH</td>
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<tr>
<td>Flush-mounting</td>
<td>NSYCUCF</td>
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<tr>
<td>Surface-mounting</td>
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<tr>
<td>Partial flush-mounting</td>
<td>NSYCUCHX</td>
</tr>
<tr>
<td>Flush-mounting</td>
<td>NSYCUCFX</td>
</tr>
</tbody>
</table>
Thermal optimisation solutions • Selection guide

Resistive heaters
- Insulated resistance heater with fan
- Thermofans
  - Power (W): 400, Voltage (V): 230 AC, Reference: NSYCR400W230VVC

Aluminum resistive heaters
- Power (W): 10, Voltage (V): 12-24 DC, Reference: NSYCR10WU1
- Power (W): 20, Voltage (V): 12-24 DC, Reference: NSYCR20WU1
- Power (W): 90, Voltage (V): 12-24 DC, Reference: NSYCR100WU1
- Power (W): 90, Voltage (V): 110-250 AC, Reference: NSYCR100WU2
- Power (W): 90, Voltage (V): 270-420 AC, Reference: NSYCR100WU3
- Power (W): 150, Voltage (V): 12-24 DC, Reference: NSYCR150WU1
- Power (W): 400, Voltage (V): 115 AC, Reference: NSYCR400W115V

Control temperature
- Control a resistance heater or an alarm
  - Setting range: 0...+60 °C, Reference: NSYCCOTHC
  - Setting range: +32...+140 °F, Reference: NSYCCOTHCF
- Control a resistance heater and a fan
  - Setting range: 0...+60 °C, Reference: NSYCCOTHD
  - Setting range: +32...+140 °F, Reference: NSYCCOTHDF

Control speed
- Control a resistance heater and a fan
  - Setting range: 0...+60 °C, Reference: NSYCCOTHI
  - Setting range: +32...+140 °F, Reference: NSYCCOTHIF

Control relative humidity
- Setting range: 20%...80%, Reference: NSYCCOHY230VID

Control temperature and relative humidity
- Setting range: +5 °C...+50 °C, Reference: NSYCCOHYT230VID
- Setting range: +5 °C...+50 °C, Reference: NSYCCOHYT120VID

PTC external temperature sensor (double insulation)
- Reference: NSYCCAST
# Table of atmosphere selection solutions

## Main problems resulting from aggressiveness or severity of the installation site

<table>
<thead>
<tr>
<th>Place of use</th>
<th>Dust on different degrees</th>
<th>Atmosphere in the presence of high humidity level or water (condensation)</th>
<th>Presence of oil</th>
<th>Aggressive chemical agents (1)</th>
<th>High or extreme external temperature (&gt;35 ºC)</th>
<th>Vibration</th>
<th>External heat radiation</th>
<th>Electromagnetic compatibility (2)</th>
<th>“Passive” solutions</th>
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</thead>
<tbody>
<tr>
<td>Paper or wood industry</td>
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</table>

## The benefits of use for each solution

### Constraints

- **Power of extraction with an equal volume**: 100-500 W(*)

### Use of “Passive” solutions

*Use of “Passive” solutions is always appropriate but more efficient with low thermal loads. Associating a “Passive” solution with an “Active” solution may help improve energy efficiency (E.g.: insulated cabinet + cooling unit: viable solution if external temperature is non-favourable > 35 ºC)*

### The behaviour of external temperature

*The behaviour of external temperature is of great assistance when it is a constraint for heat evacuation*

(1) See chemical agents table, etc.

(2) Electromagnetic compatibility problems may also occur due to installed equipment, see recommendations and solutions (to follow).

(*) Performances dependent on favourable external temperatures (more dT, better performances).
### Thermal optimisation solutions • Thermal solutions & atmosphere

and associated thermal

<table>
<thead>
<tr>
<th>&quot;Semi-passive&quot; solutions</th>
<th>Active</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circulation inside the cabinet (with cabinet closed) =&gt; solution valid only for low loads or to avoid heating premises and homogenizing the temperature</td>
<td>Forced ventilation + filters removed</td>
<td>Air-air exchangers</td>
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<td>x</td>
<td>(If ventilation used, must use OEM filters for atmospheres where oil is present)</td>
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</table>

**Gives uniform temperature inside your cabinet and avoids hot spots (temporary heating). In addition, if external temperature is favourable (<35 °C), this significantly favours passive and sealed heat extraction (up to IP65).**

**The most efficient solution if external temperature is favourable (<35 °C) and below a minimum of 3 °C (to cool down). Air is more efficient and is free!**

**Only effective if external conditions are very favourable (installed in air-conditioned rooms or industries with presence of dust particles)**

**Can be used in polluted atmospheres where air conditioning is impossible. They are also very effective in places where there is a lot of condensation.**

**Exchangers are used in very polluted atmospheres where air conditioning is impossible. Resistances are used to avoid condensation problems and maintain humidity levels at approximately 60% (recommended).**

**Filter maintenance. A lack of filter maintenance leads to filter blockage and a reduction in flow and performance.**

**Low heat extraction power indoors. They rely on a high dT (minimum10 °C) to be effective.**

**Considerable energy consumption and filter maintenance required to prevent drop in performance of cooling units. Example: mineral water production.**

**Reliant on a chilled water source (or a chiller or a water source). Water must be filtered in order not to block the exchanger.**

| 500-1000 W(*) | 3000 W(*) | 1000 W(*) | 4000 W | 4000 W |
Notes