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 catalog or visit our website at www.schneider-electric.us
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All the expertise of Schneider thermal management

Many of our customers, including design and engineering departments, panel builders, integrators, or even OEMs, ask us to help them optimize 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, created this operating guide for these customers (and any others).

Through this practical and comprehensive document, Schneider Electric wants to share its experience in thermal management of electric enclosures with its customers.
Electric devoted to the
of your enclosures

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:

- Motor industry: $13,574
- Agri-business industry: $8,144
- Microprocessor industry: $48,323,440
- Banking transaction services: $3,990,756
- Airline ticket-booking services: $122,166
- Mobile telephone operators: $63,798
- SMEs: $475
- Metalworking (foundry): $67,870
- Glassworks: $54,296
- High likelihood of a breakdown or malfunction of the installation: $475

Note: 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 installation

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

Choose the right level of protection
(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 reduced 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 v5.2 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

Heat balance with ProClima v5.2 software

How does it work? Nothing could be easier!
Simply enter the collected thermal data in the software. ProClima v5.2 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 °F</th>
<th>Maximum temperature with the risk of malfunction °F</th>
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<td>Contactors</td>
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<td>Circuit breakers</td>
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<td>131</td>
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<tr>
<td>PFC capacitors</td>
<td>122</td>
<td>131</td>
</tr>
</tbody>
</table>

Example 1:
Multiple variable speed drives can push the inner temperature up to 158 °F or higher (with no thermal solution installed).

Example 2:
Batteries are highly sensitive to temperature changes. They should not exceed 77–86 °F.

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

Example 1:
Multiple variable speed drives can push the inner temperature up to 158 °F or higher (with no thermal solution installed).

Example 2:
Batteries are highly sensitive to temperature changes. They should not exceed 77–86 °F.

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.

> Electronic equipment is the most delicate
> Ideal internal temp. = Critical temp. of the most delicate device
> High critical temp. of the variable speed drives: 122 °F

• The mean working temperature recommended for the inside of the enclosure is 95 °F. This is the reference temperature for the control equipment integrated in the thermal solution.
### Measuring the air temperature

The measurement of air temperature inside the enclosure must be taken over a **complete period** (for example, one production cycle, 24 hours, 1 week, and so on).

**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 various areas. Each case must be studied separately and in detail.

Mean temp. of the enclosure = \((T_1 + T_2 + T_3) / 3\).

### 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 v5.2 software** to find the dissipation values of the components in your enclosure. ProClima v5.2 offers the loss values for 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 (for example, one production cycle, 24 hours, 1 week, and so on).

What to measure

- Maximum mean temperature
- Minimum 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 v5.2 software
- Optimization of the thermal management solution: minimizes under- or over-sizing errors
Analysis of pollution and difficult or harsh environmental conditions

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

A prior inspection of the installation site is generally enough to identify the conditions 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 such as cemeteries, flour mills, ceramic and wood processing plants, and rubber factories
• Nuclear, chemical, and petrochemical sites
• Bottling plants (high humidity levels)
• Metalworking sites
• Textile plants (fibers 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 optimize the protection level of the thermal solution (for example, filter thickness) and the protection level of the enclosure (that is, the IP degree according to EN 60529).
Thermal optimization solutions
There are two main families of thermal management solutions: so-called “Passive” solutions (inexpensive and natural, defined upstream from the installation) and so-called “Active” solutions (corrective solutions, requiring specific sizing, possibly expensive).

“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
- Resistance heaters

Expert’s tip
Maximize the use of “Passive” solutions before choosing an “Active” solution.
"Passive" solutions

1 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.

**Expert’s tip**

When the external temperature is favorable (< 35 °C [< 95 °F]), increasing the size of the enclosure makes it possible to reduce the internal operating temperature and slow down a possible temperature rise.

2 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 favorable (< 35 °C [< 95 °F]), the energy savings can be substantial:

- Up to 50% for steel enclosures
- Up to 65% for polyester enclosures

- Helps avoid problems of condensation on the most delicate devices (electronic)
- Helps avoid 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 favorable (< 35 °C [< 95 °F]), all the walls should be left accessible to facilitate the dissipation of calories.

Insulation of the enclosure

When the external temperature is high (> 35 °C [> 95 °F]), the calorie intake through the surfaces of the enclosure increases the internal temperature.
If a high external temperature (> 40 °C [> 104 °F]) 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
Insulation can also be used as a “Passive” solution when the external temperature is very low and falls permanently below the minimum allowable temperature of the installed devices.
For example, installations in cold storage rooms or outdoors (~20 °C [~4 °F]).

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 optimize the solution and its overall cost.
• It is preferable to separate the control enclosures and the power enclosures.
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 (3.9 to 7.8 in. 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 3.9 to 7.8 in.

1. Outlet grills
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.

Expert’s tip

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

Cable layout

Wiring can be a source of heat. Follow these practices when laying out cable:

• The cables should not rest on the devices
• The ventilation grills 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 3.9 in. 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 [ft²]).
- **Type of material** (steel, polyester).
- **Other parameters** such as load arrangement, wiring, and external temp.

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

- **Equalize and lower the temperature** by distributing the calories.
- **Cool a localized 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 v5.2 software** to calculate the natural dissipation capacity of your enclosures.
- It is advisable to direct the flow from the air circulating fans towards delicate devices and recurring hot spots.
- The greater the mixing flow, the quicker dissipation will take place.
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
- Power: 17 W.
- Dimensions:
  - Fan: 4.7 x 4.7 x 1.5 in.
  - Collar: length 5.5 in., mounting center-to-center distance: 5.1 in.
- Installation on ball-bearing.
"Active" solutions

- Thermal control device
- Forced convection
- Forced ventilation
- Resistance heaters
Thermal control devices

The use of thermal controllers, such as thermostats or hygrostats, helps stabilize the temperature and humidity inside the enclosure. It also helps optimize 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 Ti = 113 °F
- Fan 2 providing support if Ti = 131 °F

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

One fan + one heater + one thermostat equipped with two probes (S1, S2) make it possible to control two local temperature levels:
- Fan active if temperature of S1 Ti = 113 °F
- Heater active if temperature of S1 Ti = 50 °F

Probe S2 located outside (outdoor applications).

**Expert’s tip**
- Two additional probes can be used to optimize 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
- N.O. (blue button) with normally open contact to control the starting of a fan when the temperature exceeds the displayed maximum value.
- N.C. (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: + 32 °F to + 122 °F.
- Simple programming.
- Option of installing an external sensor, for remotely reading the temperature (operating temperature: –22 °F to + 176 °F).
- Ventilation and heating function (2 separate relays).

Electronic hygrotherm
- Operating temperature: + 32 °F to + 122 °F.
- Option of installing an external sensor, for remotely reading the temperature (operating temperature: –22 °F to + 176 °F).

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.
Forced convection (through the device) with grills

Passive convection solutions:
- Side grills
- Roof grills
- Roof elevators

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

When 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 (for example, 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, or good air quality).
- Service the filter on a regular basis to avoid clogging and loss of flow.
Forced convection solutions with grills by Schneider Electric

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

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

Outlet grill
• 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 and air cleanliness. Also, measurements and analyses must be performed before installation.

Expert’s tip

- The external environment must be favorable: amount of dust, temperature level, and humidity level.
- 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. > 140 °F), use a centrifugal fan (ventilation with roof extraction).

X 2

Service life of the fans

+ • Increased pressure due 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 intake, leave a distance of 3.9 in. from the floor.

Side-mounted ventilation solutions by Schneider Electric

The ClimaSys forced ventilation range fulfills 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 $T_i = 113 \, ^\circ F$
- Fan 2 providing support if $T_i = 131 \, ^\circ F$

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

One fan + one heater + one thermostat equipped with two probes (S1, S2) make it possible to control two local temperature levels:
- Fan active if temperature of S1 $T_i = 113 \, ^\circ F$
- Heater active if temperature of S1 $T_i = 50 \, ^\circ F$

Probe S2 located outside (outdoor applications).
Expert’s tip

- If the enclosure heats up too much (Temp. ≥ 140 °F), use the top-mounted extraction ventilation, with high-speed centrifugal fan (from 17657.33 ft³/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).

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.
- Mounting 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.
Resistance heaters

External temperature changes (outdoor installations) or extreme temperature levels (< 41 °F), can create condensation on electronic devices located inside the enclosure or even cause malfunctions during the starting cycle.

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

By modifying the internal temperature of a sealed enclosure (IP54 or +), the relative humidity is modified and the quantity of water vapor 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 5.9 in. between the roof of the resistor and the first device.

Note: For large enclosures, leave a free column of air. For example, leave the space between two coupled enclosures free.
Resistance heater solutions by Schneider Electric

ClimaSys resistance heaters are the best way to prevent the formation of condensation or humidity inside the enclosure and 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
- Innovative design (plastic enclosure)
- Security (PTC-type heater)
- Easy installation and connection (direct clipping on 35-mm DIN rail)
- CE marking and UL and VDE conformity
ProClima v5.2 software: The essential expert’s tool

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 (such as voltage and power).**

4. **Determine the power dissipated by the equipment. If this value is not known, ProClima v5.2 can calculate 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.

Note: The technical results provided by this program are based on methods of approximation calculations, carried out starting from simplified hypotheses of operation and data not validated by Schneider Electric.

- Reliable and accurate thermal study
- Optimized solution
- Saves time
- User friendly and ergonomic
- Thermal values provided for the most common devices on the market
Practical summary
Good tips for thermal management of enclosures

- 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 analyzing them closely.

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

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

- Strictly observe the manufacturer's installation instructions (for example, installation area, mounting, wiring, and dimensions of the airing spaces).

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

Expert’s tip

Plan thermal management before installing the enclosure.
Choosing the best thermal management solution
Selection guide
# Control Panel Technical Guide • How to reduce damage to components through effective thermal management

<table>
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<th>System</th>
<th>Airing</th>
<th>Ventilating</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural convection causes the temperature to drop inside the enclosure. Simple solutions for this case include installing grills (without filter) or lifting the top.</td>
<td>Fans with filters are designed to evacuate a large amount of heat economically.</td>
<td>The resistance heaters prevent the formation of condensation and help ensure the ideal temperature for the correct operation of the electronic components.</td>
<td></td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>Ta &lt; Td</th>
<th>Ta &lt; Td</th>
<th>Ta &lt; Td</th>
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</table>

**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: IP54 or IP55.
- Small dimensions.
- Equipped with a PTC-type heating system, which stabilizes the surface temperature of the aluminum profile.
- Available in two versions: insulated with low surface temperature or in aluminum when the surface temperature is limited to 167 °F.
- The fan-equipped resistances help ensure an even temperature inside the enclosure.

**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.

**Solutions**

- Ventilation devices
- Fans and outlet grills
- Resistance heaters
### Ventilation systems with filters

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<th>Fan flow rate (m³/h)</th>
<th>Free with filter 50 Hz</th>
<th>With 1 outlet grill 50 Hz</th>
<th>With 2 outlet grills 50 Hz</th>
<th>Voltage</th>
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<th>Outlet grill</th>
<th>Color kit</th>
<th>IP55</th>
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<td>230 V</td>
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### Control temperature

#### Control a resistance heater or an alarm

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<tr>
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<td>0 to +60 °C</td>
<td>NSYCCOTHC</td>
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<tr>
<td>+32 to +140 °F</td>
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#### Control a resistance heater and a fan

<table>
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<th>Reference</th>
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<tr>
<td>+32 to +140 °F</td>
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#### Control temperature and relative humidity

| Setting range     | Display       | Reference     |
|-------------------|---------------|
| +5 °C to +50 °C   | °C or °F      | NSYCCOTH30VID|
|                   |               | NSYCCOTH20VID|

#### Control relative humidity

| Setting range     | Display       | Reference     |
|-------------------|---------------|
| 20% to 80%        | % RH          | NSYCCOHY230VID|

### Control a fan or an alarm

#### Control a resistance heater or an alarm

<table>
<thead>
<tr>
<th>Setting range</th>
<th>Reference</th>
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<tbody>
<tr>
<td>0 to +60 °C</td>
<td>NSYCCOTHO</td>
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<td>+32 to +140 °F</td>
<td>NSYCCOTHOF</td>
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#### Control a resistance heater and a fan

<table>
<thead>
<tr>
<th>Setting range</th>
<th>Reference</th>
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<tbody>
<tr>
<td>0 to +60 °C</td>
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<tr>
<td>+32 to +140 °F</td>
<td>NSYCCOTHIF</td>
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#### Thermostat with inverse contact

| Setting range     | Display       | Reference     |
|-------------------|---------------|
| +5 °C to +50 °C   | °C or °F      | NSYCCOHYT30VID|
|                   |               | NSYCCOHYT20VID|

### Control a fan or an alarm

#### Electronic thermostat

7 different operating modes. Option of installing one or two external sensors.

| Setting range     | Display       | Reference     |
|-------------------|---------------|
| 20% to 80%        | % RH          | NSYCCOHY230VID|

#### Electronic hygrostat

2 different operating modes.

### Electronic hygrotherm

3 different operating modes. Option of installing an external sensor.

| Setting range     | Display       | Reference     |
|-------------------|---------------|
| 20% to 80%        | % RH          | NSYCCOHY230VID|

### Electronic hygrostat

7 different operating modes. Option of installing one or two external sensors.

| Setting range     | Display       | Reference     |
|-------------------|---------------|
| 20% to 80%        | % RH          | NSYCCOHY230VID|

### PTC external temperature sensor (double insulation)

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<thead>
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<tbody>
<tr>
<td></td>
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Please refer to the catalog for more references and accessories.
Control Panel Technical Guide • How to reduce damage to components through effective thermal management

Insulated resistance heaters

<table>
<thead>
<tr>
<th>Power (W)</th>
<th>Voltage (V)</th>
<th>Reference</th>
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<tbody>
<tr>
<td>100</td>
<td>120–240 AC</td>
<td>NSYCR100WU2C</td>
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<td>120–240 AC</td>
<td>NSYCR10WU2C</td>
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<td>147</td>
<td>120–240 AC</td>
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Thermofans

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<tr>
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Ultra-thin heaters

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<td>200</td>
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Please refer to the catalog for more references and accessories.