Enclosure Cooling

You need to cool down

Heat inside an enclosure can decrease the life expectancy of controlling units such as your PLC, HMI, AC drives and other items. Excessive heat can cause nuisance faults from your electrical and electronic components: for example, overloads tripping unexpectedly. Heat will also change the expected performance of circuit breakers and fuses, which can cause whole systems to shut down unexpectedly. So, if you have any electronic equipment or other heat sensitive devices, you may need cooling.

What causes all that heat?

There are basically two sources that can cause the enclosure’s internal temperature to rise above the ratings of the control equipment.

Internal Sources
The same items that can be damaged by heat may also be the source of the heat. These include items such as:

- Power supplies
- Servos
- AC Drives/inverters
- Soft starters
- Transformers
- PLC systems
- Communication products
- HMI systems
- Battery back-up systems

External Sources
Other sources of heat that can cause the internal temperature of your enclosure to rise above a desired level involve the external environment. These include items such as:

- Industrial ovens
- Solar heat gain
- Foundry equipment
- Blast furnaces

Get the heat out

How do you get the heat out of your enclosure and away from those critical components? There are several basic cooling methods available, depending on the cooling requirements and the enclosure environment.

Radiation and Natural Convection Cooling
If the ambient temperature outside the enclosure is cooler than the inside of the enclosure, some heat will be radiated into the atmosphere from the surface of the enclosure. In environments where dust and water intrusion is not a concern, louvers can be added to allow outside air to flow through the enclosure via natural convection - the movement of air due to it’s expansion (reduced density) when it’s heated and contraction (increased density) when it cools.

On a large scale, natural convection can be a powerful force - it’s one of the primary drivers of our weather. But on the scale of an electrical enclosure, its cooling capacity is very limited. For larger heat loads, a more powerful cooling system may be needed.

Since they create openings in the enclosure, louvers are typically limited to NEMA 1 and/or NEMA 3R applications. However, some louvers have optional filters that can be added to maintain NEMA 12 protection.

Forced Convection Cooling
The next step up from natural convection is forced convection cooling. The basic cooling mechanism is the same: cooler air from outside the enclosure passes through the enclosure to remove the heat. The difference is that the air is mechanically forced through the enclosure by a filter fan. The fan produces higher air flow rates than natural convection, which in turn increases the amount of heat removed.

As with natural convection cooling, the ambient air temperature must be lower than the desired enclosure temperature for forced convection to be effective.

A typical forced convection system consists of a fan and a grille, with a filter on the intake device and either a filter or louvers on the exhaust device. The filters and louvers allow the enclosure to maintain NEMA 12 protection. In NEMA 4 or NEMA 4X environments, hoods can be added to both the fan and the grille to prevent the ingress of water.

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Closed Loop Cooling

If the environment is harsh, with heavy dust and debris or the presence of airborne chemicals, or there are wash-down requirements, the cooling system must be able to keep the ambient air separate from the air inside the enclosure.

Closed loop systems, which include heat exchangers and air conditioners, circulate the internal air and ambient air through separate chambers connected by a refrigeration system that transfers heat from the internal air stream to the external air stream. Heat exchangers and air conditioners are both closed loop cooling systems. The primary difference in the two is the refrigeration system.

The refrigeration system in a heat exchanger is a set of sealed tubes of alcohol. Heat absorbed from the internal enclosure air boils the liquid alcohol at the bottom of the tube, causing it to rise to the top. The heat is then rejected to the cooler ambient air stream, causing the alcohol to condense back to a liquid and fall to the bottom.

Heat exchangers are very efficient because the refrigeration system has no moving parts - the only moving parts are the two fans. But for the heat to transfer through the system, the ambient air must be colder than the air inside the enclosure, just as it must be for filter fans.

Enclosure air conditioners function in the same manner as a residential or automotive air conditioner, with refrigeration loop powered by a compressor. The refrigerant absorbs heat from the internal air at the evaporator coil and rejects it to the ambient air at the condenser coil. Unlike heat exchangers, they can provide cooling even if the ambient temperature is higher than the enclosure temperature. They can also be scaled to handle larger heat loads than any other cooling system.

Enclosure air conditioners are available for NEMA 12, NEMA 4 and NEMA 4X applications.

Vortex Coolers

Vortex coolers create a stream of extremely cold air from a supply of filtered compressed air. The cold air is injected into the enclosure, displacing warm air which is exhausted back through the vortex cooler. While not a closed-loop system, they can be used in the same harsh environments since the cold air injected into the enclosure is filtered air from a compressed air system, not ambient air. Vortex coolers can also be used where the ambient temperature is higher than the enclosure temperature.

Since vortex coolers prevent the ingress of ambient air or sprayed water and are made from corrosion-resistant materials, they can be used on NEMA 4X enclosures in harsh, wash-down, and/or corrosive environments.

Vortex coolers are commonly used in lieu of a small or medium enclosure air conditioner in applications where there isn’t adequate space to mount an air conditioner, provided there is an adequate supply of compressed air.

Thermoelectric Coolers

Another alternative to a conventional air conditioner is a thermoelectric cooler, which is sometimes referred to as a Peltier cooler. They function in a manner similar to an air conditioner or heat exchanger, with fans inside and outside the enclosure, but with a thermoelectric unit replacing the fluid-based refrigeration system.

The thermoelectric units consist of an array of semiconductors sandwiched between two ceramic plates. When a DC current is applied to the semiconductor array, heat is driven from one plate to the other, creating a cold side and a warm side. This is known as the Peltier Effect. Fans circulate air across each of the plates, allowing the cold plate to absorb heat from the enclosure and the warm plate to reject it to the ambient air.

Like vortex coolers, thermoelectric coolers can be used with NEMA 4X enclosures in harsh, wash-down, and corrosive environments, and where the ambient temperature exceeds the enclosure temperature.

Thermoelectric coolers are an alternative to air conditioners in small cooling capacity applications where there isn’t adequate space for an air conditioner.
Fan selection
To select the proper size (CFM) fan for your forced air cooling solution, you need to determine the amount of heat to be removed (in watts) and determine the Delta T (Max. allowable internal enclosure temperature °F – Max. outside ambient temperature °F).

$$\text{CFM} = \text{Cubic Feet per Minute}$$
$$P = \text{Power to be dissipated in watts}$$
$$\text{CFM} = (3.17 \times P_{watts}) / \Delta T \degree F$$

$$\Delta T = \text{max. allowable internal enclosure temperature} \degree F – \text{max.outside ambient temperature} \degree F$$

**Stego** offers an online Cooling Calculation Tool to help you calculate the required airflow rate for your application.

**Air conditioner thermoelectric cooler and vortex cooler selection**
To select the proper size air conditioner or vortex cooler, the worst-case conditions should be considered, but take care not to choose an oversized unit.

There are two main factors in choosing an uninsulated metal NEMA rated enclosure located indoors:
- Internal heat load
- Heat load transfer

**Internal Heat Load**
Internal heat load is the heat generated by the components inside the enclosure. This can be determined by a few different methods. The preferred method is to add the maximum heat output specifications that the manufacturers list for all the equipment installed in the cabinet. This is typically given in Watts, so use the following conversion:

$$\text{BTU per Hour} = \text{Watts} \times 3.413$$

Example: The Watt-loss chart for the GS3 Drives shows that a GS3-2020 AC drive has a Watt-loss of 750 watts.

$$\text{BTU per Hour} = 750 \text{ watts} \times 3.413$$

**Heat Load Transfer**
Heat load transfer is the heat lost (negative heat load transfer) or gained (positive heat load transfer) through the enclosure walls with the surrounding ambient air. This can be calculated by the following formula:

$$\text{Heat load transfer (BTU/H)} = 1.25 \times \text{surface area (sq. ft.)} \times (\text{max. outside ambient air (°F)} – \text{max. allowable internal enclosure temperature air (°F)})$$

**Surface Area (sq. ft.)** = 2 \((H \times W) + (H \times D) + (W \times D)\) / 144 sq. inches

- **Note:** 1.25 is an industry standard constant for metal enclosures; 0.62 should be used for plastic enclosures
- **Once you have determined your Internal Heat Load and the Heat Load Transfer, you can choose the proper size unit by calculating the needed cooling capacity.**

**Cooling capacity (BTU/H) = Internal Heat Load ± Heat Load Transfer**

**Fan Selection Example**
A NEMA 12 Wiegmann N12302412 enclosure (30 in [762 mm] high x 24 in [610 mm] wide x 12 in [305 mm] deep) contains a GS3-2020 AC drive (20 HP 230 volt) that has a maximum allowable operating temperature of 104°F and is located in a warehouse that has a maximum outside ambient air temperature of 92°F.

Power to be dissipated is stated in the specifications of the GS3-2020 and is found to be 750 watts, so P = 750 watts

$$\Delta T = \text{Max. operating temperature for the GS3-2020} = 104°F – \text{Max. ambient air temperature of} 92°F$$

$$\Delta T = 9°F$$

$$\text{CFM} = (3.17 \times 750 \text{ watts}) / 12°F$$

$$\text{CFM} = 198$$

Choose a Stego 018740-30 230VAC FPI filter fan with a 118740-00 exhaust grille to provide 220 CFM or a Stego 018840-00 230VAC FPO filter fan with a 118840-30 intake grille to provide 243 CFM.

**Air Conditioner Device Selection Example**
A NEMA 12 Wiegmann N12302412 enclosure (30 in [762 mm] high x 24 in [610 mm] wide x 12 in [305 mm] deep) contains a GS3-4030 AC drive (30 HP 460 volt) that has a maximum allowable operating temperature of 104°F and is located in a warehouse that has a maximum outside ambient air temperature of 115°F.

Power to be dissipated is stated in the specifications of the GS3-4030 and is found to be 1290 watts.

**Internal heat load:**

$$\text{BTU per Hour} = 1290 \text{ watts} \times 3.413$$

$$\text{BTU per Hour} = 4403 \text{ BTU/H}$$

**Heat load transfer:**

$$\text{Heat load transfer (BTU/H)} = 1.25 \times 19 \text{ sq. ft.} \times (115°F – 104°F)$$

$$\text{Heat load transfer (BTU/H)} = 261.25 \text{ BTU/H}$$

**Cooling capacity:**

$$\text{Cooling capacity (BTU/H)} = 4403 \text{ BTU/H} + 261.25 \text{ BTU/H}$$

$$\text{Cooling capacity (BTU/H)} = 4664.25 \text{ BTU/H}$$

In this example, you are able to determine that a 5000 BTU/H unit is needed. Select a TA10-050-16-12 Stratus air conditioner.

Note: The same calculation method is used for sizing thermoelectric coolers and Stratus vortex coolers. However, in this example the cooling requirements exceed the maximum capacity of the largest available vortex or thermoelectric cooler. If the example application required the use of a vortex or thermoelectric cooler instead of an air conditioner, two (2) TV35-025-4X units or ten (10) 3052303 thermoelectric units would be needed.
Industrial strength cooling options for your enclosure from AutomationDirect

• Both intake (FPI) and exhaust (FPO) fans are available.
• Exhaust fans and grilles available with air flaps or filters.
• Using air flaps on the exhaust reduces the number of filters to maintain.

Filter Fan Kits
• Easy filter change
• Outer door lock for outdoor models
• Impact resistant
• Weather/UV-resistant -f1
• Flammability Rating: UL94V-0
• Adhesive mounting for non-screw installation (except outdoor models)
• Low noise
• 120VAC and 24VDC models available

Filter Fan Plus
• Easy filter change
• Hinged cover
• Impact resistant
• Weather/UV-resistant-UL-f1
• Flammability Rating: UL94V-0
• Unique ratchet mechanism for no-screw installation
• Low noise
• 120, 230VAC and 12, 24, 48VDC models available

Hose-Proof Filter Fan Hoods
• Stainless steel hood with food-grade silicone seal
• Fits all Stego Filter Fan and Filter Fan Plus fans and exhaust grilles (except outdoor Filter Fans)
• Maintains an enclosure’s NEMA/UL Type 4 or 4X rating in washdown environments

Fan Kits
• All models are 115V with an expected service life of 30,000 hours
• High-performance fan motors and finger guards
• Polycarbonate fire retardant plastic grilles, UL94-V0
• Durable, reusable filter mat included
• Patented “Click and Fit” system allows for rapid filter fan and exhaust filter installation without screws

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Industrial strength cooling options for your enclosure from AutomationDirect

Heat Exchangers
- For NEMA 4 and 4X enclosures
- Closed loop cooling
- Energy efficient: uses approximately the same power as a filtered fan system
- 120VAC and 24VDC models available
- UL
- Made in the USA

Air Conditioning Units
- For NEMA 12, 4, 4X type enclosures
- Digital temperature controller
- Active condensate evaporation system
- High unit efficiency
- Tough industrial construction
- Compressor protection system

Enclosure Vortex Coolers
- For NEMA 12, 4, 4X type enclosures
- Operates on compressed air
- Stainless steel construction
- No moving parts, no maintenance required
- Vortex coolers can be “resized” for changing applications by simply replacing the generator inside the cooler. No need to purchase a new unit
- Replacing the vortex generator takes minutes

Seifert Thermoelectric Cooling Units
- For NEMA 4, 4X, and 12 enclosures
- Stainless steel housing
- 170, 340, 510, 680 BTU/H cooling capacity
- Recessed mounting
- No maintenance required
- 24VDC and 120VAC power options

1-800-633-0405
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Enclosure Air Conditioners

Applications
Designed to maintain the temperature inside an electrical enclosure at or below a safe level for the enclosed equipment, while maintaining a closed loop environment inside the enclosure to keep out contaminants that can be in the ambient air. Can be used in environments such as steel, food processing, petrochemical, cement, paper/pulp, and plastics industries, provided there are no corrosive gases or liquids that could damage internal components.

Features
- Programmable temperature controller with visible alarm features in a 0.57 x 0.29in [14.5 x 7.3mm] panel
- 70°F to 95°F (20°C to 35°C) temperature control range
- 50°F to 125°F (10°C to 52°C) ambient temperature range
- Pre-wired for external alarm monitoring connections (22 AWG three-conductor cable, 7 ft (2.3 m) long)
- Active condensate evaporation system with safety overflow
- Protective coated condenser coils on NEMA 4 and 4X for corrosion resistance
- Thermal expansion valve for maximum efficiency over wide range of temperatures and loads
- Anti short-cycle compressor protection
- High and low refrigerant cut-outs with fault indication
- Highly energy-efficient compressors
- UL/cUL listed

Construction
- Free-standing rigid chassis for easy installation and maintenance
- All mounting hardware, full-size template and instruction manual included
- Power input terminal block on all models
- All Type 4 and 4X models come with condenser coils coated with an electrically applied corrosion-resistant coating

Stratus Air Conditioners General Specifications

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Nominal Cooling Capacity</th>
<th>Operating Voltage</th>
<th>Inrush Current (A)</th>
<th>Running Current (A)</th>
<th>Recommended Fuse Size/Time Delay (A)</th>
<th>SCCR (A)</th>
<th>Connection</th>
<th>Refrigerant</th>
<th>Refrigerant Amount (oz)</th>
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Notes: *SCCR rating is based on the SCCR rating for the circuit protection device installed in the panel/enclosure per UL484 and UL4848a to protect the AC unit. Typically, 100kA - 200kA for Time-Delay Fuses. Atmosphere: No corrosive gases or liquids.
SoliTherm® Thermoelectric Cooling Units

Applications

Thermoelectric elements utilize the Peltier Effect to create a temperature difference between the internal and ambient heat sinks, making internal air cooler while dissipating heat into the external environment. Fans assist the convective heat transfer from the heat sinks, which are optimized for maximum flow.

The Seifert SoliTherm® Peltier thermoelectric cooling units can be mounted in nearly every position (except roof mounting) because they don’t have a compressor or any moving parts aside from the fans. Depending on the application, condensation management may need to be considered.

Construction

- Recessed mounting (flush-mounting kit sold separately)
- Cooling capacities from 170 to 680 BTU/H [50W to 200W]
- Operating Temperature Range: -4°F to 149°F [20°C to 65°C]
- AISI 304 stainless steel housing
- Condensate tray and drain available separately
- Mounting nut torque: 3.3 lb-ft [4.5 Nm]
- Connection: Terminal block
- 24 VDC units require thermostat for set-point control

Agency Approvals

- CE, RoHS, cURus
- NEMA 4X
- IP 66

### SoliTherm® Thermoelectric Cooling Unit General Specifications

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Nominal Power / Max (W)</th>
<th>Cooling Capacity</th>
<th>Operating Voltage</th>
<th>Inrush Current (A)</th>
<th>Max Current (A)</th>
<th>Recommended Fuse Size (A)</th>
<th>Integral Thermostat</th>
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<tbody>
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<td>58 - 60</td>
<td>170 BTU/H [50W]</td>
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<td>115 - 118</td>
<td>340 BTU/H [100W]</td>
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<td>340 BTU/H [100W]</td>
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</tbody>
</table>

Notes: Power and Cooling Capacity values are for 95°F [35°C] internal and ambient temperatures. Refer to Performance Graphs for values corresponding to other conditions. Fuses are Class T Time Delay.

Airflow Example

Ambient side

Supply

Peltier elements

Internal side

THERMOELECTRIC COOLING PRINCIPLE

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Vortex Coolers

**Features**
- Relief valves and seals built into the vortex coolers which enable the units to maintain the sealed nature of NEMA enclosures.
- No freon.
- Small physical size.
- Creates cool air without refrigerants (no CFCs, HCFCs).
- Exceptionally reliable - no moving parts and virtually no maintenance.
- No fans.
- Stainless steel construction.
- All replacement generators fit any of the vortex coolers. No need to purchase a new cooler if you need to change your cooling capacity.
- 5-year warranty.

**Compressed air cooling** is used where conventional enclosure cooling by air conditioners or heat exchangers is not possible. (Examples: Small to medium size enclosures, non-metallic enclosures, and areas where the size of cooling devices is restricted)

**Mounting holes**
- Mounts in a 0.25in [6 mm] electrical conduit knockout

**Agency Approvals**
- UL Recognized component [File E329932] UL/NEMA 4, 4X

**Requirements**
- Uses clean, dry, oil-free compressed air (80 to 100 PSIG / 70° F or below) required to achieve published BTU/H ratings. Lower pressures and/or higher temperatures will reduce BTU/H rating.
- A 5-micron water and particulate removal filter must be installed prior to any vortex cooler operation.
- An oil removal filter can be installed between the 5-micron filter and the Vortex Cooler if oil is present in the compressed air line.
- Thermostats, filters, regulators, and valves that work with Stratus Vortex Coolers are sold separately. Kits that include these items are listed later in this section.
- Operation above 100 PSIG is not recommended. The use of a pressure regulator will be necessary for higher pressures.
- How vortex coolers create cold air:
  - Compressed air is injected into the vortex tube at extremely high speeds and that creates a cyclone, or vortex, spinning a million revolutions per minute. Part of the air is forced to spin inward to the center and travels up a long tube where a valve turns the spinning column of air inside itself. The inside column of air gives up its heat to the outside column. The cold air is directed out the cold end of the Vortex Tube and the hot air is directed out the other end of the Vortex Tube. And since there are no moving parts there is little need for maintenance.

<table>
<thead>
<tr>
<th>Part Type</th>
<th>Part Number</th>
<th>Price</th>
<th>Description</th>
<th>Capacity BTUH [W]</th>
<th>Air Consumption SCFM [SLPM]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vortex Coolers</td>
<td>TV08-005-4X</td>
<td>$333.00</td>
<td>Stratus vortex cooler, stainless steel body. For NEMA 4/4X/12 enclosures. Distribution tube and muffler included.</td>
<td>500 [147]</td>
<td>8 [227]</td>
</tr>
<tr>
<td></td>
<td>TV10-006-4X</td>
<td>$333.00</td>
<td>Stratus vortex cooler, stainless steel body. For NEMA 4/4X/12 enclosures. Distribution tube and muffler included.</td>
<td>600 [176]</td>
<td>10 [283]</td>
</tr>
<tr>
<td></td>
<td>TV15-010-4X</td>
<td>$333.00</td>
<td>Stratus vortex cooler, stainless steel body. For NEMA 4/4X/12 enclosures. Distribution tube and muffler included.</td>
<td>1000 [293]</td>
<td>15 [425]</td>
</tr>
<tr>
<td></td>
<td>TV25-018-4X</td>
<td>$333.00</td>
<td>Stratus vortex cooler, stainless steel body. For NEMA 4/4X/12 enclosures. Distribution tube and muffler included.</td>
<td>1800 [528]</td>
<td>25 [708]</td>
</tr>
<tr>
<td></td>
<td>TV35-025-4X</td>
<td>$333.00</td>
<td>Stratus vortex cooler, stainless steel body. For NEMA 4/4X/12 enclosures. Distribution tube and muffler included.</td>
<td>2500 [732]</td>
<td>35 [991]</td>
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<tr>
<td>Replacement Generators</td>
<td>TV08-G</td>
<td>$9.00</td>
<td>Stratus vortex generator, replacement, polypropylene, white. Fits all Stratus TV series vortex cooler bodies.</td>
<td>500 [147]</td>
<td>8 [227]</td>
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<td></td>
<td>TV10-G</td>
<td>$9.00</td>
<td>Stratus vortex generator, replacement, polypropylene, orange. Fits all Stratus TV series vortex cooler bodies.</td>
<td>600 [176]</td>
<td>10 [283]</td>
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<tr>
<td></td>
<td>TV15-G</td>
<td>$9.00</td>
<td>Stratus vortex generator, replacement, polypropylene, red. Fits all Stratus TV series vortex cooler bodies.</td>
<td>1000 [293]</td>
<td>15 [425]</td>
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<tr>
<td></td>
<td>TV25-G</td>
<td>$9.00</td>
<td>Stratus vortex generator, replacement, polypropylene, blue. Fits all Stratus TV series vortex cooler bodies.</td>
<td>1800 [528]</td>
<td>25 [708]</td>
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<tr>
<td></td>
<td>TV35-G</td>
<td>$9.00</td>
<td>Stratus vortex generator, replacement, polypropylene, yellow. Fits all Stratus TV series vortex cooler bodies.</td>
<td>2500 [732]</td>
<td>35 [991]</td>
</tr>
</tbody>
</table>
Heat exchanger selection

To select the proper size heat exchanger, the worst-case conditions should be considered. For a heat exchanger to work, the ambient air temperature must be lower than the desired internal enclosure air temperature.

There are three main factors in choosing a heat exchanger for an uninsulated metal NEMA rated enclosure located indoors:

- Internal heat load
- Delta T
- Heat load transfer

**Internal Heat Load**

Internal heat load is the heat generated by the components inside the enclosure. This can be determined by a few different methods. The preferred method is to add the maximum heat output specifications that the manufacturers list for all the equipment installed in the cabinet. This is typically given in Watts.

**Delta T (ΔT)**

ΔT = maximum allowable internal enclosure temperature °F – maximum outside ambient temperature °F.

**Heat Load Transfer**

Heat load transfer is the heat lost (negative heat load transfer) or gained (positive heat load transfer) through the enclosure walls with the surrounding ambient air. This can be calculated by the following formulas:

Surface Area (sq. ft.) = 2 [(H x W) + (H x D) + (W x D)] / (144 sq. inches/sq. ft.)

Note: Only include exposed surfaces of enclosure in calculations. Exclude surfaces such as a surface mounted to a wall.

Heat Load Transfer (W/°F) = 0.22 W/°F sq. ft. x surface area

Note: Use 0.22 Watts/°F sq. ft. for painted steel and non-metallic enclosures. Use 0.10 Watts/°F sq. ft. for stainless steel and bare aluminum enclosures.

**Cooling Capacity**

Once you have determined your Internal Heat Load, the Heat Load Transfer and the Delta T, you can choose the proper size unit by calculating the needed cooling capacity.

Cooling Capacity (W/°F) = Internal Heat Load / ΔT - Heat Load Transfer

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**Heat Exchanger Selection Example**

A NEMA 12 Wiegmann N12302412 enclosure (30 in [762 mm] high x 24 in [610 mm] wide x 12 in [305 mm] deep) contains a GS3-4010 AC drive 10 HP 460 volt) that has a maximum allowable operating temperature of 104°F and is located in a warehouse that has a maximum outside ambient air temperature of 90°F.

Power to be dissipated is stated in the specifications of the GS3-4010 and is found to be 345 watts.

Internal heat load:

Internal Heat Load = 345 Watts

ΔT (°F) = 104°F – 90°F = 14°F

Heat load transfer:

Surface Area (ft.²) = 2 [(30 x 24) + (30 x 12) + (24 x 12)] / 144 sq. inches = 19 ft²

Heat Load Transfer = 0.22 x 19 ft² = 4.2 Watts/°F

Cooling capacity:

Cooling Capacity = 345 Watts/14°F - 4.2 Watts/°F = 20.4 Watts/°F

In this example, you are able to determine that a Stratus heat exchanger, with a capacity of at least 20.4 Watts/°F is needed, such as a TE30-030-17-04.

*This selection procedure applies to metal and non-metal, uninsulated, sealed enclosures in indoor locations. This selection procedure gives the minimum required size; be careful not to undersize when purchasing.*
Consider a Better Solution: Air to Air Heat Exchanger

- Always closed loop
- Low cost
- Easier to mount on only one side of your enclosure
- Energy efficient; uses no more power than a filtered fan system
- Filter-free; no diminished cooling capacity

Applications
A closed loop cooling system which employs the heat pipe principle to exchange heat from an electrical enclosure to the outside.

Construction
- Heat pipe technology
- Closed loop design

Listings
- UL File: SA34086
- Made in USA

Features
- All units are available in NEMA 4 and 4X
- Available in 120 VAC and 24 VDC
- Motors have a sealed overload protector
- Finned evaporator and condenser sections provide a closed loop
- Coil systems use aluminum end plates and baffles which improve conduction and reduce corrosion for longer life
- UL/cUL listed

Air to Air Heat Exchange
The Air to Air Heat Exchanger is a closed loop cooling system which employs the heat pipe principle to exchange heat from an electrical enclosure to the outside. Where ambient temperatures are suitable for heat pipes, they are the most efficient method of cooling as the waste heat is the engine which drives the system. The only power requirement is to operate two circulating fans or blowers.

Heat pipes have a liquid refrigerant under a partial vacuum inside sealed tubes. They operate with a phase change process which is much like that of mechanical air conditioning, but without the compressor. Each heat pipe has an evaporator section and a condenser section which are separated by a permanent baffle so as to provide a closed loop. The bottom of each heat pipe is in contact with heated air from the electrical enclosure. When the enclosure air reaches approximately 75° F, the refrigerant changes to vapor phase (boils) and the vapor (steam) rises to the top of the tube which is in contact with cooler outside (ambient) air.

When the outside air temperature is lower than the enclosure temperature, the refrigerant vapor gives up heat to the outside air and returns to the liquid phase. It then falls to the bottom and repeats the cycle endlessly so long as there is a negative temperature differential between the enclosure and outside. Heat pipes will not operate in reverse cycle so heat cannot be transferred from the ambient to the interior of the enclosure. Although the operation is self limiting, thermostatic control can be used to shut off the fans when not needed.

The Stratus design has a top-to-bottom enclosure air flow pattern with maximum separation of the inlet and outlet. This design pulls the hottest air from the top of the enclosure and returns the cooled air from the bottom of the heat pipe to the enclosure. The air flow on the ambient side is bottom in, top out, so that the hotter discharge air moves up and away rather than being recirculated.

The units use aluminum end plates and baffles which improve conduction and reduce corrosion for longer life. The center aluminum baffle, which is swaged into the heat pipe coil, provides an air tight seal between the two air systems.

www.automationdirect.com
In this image, a standard installation shows where the dirt and particulate will enter the enclosure and be pulled in by the fans on your drives and devices. Filters or not, contamination is invited in by this open loop approach.

In this image, a standard installation demonstrates the closed loop condition maintained by the Air to Air Heat Exchanger. Cool air inlet and outlet vents are completely covered by the heat exchanger. This provides NEMA type 4 or 4X.

### Stratus Air to Air Heat Exchangers Specifications

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Price</th>
<th>Operating Voltage Range (V)</th>
<th>Inrush Current (Start Up Current) (A)</th>
<th>Loading Current (Running Current) (A)</th>
<th>SCCR (Short Circuit Current Rating) (A)</th>
<th>Recommended Circuit Protection Device Rating (A)</th>
<th>VA Rating (W)</th>
<th>Refrigerant Type (oz)</th>
<th>Watts/°C (°F°)</th>
<th>Free Air Flow (CFM)</th>
<th>Weight Without Packaging (lbs)</th>
<th>Body Style</th>
<th>Material Type</th>
<th>Voltage/Hz</th>
<th>Maximum Ambient Temperature</th>
<th>Agency Approval</th>
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<tbody>
<tr>
<td>TE20-015-17-4X</td>
<td>$1,578.00</td>
<td>± 10%</td>
<td>1.92</td>
<td>0.37</td>
<td>Refer to Footnote 1</td>
<td></td>
<td></td>
<td>Methanol (0.41)</td>
<td>22 (12)</td>
<td>131</td>
<td>16</td>
<td>compact</td>
<td>2CRS with ANSI 61 gray powder coat</td>
<td>120 VAC 50/60</td>
<td>160°F (71.1°C)</td>
<td>UL File: SA34086</td>
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<td>TE20-015-17-4X</td>
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<td>0.37</td>
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<td>Methanol (0.41)</td>
<td>44 (24)</td>
<td>127</td>
<td>19</td>
<td>deep</td>
<td>3Stainless Steel</td>
<td>120 VAC 50/60</td>
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<td>UL File: SA34086</td>
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<td>TE20-015-24D-04</td>
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<td>Methanol (0.81)</td>
<td>71.6 (40)</td>
<td>131</td>
<td>32</td>
<td>tall</td>
<td>3Stainless Steel</td>
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<td>24 VDC</td>
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<td>TE30-030-24D-4X</td>
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</tbody>
</table>

Notes:
1. SCCR rating is based on the SCCR rating for the circuit protection device installed in the panel / enclosure per UL50 and UL508a to protect the AC unit Typically 10KA for Fast Acting Fuses.
2. Cold-rolled steel with ANSI-61 gray polyester powder coating inside and out.
3. Fabricated from 16-gauge 304 stainless steel.