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.
**Enclosure Cooling – Selecting a Fan or Cooling Device**

**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).

\[
\text{CFM} = \frac{3.17 \times P_{\text{watts}}}{\Delta T \, ^\circ F}
\]

\[
\Delta T = \text{max. allowable internal enclosure temperature °F} - \text{max. outside ambient temperature °F}
\]

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.

\[
\text{BTU per Hour} = 750 \text{ watts} \times 3.413 = 2559 \text{ BTU/H}
\]

**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:

\[
\text{Heat load transfer (BTU/H)} = 1.25 \times \text{surface area (sq. ft.)} \times (\text{max. outside ambient air} \,(^\circ F) - \text{max. allowable internal enclosure temperature air} \,(^\circ F))
\]

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.

\[
\text{Cooling capacity (BTU/H)} = \text{Internal Heat Load} \pm \text{Heat Load Transfer}
\]

**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

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

\[
\Delta T = 9°F
\]

\[
\text{CFM} = \frac{(3.17 \times 750 \text{ watts})}{12°F} = 198\text{ CFM}
\]

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.

\[
\text{Internal heat load:}
\]

\[
\text{BTU per Hour} = 1290 \text{ watts} \times 3.413 = 4403 \text{ BTU/H}
\]

\[
\text{Heat load transfer:}
\]

\[
\text{Heat load transfer (BTU/H)} = 1.25 \times 19 \text{ sq. ft.} \times (115°F - 104°F) = 261.25 \text{ BTU/H}
\]

\[
\text{Cooling capacity:}
\]

\[
\text{Cooling capacity (BTU/H)} = 4403 \text{ BTU/H} + 261.25 \text{ BTU/H} = 4664.25 \text{ BTU/H}
\]

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

For the latest prices, please check AutomationDirect.com.
1-800-633-0405
Applications
Filter fans provide an optimum climate in enclosures. The interior temperature of enclosures is reduced by channeling cooler filtered outside air into the enclosure, thus expelling heated internal air. The resulting air flow prevents formation of localized heat pockets and protects electronic components from overheating.

Outdoor filter fans are used in outdoor enclosures where warm air must be dissipated. To clean and exchange the filter mat, you open the lockable door of the outdoor hood, eliminating the need to allow interior access to the enclosure. IP55 protection type is achieved due to the special design of the hood and the use of fine filter mats.

Features
• Easy filter change
• Outdoor door lock for outdoor models
• Impact resistant
• Weather/UV-resistant UL-f1
• Flammability Rating: UL 94V-0
• No-screw installation — except outdoor models
• Low noise
• 120VAC and 24VDC models available
• Service life — 50,000 hrs@77°F (25°C) + 65%RH
• Connection type - 12 to 69 CFM - 2 wires w/case clamps, AWG 14, length 4.0in [103mm]/136 to 373 CFM - 3 pole terminal, AWG 14, clamping torque 0.8 N·m
• Airflow direction easily switched by reversing the axial fan (except on models 018040-01 and 018050-01)
• Includes self-adhesive gasket pre-installed on frame
• Optional mounting screws for additional support
• G3 (coarse), G4 (medium) and M5 (fine) replacement filter mats available

Standards
• All models: IP54, VDE, EAC, UL 12 when using supplied filter (outdoor models IP55)
• UL recognized — file: E234324

Note: Using fine filter mat M5 reduces the airflow. (No test data available for G3 filter mats. See Stego Air Volume and Pressure Data, later in this section.)

### Part Number | Price | Cutout Dimensions | Operating Voltage | Power Consumption1 (W) | Current Draw1 (mA) | FreeAirflow 1,2 (CFM) | Air Flow with Grille and Filters1,3 (CFM) | Max. Static Pressure (Pa)1,2 | Sound Level (dB)1 | Min/Max Operating Temp. | Included Filter Rating | Average Arrestance | Notes
--- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | ---
018000-02 | $109.00 | 3.82 x 3.82 [97 x 97] | 24VDC | 2.2 | 90 | 9 | 19 | 31 | 14/158°F [-10/70°C] | G4 (medium) | 94% |
018000-01 | $81.00 | | 120VAC | 13 | 160 | 11 | 18 | 31 | |
018010-02 | $121.00 | 4.92 x 4.92 [125 x 125] | 24VDC | 5 | 210 | 32 | 25 | 40 | |
018010-01 | $91.00 | | 120VAC | 15 | 180 | 37 | 28 | 40 | |
018020-02 | $123.00 | 6.93 x 6.93 [176 x 176] | 24VDC | 5 | 210 | 60 | 40 | 23 | 39 | |
018020-01 | $108.00 | | 120VAC | 15 | 180 | 69 | 46 | 27 | 39 | |
018040-02 | $186.00 | | 120VAC | 15 | 180 | 136 | 84 | 60 | 52 | -13/140°F [-25/60°C] | |
018030-03 | $329.00 | 9.84 x 9.84[250 x 250] | 24VDC | 20 | 840 | 176 | 135 | 23 | 53 | 14/158°F [-10/70°C] |
018030-01 | $316.00 | | 120VAC | 60 | 700 | 202 | 156 | 27 | 53 | -13/140°F [-25/60°C] |
018050-01 | $260.00 | | 120VAC | 15 | 180 | 85 | 203 | 85 | 52 | |

Outdoor Filter Fans (Rain Hoods)
018210-04 | $172.00 | 4.92 x 4.92 [125 x 125] | 24VDC | 5 | 210 | 12 | 11.8 | 48 | 40 | 14/158°F [-10/70°C] | G5 (fine) | 98% |
018210-02 | $147.00 | | 120VAC | 15 | 180 | 14 | 14 | 54 | |

Notes: Performance data (current draw, power consumption, free airflow, airflow with grille and filters, sound level) for all 120VAC fans is based on 60Hz. Free airflow and maximum static pressure are measured with fan and louvered housing only. Airflow with grille and filters include entire system: complete fan assembly with filter and exhaust grille with filter. Dimensions in inches [millimeters].
Filter Fan – Dimensions

Dimensions

For the latest prices, please check AutomationDirect.com.
Filter Fan – Dimensions

Dimensions

For the latest prices, please check AutomationDirect.com. 1-800-633-0405
Filter Fan – Dimensions

Dimensions

For the latest prices, please check AutomationDirect.com.

1-800-633-0405
Filter Fan – Dimensions

Dimensions

![Diagram of Filter Fan Dimensions](image_url)
Exhaust Grilles With Filters

**Features**
- No-screw installation
- G3 (coarse), G4 (medium) and M5 (fine) replacement filter mats available

**Accessories**
- Come with gaskets attached (adhesive-sided to stick on panel)

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Price</th>
<th>Cutout Dimensions</th>
<th>Included Filter Rating</th>
<th>Average Areatance</th>
</tr>
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<tbody>
<tr>
<td><strong>Exhaust Grilles</strong></td>
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<tr>
<td>118000-00</td>
<td>$18.50</td>
<td>3.82 x 3.82 [97 x 97]</td>
<td>G4 (medium)</td>
<td>94%</td>
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<td>118010-00</td>
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<td>4.92 x 4.92 [125 x 125]</td>
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</tr>
<tr>
<td>118020-00</td>
<td>$27.50</td>
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<td>118030-00</td>
<td>$67.00</td>
<td>9.84 x 9.84 [250 x 250]</td>
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<tr>
<td><strong>Outdoor Exhaust Grilles</strong></td>
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<td>118210-00</td>
<td>$106.00</td>
<td>4.92 x 4.92 [125 x 125]</td>
<td>G5 (fine)</td>
<td>98%</td>
</tr>
</tbody>
</table>

Note: Dimensions in inches (millimeters).

**Dimensions**

For the latest prices, please check AutomationDirect.com.

1-800-633-0405
Filter Fan Exhaust Grille Dimensions

Dimensions

118010-00

118020-00

For the latest prices, please check AutomationDirect.com.

www.automationdirect.com

Enclosures Thermal Management

tENC-391
Filter Fan Exhaust Grille Dimensions

Dimensions

118030-00

118210-00

For the latest prices, please check AutomationDirect.com.

1-800-633-0405
Filter Mats
- Synthetic fiber with progressive construction
- Temperature resistant to 212 °F (100°C)
- Rating: G3 (coarse), G4 (medium), and G5 (fine)
- Self-extinguishing class F1
- Moisture resistant to 100% RH
- Reusable: can be cleaned with mild soap or vacuuming

Applications
- Replacement filter mats for Stego series Filter Fan Plus, Filter Fan, and Stego series exhaust/intake grilles

Features
- Filter media for enclosure fans
- Fine or medium density
- Fits 3.82 x 3.82in [97 x 97 mm], 4.92 x 4.92in [125 x 125 mm], 6.93 x 6.93in [176 x 176 mm], or 9.84 x 9.84in [250 x 250 mm] Filter Fan
- Fits 3.62 x 3.62in [91.9mm], 4.88 x 4.88in [124 x 124 mm], 6.93 x 6.93 [176 x 176 mm], 8.78 x 8.78in [223 x 223 mm], and 11.46 x 11.46 in [2391 x 231 mm] inch Filter Fan Plus

### Replacement Filter Elements

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Price</th>
<th>Dimensions HxW in (mm)</th>
<th>Use With Filter Fan Part Number</th>
<th>Use With Intake or Exhaust Grille Part Number</th>
<th>Filter Rating</th>
<th>Average Arrestance (Filtering Level)</th>
<th>Filter Density g/m²</th>
<th>Pieces per Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>086330-00</td>
<td>$9.00</td>
<td>3.31 x 3.31 [84 x 84]</td>
<td>018700-30 018701-30 018702-30 018703-30 018709-30 018800-40 018809-40</td>
<td>118800-30</td>
<td>G3(coarse)</td>
<td>84%</td>
<td>200</td>
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<td>086340-00</td>
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<td>G3(coarse)</td>
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<td>G3(coarse)</td>
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<td>G3(coarse)</td>
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Note: Dimensions in inches [millimeters].

Table continued on next page
## Replacement Filter Elements

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Price</th>
<th>Dimensions HxW in (mm)</th>
<th>Use With Filter Fan Part Number</th>
<th>Use With Intake or Exhaust Grille Part Number</th>
<th>Average Arrestance (Filtering Level)</th>
<th>Filter Density g/m²</th>
<th>Pieces per Package</th>
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<tr>
<td>086000-00</td>
<td>$6.50</td>
<td>3.50 x 3.50 [89 x 89]</td>
<td>018000-01, 018000-02</td>
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<td>94% G4 (medium)</td>
<td>350</td>
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Note: Dimensions in inches [millimeters].
### Airflow and Pressure Data for Upgraded Filter Mats

<table>
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<th>Fan Part Number</th>
<th>Filter Mat Airflow (cfm)</th>
<th>Filter Mat Static Pressure (Pa)</th>
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<td>G4 fan filter*</td>
<td>G4 fan filter and exhaust filter**</td>
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<td>018000-02</td>
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<td>121</td>
</tr>
<tr>
<td>018740-30</td>
<td>250</td>
<td>212</td>
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<tr>
<td>018840-00</td>
<td>428</td>
<td>218</td>
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<tr>
<td>018840-40</td>
<td>300</td>
<td>153</td>
</tr>
</tbody>
</table>

Notes: *Fan with filter and louver
**Fan with filter, louver, exhaust filter, and grille.

Part numbers not listed in this table have no test data available.
Hose-Proof Hood for Stego Fans

**Features**
- Stainless steel hood
- Food-safe silicone seal
- Increase of protection class to UL Type 4X
- Easy to clean
- Filter mat change from outside
- Impact-resistant
- Optional security feature to restrict unauthorized access (M6x1 security screw included)
- Weather resistant
- Versatile
- Protective grid
- Mounting screws provided

**Applications**
- Designed to increase the protection class and serve as a protective cover to filter fans, intake and exit filters
- Used for protection against water projected by a hose and extreme climatic influences if located outdoors in industrial applications with harsh environmental conditions
- Hood removes easily for cleaning and filter change without opening the enclosure

**Standards**
- UL 4/4X when used with STEGO Filter Fan Plus and Filter Fans
- UL Recognized File No. E234324
- RoHS 2 compliant
- IP56

### Hose-Proof Hood for Stego Fans

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Price</th>
<th>Stego Filter Fan Plus FPI/FPO Cutout Size</th>
<th>Stego Filter Fan Cutout Size</th>
<th>Dimensions (H x W x D)</th>
<th>Max. Covered Area (X x Y)</th>
<th>Weight (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>086700-00</td>
<td>$137.00</td>
<td>3.62 x 3.62 [92 x 92]</td>
<td>3.82 x 3.82 [97 x 97]</td>
<td>8.42 x 7.67 x 1.88 [214 x 195 x 48]</td>
<td>5.27 x 5.63 [134 x 143]</td>
<td>1.76</td>
</tr>
<tr>
<td>086710-00</td>
<td>$167.00</td>
<td>4.88 x 4.88 [124 x 124]</td>
<td>4.92 x 4.92 [125 x 125]</td>
<td>11.00 x 8.92 x 2.39 [280 x 226 x 61]</td>
<td>6.39 x 6.75 [162 x 171]</td>
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<tr>
<td>086720-00</td>
<td>$198.00</td>
<td>6.93 x 6.93 [176 x 176]</td>
<td>6.93 x 6.93 [176 x 176]</td>
<td>14.01 x 11.44 x 2.68 [356 x 291 x 68]</td>
<td>9.19 x 9.19 [233 x 233]</td>
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<td>16.19 x 14.5 x 3.07 [411 x 388 x 78]</td>
<td>11.69 x 11.31 [297 x 287]</td>
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<td>$312.00</td>
<td>11.46 x 11.46 in [291 x 231 mm]</td>
<td>—</td>
<td>18.94 x 15.96 x 4.05 [481 x 405 x 103]</td>
<td>13.25 x 13.31 [337 x 338]</td>
<td>8.15</td>
</tr>
</tbody>
</table>

Notes: Dimensions in inches [millimeters].
None of the above models fit 018210-04 and 018210-02 outdoor filter fans.

**Dimensions**

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For the latest prices, please check AutomationDirect.com.