To the Stage of Control Panel Coolers

The Advent of the Next-Generation, Intellignet FA Coolers

The ENC Series, the No.1 delivering control panel cooler, has been redesigned completely!

EX-series
- ENC-AR510EX
- ENC-AR520EX
- ENC-AR510EX
- ENC-AR520EX
- ENC-AR510EX
- ENC-AR520EX
- ENC-AR710EX
- ENC-AR720EX
- ENC-AR1110EX
- ENC-AR1120EX
- ENC-AR1652EX
- ENC-AR2200EX
- ENC-AR2900EX

L-series
- ENC-AR110L
- ENC-AR120L
- ENC-AR130L
- ENC-AR140L
- ENC-AR150L
- ENC-AR200L
- ENC-AR250L
- ENC-AR300L

For details of the products, contact Apiste head office.
The models, specifications, and other descriptions are subject to change without prior notice.

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Apiste “ENC series”

Protect control panels from breakdown and troubles!

What’s the problem of control panels?

- **Heat**
  - By temperature rising, electric devices are deteriorated and broken down.

- **Moisture**
  - Moisture brings corrosion, rust, insulation deterioration and a short circuit accident.

- **Dust Particle**
  - Fire, operation deterioration and insulation deterioration are occurred by particles and oil mist.

Heat

Moisture

Dust Particle

What’s Apiste’s Panel Cooler “ENC series”?

- **Effect**
  - Cooling & Dehumidification & Dust Prevention
  - By Internal Air-Circulation

- **Digest Features**
  - Direct easy mounting
  - Automatic temperature humidity control
  - Mild cooling without condensation
  - Easy maintenance Diagnosis function

EX-series (Top mount)

L-series (Side mount)

Design

EX-series (Top mount)

L-series (Side mount)

Application

For die casting machine panel

For painting robot panel

For NC machine panel

For film molding base panel

For generator panel

For furnace panel

For stamping press panel

For wire forming panel
The FA Cooler Evolving Continuously

Self-diagnosis Function for Ultimate Safety

Apiste’s FA coolers are designed to provide doubled or tripled safety measures all of the time. They conduct continuous self-diagnosis and monitor cooling operations in real time.

Self-diagnosis for proper operation

Alarm display & External output

Apiste’s cooler’s self-diagnosis function not only detects clogged filters but also checks various points. The safety-conscious design monitors operation in real time and provides alarm display and external output when an abnormal condition is detected. Coolers that only cool are behind the times now.

Monitoring clogged filters

Newly-developed the wind velocity sensor

The decrease in the heat radiation air volume due to clogged filters causes lower cooling ability and a shorter operating life. The ENC-AR series features Apiste’s original the wind velocity sensor, which monitors the flow of heat-dissipating air sent from the condenser and conducts self-diagnosis of the heat exchange of the cooler. When the air flow decreases, the cooler outputs an alarm signal, allowing a significant reduction of man-hours for inspection.

The next-generation self-diagnosis function ensures stable cooling ability and promotes a longer operating life for the cooler.

Safety design preventing water leakage

Overflow sensor + Double drain pan

The top-mount type coolers have a well designed draining structure. With the reliable double drain pan structure, if water leakage from the first drain pan, the second drain pan holds and drains the water. Moreover, an overflow sensor is mounted inside the first drain pan and activates the protection circuit if the drain water level becomes abnormally high. An alarm sign is displayed, an external output is provided, and the cooling operation is forced to stop. As a result, a water leakage can be prevented reliably.

Industry-first remote monitoring

Monitoring compressor operation

The ENC-AR series features a cooling operation confirmation output as standard. The operating status of the cooler’s compressor can be monitored continuously. Using this output together with various diagnosis functions also enables advanced inspection and maintenance.

Industry-first function to prevent inspection from being overlooked

Maintenance notification

For every product, regular maintenance is effective for long time use. The ENC-AR series features a function to calculate its operating period and automatically notifies users of the time for inspection. This function is useful to prevent inspections from being overlooked.

Energy-saving operation mode

In today’s environment even control panel coolers must be conscious of ecology. Unlike conventional coolers which operate ventilating fans continuously, the new ENC-AR series offers an energy-saving mode to operate the fans according to the compressor operation. You can save electricity as compared to coolers whose fans operate all of the time and even during winter. The energy-saving mode also offers periodic ventilation during a cooling operation. This reduces current consumption and makes the ENC-AR series fully compliant with the Revised Energy Conservation Law of Japan.

With the rapidly growing globalization of the marketplace and the necessity for worldwide cost competitiveness, it is urgent to improve production efficiency in factories or to establish an automation system. Apiste’s idea is that it is also a new age for control panel coolers, which are indispensable for such sophisticated production systems. Witness the advent of the next-generation control panel cooler, offering unprecedented safety and reliability.
No need for additional options
Half embedded-mounting supported as standard

Conventional lateral mount type coolers may not be mounted properly due to their thickness when there are obstacles around or when the control panel faces a passage. The lateral-mount type of the ENC-AR Series(*) has adopted a separate body to allow easy half embedded-mounting without requiring additional options.

* For ENC-AR610L/AR620L/AR1110L/AR1120L only.

Earth-friendly design
Lead-free control PWB

It is said that the 21st century is the age of the environment. Apiste took an early lead in working on the global environment issues that have been receiving attention in recent years. The “lead-free” control PWB of the ENC-AR series is the outcome of such efforts. The ENC Series will continue constant evolution with the aim of bringing an earth-friendly product.

Highly rugged design as defense against harsh environments
Special fan against oil mist (optional)

Most FA coolers are installed in harsh environments, and the ENC-AR Series has a long-established reputation for its high durability. Now, Apiste has developed an original oil-resistant fan in order to ensure a longer life in environments with a lot of oil mist (Optional accessory). The fan can be attached not only to new cooler models but also to conventional, existing coolers.

A concept, constant, manufacturing field-oriented
Usable design for maintenance efficiency

The filter can be replaced by simply detaching it from the aluminum frame. The fan can also be replaced easily by removing the front panel. The separate body structure makes inspection of main parts easier. The ENC-AR Series has achieved high maintenance efficiency.

A concept profoundly customer-oriented
Outer and panel cutout dimensions unchanged from conventional models(*)

Apiste’s redesigned coolers are compatible with conventional models in terms of outer and panel cutout dimensions. There is no need to worry about replacing old coolers.

* Some models have additional dimensions for half embedded mounting.

Safety-conscious design
Compliance with Electrical Appliance and Material Safety Law

The ENC-CCC Series meets the two requirements, “Safety” and “EMC” under the CCC certification, based on the favorably-received ENC-A Series that gathers our individual control panel cooling technologies that we have accumulated for many years as a manufacturer specialized in control panel coolers.

ENC-CU model (all 12 models)

With the release of the ENC-CU Series, Apiste has become the first Japanese domestic manufacturer to release control panel coolers with full certification for both the CE marking and the UL standard at the same time. The ENC-CU lineup consists of twelve coolers: six ceiling-mount and six lateral-mount type models.

Naturally, the lineup is environmentally-friendly, being RoHS Directive compliant.

In U.S.A., the UL standard is known as the highest authority of safety standard. In Japan, the CE marking is the safety mark that must be compulsorily applied to speciﬁc products for marking in the EU area. Customs have made it practice to check for the UL mark to verify product safety. Thus, the UL mark serves as an index for product selection. For example, people who see a ruler with the JIS mark think that it is a high-precision product. As with the JIS mark, the UL mark is recognized as a high-quality product.

Acquisition of the highest authority’s certification

The RoHS Directive was enacted on July 1, 2006 by EU (European Union). “RoHS” is an abbreviation for “Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment”, which means that electrical and electronic equipment are prohibited from containing specific hazardous substances. There are six substances subject to control which were agreed upon at the EU Mediation Committee in November 2002.
Outer Dimensions (unit: mm)

L-series

ENC-AR310L / AR320L

ENC-AR451S / AR452S

ENC-AR610L / AR620L

ENC-AR1110L / AR1120L

ENC-AR1651L / AR1652L

ENC-AR2200L

ENC-AR2900L
Outer Dimensions (unit: mm)

**EX-series**

ENC-AR310EX / AR320EX

ENC-AR510EX / AR520EX

ENC-AR710EX / AR720EX

ENC-AR1110EX / AR1120EX

ENC-AR1652EX

ENC-AR2900EX

ENC-AR2200EX

- Power cable/External length 3m
- Cooling operation output cable/External length 3m
- Alarm output cable/External length 3m

Diagram of each model showing dimensions and parts, including power, cooling, and alarm cables.
Diagram of Panel Cutout  (unit: mm)

**L-series**

- ENC-AR310L / AR320L
- ENC-AR451S / AR452S
- ENC-AR610L / AR620L
- ENC-AR1110L / AR1120L
- ENC-AR1651L / AR1652L
- ENC-AR2200L
- ENC-AR2900L

**EX-series**

- ENC-AR310EX / AR320EX
- ENC-AR510EX / AR520EX
- ENC-AR710EX / AR720EX
- ENC-AR1110EX / AR1120EX
- ENC-AR1652EX
- ENC-AR2200EX
- ENC-AR2900EX
Diagram of Cooling Characteristics (unit: mm)

L-series

ENC-AR310L / AR320L
ENC-AR315L / AR325L
ENC-AR330L

EX-series

ENC-AR310EX / AR320EX
ENC-AR315EX / AR325EX
ENC-AR330EX

Consideration for the global environment

Completely eliminating hazardous chemical substances from the standard models

The ENC-CCC Series’ standard models are completely free from the six hazardous chemical substances subjected to control in EU, and made only of materials friendly to the global environment. The display substrate is also lead-free. Thereby, the ENC-CCC Series is made entirely of environmental-friendly materials.

Apiste uses R-134a, because it is not subjected to control and has been proven in CFC gas is required for coolers. Apiste uses R-134a, because it is not subjected to control and has been proven in

Operation in energy-saving mode

The ENC-CCC Series provides the intermittent operation mode that conducts air blowing operation at regular intervals, to ensure energy conservation. The fan also provides the energy-saving mode that runs in synchronization with compressor operation. Thereby, the ENC-CCC Series’ models are designed with consideration for the global environment.

Commitment to greenhouse gas reduction

GHC gas is required for coolers. Apiste uses R-134a, because it is not subjected to control and has been proven in handling reliability and safety.

<table>
<thead>
<tr>
<th>Refrigerant</th>
<th>Ozone depletion coefficient</th>
<th>Greenhouse coefficient (GWP)</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-407c</td>
<td>0.055</td>
<td>0.4</td>
<td>smoothly approved as refrigerant. It phased out in 2017, is almost used in large-size air-conditioners with GWP=0.04</td>
</tr>
<tr>
<td>R-134a</td>
<td>0.25</td>
<td>0.45</td>
<td>smoothly approved as refrigerant. R-134a is frequently used in refrigerators, as a substitute for R-12.</td>
</tr>
<tr>
<td>R-22</td>
<td>0.85</td>
<td>0.36</td>
<td>There are wide applications in various fields. However, the complete elimination of R-22 before 2020 has been decided, and is being ended soon.</td>
</tr>
<tr>
<td>R-12</td>
<td>1</td>
<td>0.79</td>
<td>low temperature of 0°C may expanded at the end of 1999, as an ozone layer depletion</td>
</tr>
</tbody>
</table>

[Note: When CFC=1]
## Specifications

### EX-series

<table>
<thead>
<tr>
<th>Type</th>
<th>Top-mount Type</th>
<th>Lateral-mount Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>ENC-AR110EX</td>
<td>ENC-AR110L</td>
</tr>
<tr>
<td>Cooling capacity*3</td>
<td>360 / 290 (50/60 Hz)</td>
<td>260 / 200 (50/60 Hz)</td>
</tr>
<tr>
<td>Power supply</td>
<td>Single-phase 100V±10%/50/60Hz</td>
<td>Single-phase 200V±10%/50/60Hz</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>20 to 55°C</td>
<td>20 to 55°C</td>
</tr>
<tr>
<td>No. of fan</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Paint color</td>
<td>Munsell 5Y 7/1 Equivalent color of light beige</td>
<td>Munsell 5Y 7/1 Equivalent color of light beige</td>
</tr>
<tr>
<td>Weight</td>
<td>15kg</td>
<td>32kg</td>
</tr>
</tbody>
</table>

*3 The rated capacity value with an ambient temperature of 35°C and a panel internal temperature of 35°C.

### L-series

<table>
<thead>
<tr>
<th>Type</th>
<th>Top-mount Type</th>
<th>Lateral-mount Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>ENC-AR310L</td>
<td>ENC-AR120L</td>
</tr>
<tr>
<td>Cooling capacity*3</td>
<td>500 / 600 (50/60 Hz)</td>
<td>400 / 450 (50/60 Hz)</td>
</tr>
<tr>
<td>Power supply</td>
<td>Single-phase 100V±10%/50/60Hz</td>
<td>Single-phase 200V±10%/50/60Hz</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>20 to 55°C</td>
<td>20 to 55°C</td>
</tr>
<tr>
<td>No. of fan</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Weight</td>
<td>12kg</td>
<td>22kg</td>
</tr>
</tbody>
</table>

*3 The rated capacity value with an ambient temperature of 35°C and a panel internal temperature of 35°C.

### Noise immunity*4

- **Level 4 in the fast transient/burst immunity test**
- **Total amplitude: 20 mm, Frequency: 300 CPM**
- **Munsell 5Y 7/1 Equivalent color of light beige**
- **Weight: 15kg**

*4 Level 4 in the fast transient/burst immunity test.
Advancement of Factory Automation and control devices

As automation advances, FA has contributed to a sophisticated production system that deals with diversification and customization, which are the demands of the time. As a result, the concept of control has also greatly changed.

Advanced automation and the increase in control devices

The phenomenon called “3K alienation” (trend in the labor market in Japan in which people do not want to do jobs that can be characterized by three Japanese words starting with “k”: “kiken (danger),” “kitanai (dirty),” and “kitsui (hard)” is continuing even today when job shortages are a societal concern. In order to solve this problem, factories promote the automation of the production process by using robots or automatic machinery, resulting in a steady increase in the use of control devices. Consequently, in more and more cases, a centralized control system is established on a mezzanine added to the factory, from which workers manage a control panel consisting of several control devices.

Proliferation of integrated production line and advanced control systems

In the past, there were several factories (processes) specializing in a certain process, such as heat treatment, working, or assembly. In new FA systems, however, these factories (processes) are integrated into a single production line system including upstream and downstream processes. Production systems such as FMS have become more advanced. It is natural that people will request a flexible and intelligent control system with advanced, multi-functional control devices.

Increased dependence on control systems and more expense for control devices

When FA increases dependence on control systems, other challenges arise. The first is that the environment of control devices becomes more important for risk management in the factory. The second contradicts the above issue that the current FA environment is not suitable for control devices.

Tendency to suffer greater damage from the failure of control devices

The integrated production line and highly-systematized production in a factory involves the risk of a failure or breakdown of a single process affecting the operation of the entire factory. Since the control system is a vital part of FA, even the breakdown of a single control device may cause significant damage. In other words, we must understand that the reliability of the control devices is an extremely important issue.

Factory environment unsuitable for control devices

Furthermore, the advancement of the integrated production line results in an environment hostile to certain devices such as an assembly robot operating near a heat treatment process. Such factory environments are detrimental to multi-functional, sophisticated control devices. Semiconductor and electronics components used as the core of those control devices are easily affected by heat, moisture and dust.

Semiconductor / electronics components are easily affected by heat, moisture and dust.

Data has proven that heat and moisture greatly increase the failure rate of semiconductor and electronics components and shorten their operating life.

Panel air-conditioners are rapidly becoming widespread.

The reason why required
Heat accelerates the failure rate of semiconductor/electronics components

The graph on the right shows the relationship between the temperature and acceleration of semiconductor failure*. The Y axis shows the acceleration of the failure. At a temperature of 25°C, the failure rate is less than 0.5 at 40°C, the failure rate is 1. The ratio, however, increases to 30 to 50 times at 60°C, and jumps to 100 to 300 times at 85°C. This graph clearly shows that an increase in temperature greatly affects the failure rate of semiconductor/electronics components.

Heat dramatically shortens the life of semiconductor/electronics components

The next graph shows the relationship between the temperature and the life of a capacitor. At a temperature of 30°C, the life of a capacitor is about 80,000 hours. At 40°C, the life becomes 40,000 hours, it means about half the life at 50°C. At 60°C, the life is further shortened to about 10,000 hours. Heat also greatly affects the life of semiconductor/electronics components.

Destructive influence of moisture on control devices

Control devices have a lot of joints and moisture is one of the greatest enemies of these joints. The graph on the right shows “the relationship between corrosion and relative humidity”. You can see that corrosion rapidly advances when humidity exceeds 60%. Since humidity around 70% is a normal level in Japan, measures against moisture are crucial for control devices. Furthermore, corrosion advances more rapidly at higher temperatures, so the measures against moisture must be considered along with the measures against heat.

In conclusion, we should review the approach to the environment for control devices from the beginning. For example, when a control panel is installed as the mezzanine of the factory as described earlier, the temperature on the mezzanine is usually higher than the ground surface by 5°C. In summer in particular, the temperature becomes extremely high due to the heat from the factory roof.

Needless to say, such an environment is the worst for control devices. In some cases, chemical absorption agents are installed in the control panels, but these are only a band-aid-like solution. This problem must be taken seriously along with the measures against heat and moisture.

Influence of control device breakdown

What happens to the production activity when control devices suffer a breakdown? Possible results are as follows:

Tremendous loss of time

Assume that one control panel suffers a breakdown. Even if the breakdown lasts for only 30 minutes, the previous and next production processes also stop because of interlocks of the integrated and systematized production line. If a device such as a furnace stops, it takes at least one or two hours to recover normal operation. As a result, the failure of a single control panel will stop the operation of the previous and next lines, resulting in a time loss of about two hours.

Significant loss of cost

The cost of replacing an inverter is expected to be about ¥300,000 for a 30 kW inverter. Replacing only a PC board will cost about ¥60,000. Moreover, ordering a necessary part requires at least two to three weeks. If you plan to have the inverter in stock, another ¥200,000 is required. Assigning maintenance staff to find failures at an early stage requires the cost of “(Basic salary) × (Working hours) × (No. of people)” at any rate, you have to be prepared to pay a considerable cost.

What is the best way to solve these problems at their source? After all, these problems can be considered to be an environmental problem of the integrated control devices or control panel.

Conventional measures for maintaining the proper environment for a control panel

In production sites, various measures have been taken against these problems for a long time. Such measures, however, were insufficient to solve these problems at their source. The following is a brief explanation and the drawbacks of such measures

Axial fan

Axial fans are often installed inside control panels to prevent control devices from heating up. This is, however, far from an ideal solution. Since axial fans take in outside air indirectly, they cannot prevent the ingress of oil mist or dust in the factory air. The cooling ability may be totally insufficient because it depends on the temperature of the outside air.

Spot type air-conditioner

Spot type air-conditioners are also often used as a method to cool the inside of control panels. They are, however, originally designed for home use, not for the control panels in factories. Therefore, the air is not completely separated from outside air, resulting in contamination with oil mist or dust. Spot type air-conditioners are not suitable for cooling the inside of control panels either.

Air-conditioned control room

Another method is to install several control panels in a control room with an air-conditioner. The potential problems are: It is difficult to find the space for the room, construction requires considerable cost and it is difficult to change the layout when the production system is changed. Dust may be another problem because many people go in/out of the room.

After reviewing these issues, the best measure for maintaining the proper environment for control panels is finally found: a panel air-conditioner or an air-conditioner specially designed for a control panel. Quite and some innovative, such related parties are the first to focus attention on such air-conditioners.
Panel air-conditioner providing measures against "heat", "moisture", and "dust"

1 Against heat — Keeping the temperature inside the control panel constant

Apiste is a manufacturer specializing in panel air-conditioners. We have been working to understand the realities of production sites and the environment of control devices, and to identify problems and solutions from the standpoint of specialists. These efforts have led to the development of various Apiste panel air-conditioners, of which details are provided in this catalog. The basic concept is to provide measures against "heat", "moisture", and "dust".

Temperature inside and outside the control panel of an automotive manufacturer after an FA air-conditioner is installed

![Graph showing temperature changes inside and outside the control panel]

- **Conditions:** ENC-720EX
- **Size:** 1500 (H)x800 (W)x400 (D) mm
- **Contained devices:** Sequencer, transformer, and other controllers for measurement

Panel air-conditioners have a separate air circulation structure to prevent oil mist or dust in a factory from entering the control panel. Their internal air circulation system circulates air only inside the control panel for cooling and dehumidifying the air. They actively cool and dehumidify the air and prevent dust from entering the control panel by establishing independent air circulation inside the control panel. Thus, all measures against heat, moisture, and dust are implemented. This is the first achievement of an ideal environment for control devices using semiconductor/electronics components in a hostile production atmosphere. This fact has become the focus of attention of FA-related parties. Panel air-conditioners are being recognized as necessities in the FA environment.

2 Against moisture — Dehumidification to prevent condensation

Panel air-conditioners feature various measures against moisture and condensation as well as gradual cooling.

![Graph showing humidity trend after installation of panel air-conditioner]

**Conditions for the occurrence of condensation**

- **Temperature difference:** Difference in temperature between air and object surface (°C)
- **Condition:** Outside temperature is 25°C

3 Against dust — Separate air circulation shutting the outside air out of the panel

Panel air-conditioners have a separate air circulation structure to prevent oil mist or dust in a factory from entering the control panel. Their internal air circulation system circulates air only inside the control panel for cooling and dehumidifying the air.

**Structure of FA air-conditioners**

Structure of FA air-conditioners offers various functions in addition to cooling the air.

They actively cool and dehumidify the air and prevent dust from entering the control panel by establishing independent air circulation inside the control panel. Thus, all measures against heat, moisture, and dust are implemented. This is the first achievement of an ideal environment for control devices using semiconductor/electronics components in a hostile production atmosphere. This fact has become the focus of attention of FA-related parties. Panel air-conditioners are being recognized as necessities in the FA environment.
Selection of indoor panel air-conditioner

1) to 6) Determine the numeric values used for calculation.
   - Estimated heat generation inside a control panel: (W)
     1) Determine the heat generation for each device installed inside the control panel according to the "List of heat generation from devices inside a control panel".
     2) Obtain the sum of the heat generation.
     3) For a power control panel, correct the value to practical heat generation by multiplying the value by the in-load ratio.
   - Surface area of control panel cabinet: S(m²)
     4) For a freestanding type, subtract the bottom area.
   - Operating power frequency: F(Hz)
     5) Used as a guide to select cooling unit.
   - Maximum outside temperature: Tc(C)
     6) Recommended setting temperature is between 35°C and 45°C.

7) Compare the maximum outside temperature and the target temperature inside the control panel, then go to the next step.
   - When the maximum outside temperature is lower than the target temperature
     1) Use calculation 8) "To set the target temperature higher than the maximum outside temperature".
     2) Use calculation 9) "To set the target temperature lower than the maximum outside temperature".
   - When the maximum outside temperature is higher than the target temperature
     Use calculation 8) "To set the target temperature higher than the maximum outside temperature".

8) or 9) → 10) Substitute the values above into the appropriate calculation to obtain required cooling capacity.
8) To set the target temperature higher than the maximum outside temperature
   Required cooling capacity (W) = \( P + S \times S \)
9) To set the target temperature lower than the maximum outside temperature
   Required cooling capacity (W) = \( P + S + S \) (Overall heat transfer rate/\( S \) x (S/m²) x (T-Tm))
   * Overall heat transfer rate for typical control panels is normally 5.0 to 6.0.

10) Obtain the "required cooling capacity".

11) Select an optimal air-conditioner model by referring to the required cooling capacity and the cooling capacity characteristics of each panel air-conditioner.

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### Selection of Indoor Panel Air-Conditioner

#### Model selection flow

1. Identify major devices contained in the control panel.
2. From the list, obtain the "estimated heat generation inside a control panel".
3. Obtain the "surface area of control panel cabinet".
4. Check the "operating power frequency".
5. Measure the "maximum outside temperature".
6. Determine the "target temperature inside control panel".
7. Compare the "maximum outside temperature" and "target temperature inside control panel" to select the appropriate calculation.
8. Set the target temperature higher than the maximum outside temperature.
9. Set the target temperature lower than the maximum outside temperature.
10. Obtain the "required cooling capacity".
11. Select optimal model by referring to the "required cooling capacity" and the "cooling capacity characteristics of each panel air-conditioner".

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### List of heat generation from devices inside a control panel

#### 1. Power supply/transformer

<table>
<thead>
<tr>
<th>Device inside a control panel</th>
<th>Heat generation (referential value)</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small transformer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated capacity: 1.1 kW or less</td>
<td>Approx. 5%</td>
<td>Smaller device shows higher heat generation ratio.</td>
</tr>
<tr>
<td>1.1 kW or less</td>
<td>Approx. 20%</td>
<td></td>
</tr>
<tr>
<td>1.5 kW or less</td>
<td>Approx. 5%</td>
<td></td>
</tr>
<tr>
<td>2.2 kW or less</td>
<td>Approx. 10%</td>
<td></td>
</tr>
<tr>
<td>3.0 kW or less</td>
<td>Approx. 15%</td>
<td></td>
</tr>
<tr>
<td>4.0 kW or less</td>
<td>Approx. 20%</td>
<td></td>
</tr>
<tr>
<td>5.5 kW or less</td>
<td>Approx. 25%</td>
<td></td>
</tr>
<tr>
<td>3.0 kW or less</td>
<td>Approx. 35%</td>
<td></td>
</tr>
<tr>
<td>5.5 kW or less</td>
<td>Approx. 50%</td>
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</tr>
<tr>
<td>8.0 kW or less</td>
<td>Approx. 60%</td>
<td></td>
</tr>
<tr>
<td>11 kW or less</td>
<td>Approx. 75%</td>
<td></td>
</tr>
<tr>
<td>16 kW or less</td>
<td>Approx. 100%</td>
<td></td>
</tr>
<tr>
<td>Voltage regulator</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Approx. 5% of the rated capacity | | |}

#### 2. Amplifiers

<table>
<thead>
<tr>
<th>Device inside a control panel</th>
<th>Heat generation (referential value)</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC servo amplifier</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated capacity: 0.75 kW or less</td>
<td>Approx. 10%</td>
<td>Smaller device shows higher heat generation ratio.</td>
</tr>
<tr>
<td>0.75 kW or less</td>
<td>Approx. 15%</td>
<td></td>
</tr>
<tr>
<td>1.5 kW or less</td>
<td>Approx. 20%</td>
<td></td>
</tr>
<tr>
<td>2.2 kW or less</td>
<td>Approx. 25%</td>
<td></td>
</tr>
<tr>
<td>3.0 kW or less</td>
<td>Approx. 30%</td>
<td></td>
</tr>
<tr>
<td>4.0 kW or less</td>
<td>Approx. 35%</td>
<td></td>
</tr>
<tr>
<td>5.5 kW or less</td>
<td>Approx. 40%</td>
<td></td>
</tr>
<tr>
<td>8.0 kW or less</td>
<td>Approx. 45%</td>
<td></td>
</tr>
<tr>
<td>11 kW or less</td>
<td>Approx. 50%</td>
<td></td>
</tr>
<tr>
<td>16 kW or less</td>
<td>Approx. 55%</td>
<td></td>
</tr>
<tr>
<td>Inverter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated capacity: 0.75 kW or less</td>
<td>Approx. 10%</td>
<td>Smaller device shows higher heat generation ratio.</td>
</tr>
<tr>
<td>0.75 kW or less</td>
<td>Approx. 15%</td>
<td></td>
</tr>
<tr>
<td>1.5 kW or less</td>
<td>Approx. 20%</td>
<td></td>
</tr>
<tr>
<td>2.2 kW or less</td>
<td>Approx. 25%</td>
<td></td>
</tr>
<tr>
<td>3.0 kW or less</td>
<td>Approx. 30%</td>
<td></td>
</tr>
<tr>
<td>4.0 kW or less</td>
<td>Approx. 35%</td>
<td></td>
</tr>
<tr>
<td>5.5 kW or less</td>
<td>Approx. 40%</td>
<td></td>
</tr>
<tr>
<td>8.0 kW or less</td>
<td>Approx. 45%</td>
<td></td>
</tr>
<tr>
<td>11 kW or less</td>
<td>Approx. 50%</td>
<td></td>
</tr>
<tr>
<td>16 kW or less</td>
<td>Approx. 55%</td>
<td></td>
</tr>
<tr>
<td>Power unit (DC servo amplifier)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage drop at the rated power output (kW)</td>
<td>Approx. 5% to 15% of the rated power output</td>
<td>Smaller device shows higher heat generation ratio.</td>
</tr>
</tbody>
</table>

---

### 3. Wiring devices

<table>
<thead>
<tr>
<th>Device inside a control panel</th>
<th>Heat generation (referential value)</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device inside a control panel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated current of MCCB</td>
<td>Approx. 5%</td>
<td>Smaller device shows higher heat generation ratio.</td>
</tr>
<tr>
<td>20 A or less</td>
<td>Approx. 15%</td>
<td></td>
</tr>
<tr>
<td>30 A or less</td>
<td>Approx. 20%</td>
<td></td>
</tr>
<tr>
<td>40 A or less</td>
<td>Approx. 25%</td>
<td></td>
</tr>
<tr>
<td>Ground leakage current</td>
<td>Approx. 30%</td>
<td></td>
</tr>
<tr>
<td>100 A or less</td>
<td>Approx. 50%</td>
<td></td>
</tr>
<tr>
<td>Thermal overload relay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated capacity: 0.1 A or less</td>
<td>Approx. 10%</td>
<td>Smaller device shows higher heat generation ratio.</td>
</tr>
<tr>
<td>0.1 A or less</td>
<td>Approx. 20%</td>
<td></td>
</tr>
<tr>
<td>0.5 A or less</td>
<td>Approx. 30%</td>
<td></td>
</tr>
<tr>
<td>1.0 A or less</td>
<td>Approx. 40%</td>
<td></td>
</tr>
<tr>
<td>Thermal magnetic relay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated capacity: 0.1 A or less</td>
<td>Approx. 10%</td>
<td>Smaller device shows higher heat generation ratio.</td>
</tr>
<tr>
<td>0.1 A or less</td>
<td>Approx. 20%</td>
<td></td>
</tr>
<tr>
<td>0.5 A or less</td>
<td>Approx. 30%</td>
<td></td>
</tr>
<tr>
<td>1.0 A or less</td>
<td>Approx. 40%</td>
<td></td>
</tr>
</tbody>
</table>

---

### CAUTION

Precautions on selection
1. Note that the heat generation of a power control device (inverter) greatly varies depending on the usage or motor torque.
2. To in-service of MCCB or other output power protection device, heat generation greatly varies according to the manufacturer.
3. Contact the respective manufacturer for precise values.
4. The selection chart can be applied to thyristors only. The thyristor may be inappropriate with products of the other companies.
5. If an unknown difference between the calculations, while following steps on the selection chart, it will deserve a resolution.
6. Provide sufficient allowance for model selection. Required capacity should not be underestimated due to the chances of the control unit, the position of heat-generating objects, or dirty environment.
7. Note that the formulas above are used only as a guide. They do not indicate universal values.

---

### List of heat generation from devices inside a control panel

#### Voltage regulator

- Approx. 10% of the rated capacity

---

### Power unit (DC servo amplifier)

- Approx. 5% to 15% of the rated power output (kW)

---

### Remark

- Smaller device shows higher heat generation ratio.
- Smaller device shows higher heat generation ratio.
- Smaller device shows higher heat generation ratio.
- Smaller device shows higher heat generation ratio.
Panel air-conditioners are rapidly becoming a popular choice for modern spaces. This trend is driven by their efficiency, environmental impact, and operational benefits. As the technology advances, these devices continue to evolve, making them an attractive option for consumers. Here, we delve into the specifics of various related devices and their impact on the overall energy consumption, focusing on control devices and motor control units.

### 4. Control devices

<table>
<thead>
<tr>
<th>Device inside a control panel</th>
<th>Heat generation (referential value)</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small relay</td>
<td>Approx. 1 W to 2 W</td>
<td></td>
</tr>
<tr>
<td>Solid-state relay (SSR)</td>
<td>Approx.</td>
<td></td>
</tr>
<tr>
<td>Temperature regulator</td>
<td>Approx. 0.5 W to 2 W</td>
<td></td>
</tr>
<tr>
<td>Sequencer</td>
<td>Approx. 3% of current consumption</td>
<td></td>
</tr>
</tbody>
</table>

#### 5. Computer-related devices

<table>
<thead>
<tr>
<th>Device inside a control panel</th>
<th>Heat generation (referential value)</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal computer (factory computed)</td>
<td>100 W to 300 W</td>
<td></td>
</tr>
<tr>
<td>CRT (Monitor)</td>
<td>Approx. 300 W to 1500 W</td>
<td></td>
</tr>
<tr>
<td>Floppy disk drive</td>
<td>Approx. 5 W to 300 W</td>
<td></td>
</tr>
<tr>
<td>Hard disk drive</td>
<td>Approx. 300 W</td>
<td></td>
</tr>
</tbody>
</table>

#### 6. Other

<table>
<thead>
<tr>
<th>Device inside a control panel</th>
<th>Heat generation (referential value)</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fax motor</td>
<td>Approx. 10 W</td>
<td></td>
</tr>
</tbody>
</table>

### 7. Motor control devices

#### 7.1. Motor control devices —①

<table>
<thead>
<tr>
<th>Contained devices</th>
<th>Heat generation (referential value)</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 V-class, Device</td>
<td>Incl. starting</td>
<td>Control resistor</td>
</tr>
<tr>
<td>400 V-class, Large AC SERVO amplifier</td>
<td>Control unit</td>
<td>Rated capacity</td>
</tr>
</tbody>
</table>

#### 7.2. Motor control devices —②

<table>
<thead>
<tr>
<th>Contained devices</th>
<th>Heat generation (referential value)</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 V-class, Device</td>
<td>Incl. starting</td>
<td>Control resistor</td>
</tr>
<tr>
<td>400 V-class, Large AC SERVO amplifier</td>
<td>Control unit</td>
<td>Rated capacity</td>
</tr>
</tbody>
</table>

#### 7.3. Motor control devices —③

<table>
<thead>
<tr>
<th>Contained devices</th>
<th>Heat generation (referential value)</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 V-class, Device</td>
<td>Incl. starting</td>
<td>Control resistor</td>
</tr>
<tr>
<td>400 V-class, Large AC SERVO amplifier</td>
<td>Control unit</td>
<td>Rated capacity</td>
</tr>
</tbody>
</table>

### Selecting a breaker

Use the following table to select the breaker capacity.

<table>
<thead>
<tr>
<th>Power Supply</th>
<th>Applicable capacity of a breaker (Unit: A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-phase, 100 V</td>
<td>More than the maximum current consumption of the panel air-conditioner to be used</td>
</tr>
<tr>
<td>Single-phase, 200 V</td>
<td>More than the maximum current consumption of the panel air-conditioner to be used</td>
</tr>
<tr>
<td>3-phase, 200 V</td>
<td>More than the maximum current consumption of the panel air-conditioner to be used</td>
</tr>
</tbody>
</table>

### Selecting a transformer

When using an air-conditioner with a 400V power supply, use the following table to select the capacity of a transformer.

<table>
<thead>
<tr>
<th>Power Supply</th>
<th>Calculation to obtain the capacity of a transformer (Unit: kVA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-phase, 100 V</td>
<td>100 V x Starting current of the panel air-conditioner (A)</td>
</tr>
<tr>
<td>Single-phase, 200 V</td>
<td>100 V x Starting current of the panel air-conditioner (A)</td>
</tr>
<tr>
<td>3-phase, 200 V</td>
<td>100 V x Starting current of the panel air-conditioner (A)</td>
</tr>
</tbody>
</table>

*Note: Please check the specifications for further details.*