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

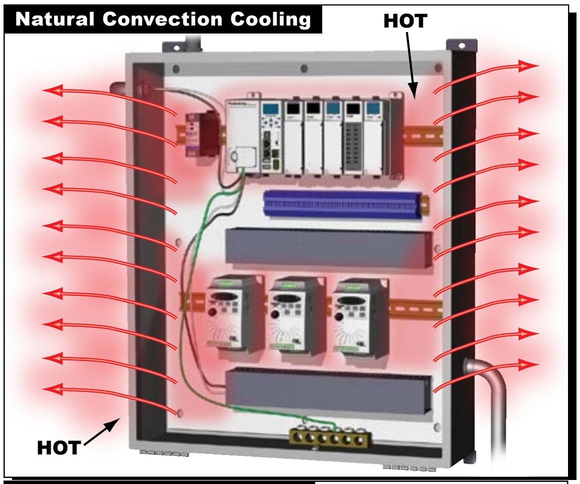
How do you get the heat out of your enclosure and away from those critical components? There are several basic cooling methods available, depending on the cooling requirements and the enclosure environment.

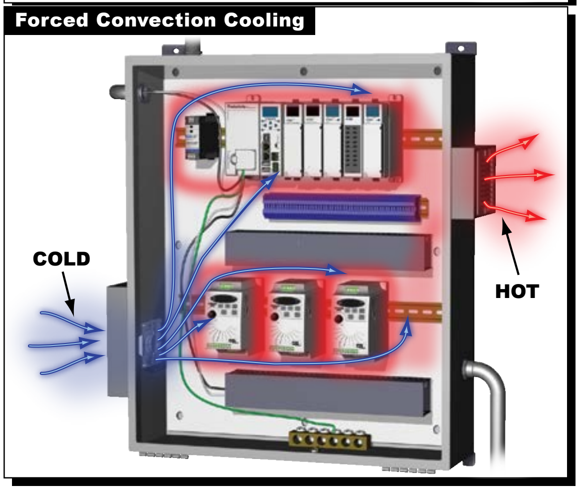
Radiation and Natural Convection Cooling

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

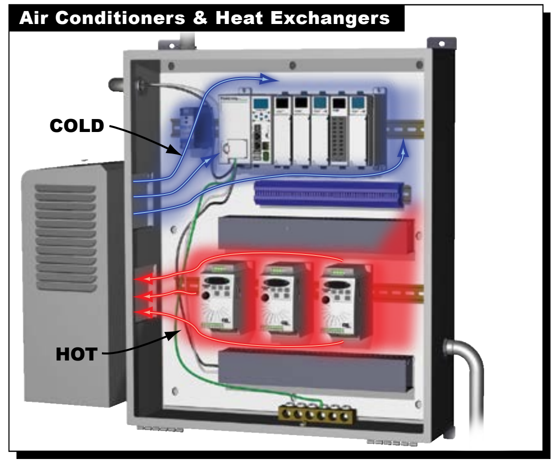
The next step up from natural convection is forced convection cooling. The basic cooling mechanism is the same: cooler air from outside the enclosure passes through the enclosure to remove the heat. The difference is that the air is mechanically forced through the enclosure by a filter fan. The fan produces 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

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 an air-to-air 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.

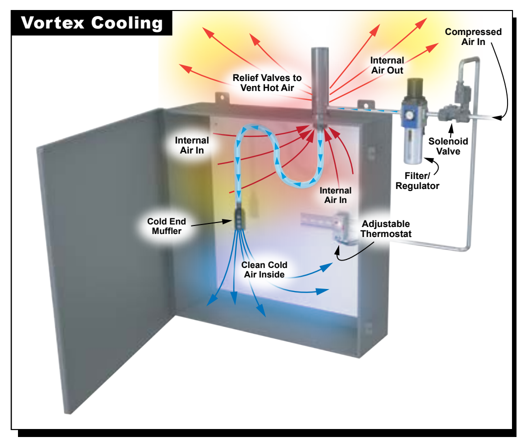
Heat exchangers are very efficient because the refrigeration system has no moving parts - the only moving parts are the fans. But for the heat to transfer through the system, the ambient air must be colder than the air inside the enclosure, just as it must be for filter fans.

If the ambient air temperature is too high, and a source of chilled water is available, then an air-to-water heat exchanger may be the ideal solution. Air-to-water heat exchangers use fans to blow across tubes with chilled water running through them. This creates a very effective closed loop cooling effect, but requires an external source of chilled water.

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

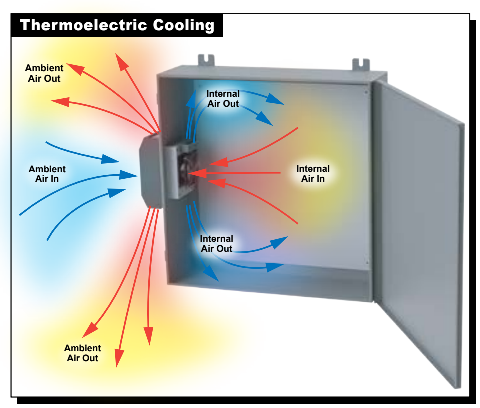


Vortex coolers create a stream of extremely cold air from a supply of filtered compressed air. The cold air is injected into the enclosure, displacing warm air which is exhausted back through the vortex cooler. While not a closed-loop system, they can be used in the same harsh environments since the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

Selecting an Enclosure Cooling Device

Cooling Basics

To select the proper cooling device for your enclosure, you need to determine how much heat the device must remove from the enclosure to maintain the desired internal temperature, which is the sum of two component heat loads: **Internal Heat Load** and **Heat Transfer Load**.

Internal Heat Load (Q_i)

The sum of all heat generated by the components within the enclosure. This can be calculated by adding the maximum heat output for each device installed in the enclosure (the worst-case conditions for the enclosure). The maximum heat output is typically specified in watts in the manufacturer's documentation. If it is not, contact the manufacturer to request the heat output or for guidance on how to measure or calculate it.

Heat Transfer Load (Q_x)

The heat gained (positive heat transfer) or lost (negative heat transfer) through the enclosure exterior surface with the surrounding ambient air. This can be calculated with the following formula:

$Q_x = kA\Delta T$ (BTU/h), where:

k = heat transfer coefficient (BTU/(h·ft²·°F))

The heat transfer coefficient is a measure of how easily an enclosure conducts heat from the internal air to the external air, which varies with the enclosure material. Suggested values for various enclosure materials are provided below:

Enclosure Material	*k, BTU/(h·ft²·°F)*
Painted carbon steel	0.97
Stainless steel	0.83
Aluminum	2.1
Polycarbonate, fiberglass, PVC, ABS	0.62

A = exposed enclosure surface area (ft^2)

The total surface area of a rectangular enclosure is:

A = 2HW + 2HD + 2WD, where:

H = height

W = width

D = depth

But it's important to properly account for any surfaces that are against walls or floors, as those surfaces will absorb/reject heat from adjacent surfaces at a different rate (that is, have a different k value) than the exposed surfaces. Quantifying that difference is far beyond the scope of this document, but the q value for those surfaces will usually be less than the value for exposed surfaces. Therefore, the conservative design approach should be to ***exclude those surfaces when $\Delta T < 0$ and use the total surface area when $\Delta T > 0$.***

The equations for excluding those surfaces in several common situations are listed below.

Wall-mount (excludes back of the enclosure)	*A = HW + 2HD + 2WD*
Freestanding enclosure (excludes the bottom of the enclosure)	*A = 2HW + 2HD + WD*
Freestanding enclosure against a wall (excludes both the bottom and back)	*A = HW + 2HD + WD*
Freestanding enclosure in a corner (excludes the bottom, back, and one side)	*A = HW + HD + WD*

Using these formulas as written will produce answers in either in^2 or mm^2, depending on the enclosure. To convert to ft^2 use the appropriate conversion:

$1\ ft^2 = 144\ in^2$

$1\ ft^2 = 92{,}900\ mm^2$

Selecting an Enclosure Cooling Device

ΔT = T_A – T_E , where T_A is maximum ambient air temperature (°F) and T_E is maximum allowable enclosure air temperature (°F)

Note that ΔT may be negative if the ambient temperature is less than the enclosure temperature. When this is the case, the heat transfer load will also be negative, meaning that the ambient air is providing some degree of cooling. Whereas a positive ΔT indicates that the ambient air is warming the enclosure.

A positive ΔT also indicates that neither a fan nor a heat exchanger is a viable cooling device for this application. Both devices exchange heat between the interior and exterior of the enclosure. Since heat will always move from the higher temperature material to the lower temperature, these devices will add heat to the enclosure which will raise the internal air temperature, not lower it.

The maximum allowable enclosure air temperature will typically be dictated by the maximum operating temperature of the components inside the enclosure. Be sure to choose the component value with the lowest maximum operating temperature.

Required Cooling Capacity (Q_r)

The required cooling capacity (Q_r) for an enclosure is simply the sum of the Internal Heat Load and the Heat Transfer Load. However, as presented these values cannot be simply added since one is typically given in watts and the other in BTU/h. Additionally, fan and heat exchanger sizing formulas require the total heat load in watts, while the cooling capacities of vortex coolers are generally expressed in BTU/h. However, the cooling capacities of air conditioners and thermoelectric coolers may be expressed in either unit, or sometimes both. Apply one of the following conversions to the heat loads to add them:

1 W = 3.41 BTU/h Q_r ***(BTU/h) =*** Q_i ***x 3.41 (BTU/h)/W +*** Q_x

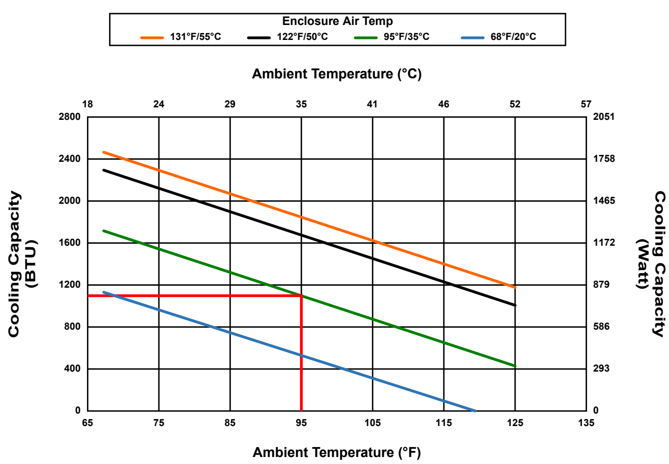
1 BTU/h = 0.293 W Q_r ***(W) =*** Q_i ***+*** Q_x ***x 0.293 W/(BTU/h)***

Vortex Cooler Selection

Once the required cooling capacity has been calculated, selection of a vortex cooler is simple – just select a cooler with a nominal cooling capacity greater than the calculated requirement.

Air Conditioner, Air-to-Water Heat Exchanger, and Thermoelectric Cooler Selection

Selecting an air conditioner, air-to-water heat exchanger, or thermoelectric cooler is more complex because their performance depends on both the ambient temperature and the enclosure temperature or the chilled water temperature. Generally, more strenuous operating parameters (higher ambient temperature, lower enclosure air temperature) will reduce the unit's performance. For this reason, manufacturers publish curves that graphically describe the unit's cooling capacity over a range of conditions. Here's an example:



As indicated by the red lines, this air conditioner would be able to remove 1000 BTU/H when the ambient temperature is 95°F and enclosure air temperature is 95°F. If the ambient temperature was only 75°F, the cooling capacity of the unit would increase to approximately 1105 BTU/H as the lower ambient temperature increases the unit's condenser's ability to reject heat to the surrounding atmosphere. Conversely, at a 95°F ambient temperature and a 68°F enclosure air temperature, the unit's capacity would be reduced to approximately 945 BTU/H, as the lower enclosure air temperature would reduce the heat transfer rate between the internal enclosure air and the unit's evaporator coils.

An air-to-water heat exchanger performance curve is similar only the x-axis is the temperature of the chilled water provided to the heat exchanger instead of the ambient air temperature.

To determine if an air conditioner, air-to-water heat exchanger, or thermoelectric cooler meets application requirements, simply plot the two maximum temperatures used in the ΔT calculations and read the corresponding cooling capacity on the y-axis of the chart. If that value exceeds the required cooling capacity, the air conditioner will be adequate for the application. If not, select a larger capacity unit.

Selecting an Enclosure Cooling Device

The 95°F/95°F point is typically used as the nominal cooling capacity of the unit. But always keep in mind that any nominal capacity only represents one set of operating parameters. If those parameters to not match the actual application conditions, the actual performance of the air conditioner/thermoelectric cooler will be different.

> Never rely solely on a nominal cooling capacity when selecting an air conditioner or a thermoelectric cooler! The nominal capacity is solely intended to provide an approximation to get the user "in the ballpark" of the selection process.

In addition to the required cooling capacity, an air conditioner, air-to-water heat exchanger, or thermoelectric cooler should also maintain the NEMA rating of the enclosure. Ideally, it should also operate on a voltage already available within the enclosure to avoid necessitating a transformer or power supply.

Air Conditioner Selection Example

A NEMA 12 Wiegmann N12302412 wall-mount enclosure (30 in high x 24 in wide x 12 in deep) contains a GS4-4060 AC drive (60 HP 460V) that has a maximum allowable operating temperature of 104°F and is inside a plant with a maximum ambient air temperature of 115°F. The GS4-4060 specifications table indicates its maximum Watt Loss to be 1147 W.

Internal heat load:

$$Q_i = 1147\ W \times 3.413\ (BTU/h)/W = 3914\ BTU/h$$

Heat load transfer:

$$k = 0.97\ BTU/(h \cdot ft^2 \cdot °F)$$

$$\Delta T = 115°F - 104°F = 11°F$$ (Reminder: ΔT >0 means that fans or heat exchangers will not cool the enclosure!)

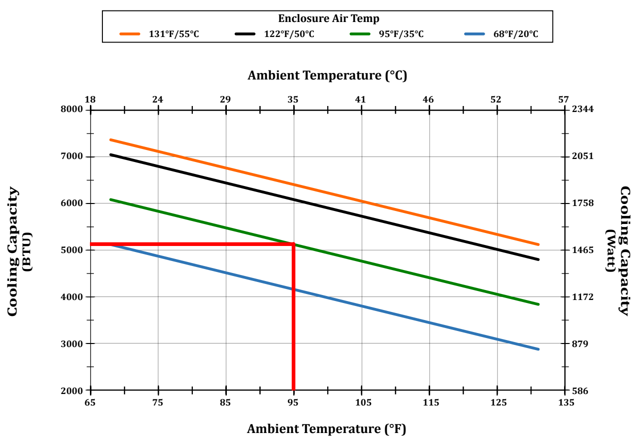
$$A = [2(30\ in \times 24\ in) + 2(30\ in \times 12\ in) + 2(24\ in \times 12\ in)]/144\ in^2/ft^2 = 19\ ft^2$$

$$Q_x = kA\Delta T = (0.97\ BTU/(h \cdot ft^2 \cdot °F))(19\ ft^2)(11°F) = 202\ BTU/h$$

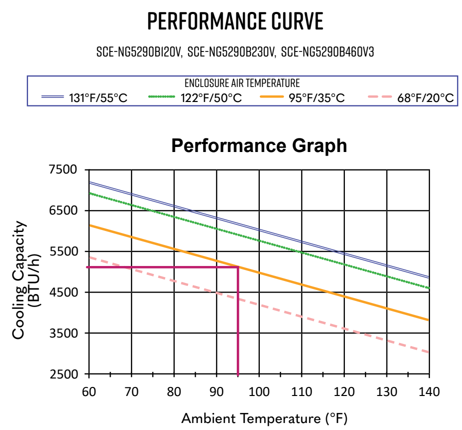
Required cooling capacity:

$$Q_r = Q_i + Q_x = 3914\ BTU/h + 202\ BTU/h = 4116\ BTU/h$$

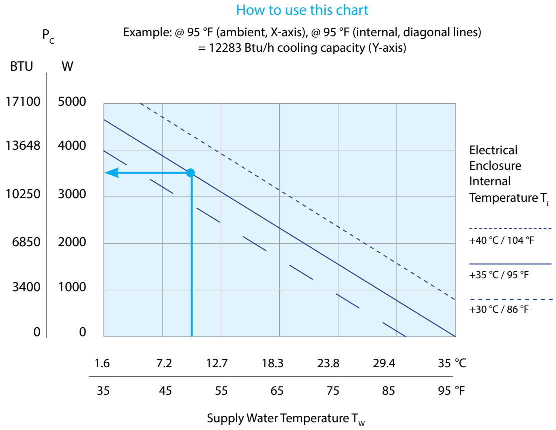
AutomationDirect offers several NEMA 12 460VAC models that meet or exceed 4605 BTU/h at 104°F. The curves for the appropriate sizes of some of these series are shown below.



The NEMA 12 460VAC selection from this series is SCE-AC5100B460V.



The NEMA 12 460VAC selection from this series is SCE-NG5290B460V3.



The NEMA 12 115VAC air-to-water heat exchanger 12358410045 will work as long as chilled water at least 65°F is readily available

Selecting an Enclosure Cooling Device

Air-to-Air Heat Exchanger Selection

Air-to-Air Heat exchanger capacities also depend on the internal enclosure air temperature and the ambient temperature, but the dependency is a simple linear relationship between the capacity and ΔT. So rather than graphing the cooling capacity of the heat exchanger, it is simply expressed in terms of W/°C and compared to the value of $-Q_r/\Delta T$.

To convert ΔT from °F to °C, use the conversion 1°C = 1.8°F.

Note that this simplified conversion only works for temperature differences. It does not work for measured temperatures since 0°F ≠ 0°C. DO NOT apply this conversion directly to the ambient and enclosure air temperatures. Only apply it to ΔT.

Air-to-Air Heat Exchanger Selection Example

A NEMA 12 Wiegmann N12302412 wall-mount enclosure (30 in high x 24 in wide x 12 in deep) contains a GS4-4010 AC drive (10 HP 460 volt) that has a maximum allowable operating temperature of 104°F and is in a plant that has a maximum ambient air temperature of 90°F.

The GS4-4010 specifications table indicates its maximum Watt Loss to be 292 watts.

Internal heat load:

$Q_i = 292\ W$

Heat load transfer:

$k = 0.97\ BTU/(h\cdot ft2\cdot °F)$

$\Delta T = 90°F – 104°F = -14°F$ (Since ΔT <0, a heat exchanger is a potentially valid cooling device)

$\Delta T = -14°F/(1.8°F/°C) = -7.8°C$

$A = [(30\ in \times 24\ in) + 2(30\ in \times 12\ in) + 2(24\ in \times 12\ in)]/144\ in^2/ft^2 = 14\ ft^2$

$Q_x = kA\Delta T = (0.97\ BTU/(h\cdot ft^2\cdot °F))(14\ ft^2)(-14°F) = -190\ BTU/h \times 0.293\ W/(BTU/h) = -56\ W$

Required cooling capacity:

$Q_r = Q_i + Q_x = 292\ W - 56\ W = 236\ W$

$-Q_r/\Delta T = -236\ W/-7.8°C = 30\ W/°C$

A Stratus heat exchanger with a capacity of at least 30 W/°C is needed, such as a TE30-030-17-04.

Selecting an Enclosure Cooling Device

Fan Selection

A fan cools the enclosure simply by displacing the hot air within the enclosure with cooler air from the outside. Combining the specific heat of air, the density of air, and various conversion factors into a single coefficient gives a simple equation for correlating a fan's required airflow rate to the enclosure's required cooling capacity:

$$F_r = -(3.17\ CFM{\cdot}°F/W)Q_r / \Delta T$$

Once the fan airflow requirement is determined, fan selection is simply a matter of finding a fan with an airflow greater than the required airflow. Most applications will require an accompanying grille and one or more filters which will restrict airflow to some degree. (Exceptions would be a NEMA 1 enclosure or a similar circumstance where an open vent can be used for exhaust/makeup air.) Therefore, the fan selection should almost always be made based on the "Airflow with Grille and Filters (CFM)" column of the specifications, not the fan's Free Airflow.

Fan Selection Example

A NEMA 12 Wiegmann N12302412 wall-mount enclosure (30 in high x 24 in wide x 12 in deep) contains a GS4-2025 AC drive (25 HP 230 volt) that has a maximum allowable operating temperature of 104°F and is in a plant that has a maximum ambient air temperature of 92°F.

The GS4-2025 specifications table indicates its maximum Watt Loss to be 733 watts.

Internal heat load:

$$Q_i = 733\ W$$

Heat load transfer:

$$k = 0.97\ BTU/(h{\cdot}ft^2{\cdot}°F)$$

$$\Delta T = 92°F - 104°F = -12°F \text{ (Since } \Delta T < 0\text{, a fan is a potentially valid cooling device)}$$

$$A = [(30\ in \times 24\ in) + 2(30\ in \times 12\ in) + 2(24\ in \times 12\ in)]/144\ in^2/ft^2 = 14\ ft^2$$

$$Q_x = kA\Delta T = (0.97\ BTU/(h{\cdot}ft^2{\cdot}°F))(12\ ft^2)(-12°F) = -163\ BTU/h \times 0.293\ W/(BTU/h) = -48\ W$$

Required cooling capacity:

$$Q_r = Q_i + Q_x = 733\ W - 48\ W = 685\ W$$

Required air flow:

$$F_r = -(3.17\ CFM{\cdot}°F/W)(685\ W)/-12°F = 181\ CFM$$

Possible 230VAC fan & grille combinations include:

- Stego 018840-40 exhaust fan with 118840-30 grille (187 CFM)
- Fandis FF20A230UE1 intake fan with FF20U grille (209 CFM)
- Stego 018740-30 intake fan with 118740-00 grille (220 CFM)
- Stego 018840-00 exhaust fan with 118840-30 grille (243 CFM)
- Fandis TP19U230B1 roof-mount exhaust fan with FF20U grille (297 CFM)

Filter Fan Options for Cooling your Enclosure

- 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 Series

- 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 Series

- 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

Virdis Series

- Cover slides open for easy filter change without tools
- Available in NEMA 12 indoor models and NEMA 3R outdoor models
- Flammability Rating: at least UL 94V-0
- Quick, tool-free mounting
- Low noise
- 120VAC , 230VAC and 24VDC models available
- Includes self-adhesive gasket pre-installed on frame
- G3 (coarse) and G4 (coarse) replacement filter mats available

Filter Fan Hoods

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

Virdis Series Filter Fans

Fandis

Applications

Virdis Series Filter fans are a practical solution for removing heat from the cabinet. They channel filtered ambient air into the enclosure, expelling warm internal air through an exhaust filter or roof unit to reduce temperatures and protect electronic components from overheating.

Features

- Cover slides open for easy filter change without tools
- No-screw installation
- Low noise
- 120VAC, 230VAC, and 24VDC models available
- Permanent Polyurethane sealing gasket
- G3 (coarse) and G4 (coarse) replacement filter mats available

Easy Filter Access

Tool Free Mounting System

Virdis Series NEMA 12 Filter Fans

Fandis

Applications

NEMA 12 filter fans are for indoor use only. They are typically mounted on the side or the door of an enclosure, but can be mounted on the bottom surface of a wall-mounted enclosure. They should not be mounted on the roof of an enclosure. Fan airflow direction is from outside to inside the enclosure. A grille or roof vent with an equal or larger cutout is required to exhaust the warm air from the inside of the enclosure.

Features

- Available in ANSI 61 gray and RAL 7035 light gray
- Average arrestance: 85% with included G3 (coarse) filter
- Connection Type- 8.8-9.4 CFM is 22AWG flying leads, all others are 20-14AWG screwless cage clamps
- G3 (coarse) and G4 (coarse) replacement filter mats available
- Flammability Rating: UL 94V-5VB for ANSI 61 units, RAL 7035 units are rated UL94V-V0

Agency Approvals

- All models: IP54 and UL Type 12 when using supplied filter
- UL Recognized File E237844
- UL Listed File E500932
- CSA Certified File 260922

Virdis Series NEMA 12 Filter Fans

Part Number	Price	Color	Cutout Dimensions	Operating Voltage[1]	Power Consumption[1] (W)	Current Draw[1]	FreeAirflow[1,2] (CFM)	Air Flow with Grille and Filters[1,3] (CFM)	Max. Static Pressure (Pa)	Min/Max Operating Temp.	L10 Life Expectancy	Drawing Link
FF08A115UN	$66.00	RAL 7035	3.62 x 3.62 [92 x 92]	115 VAC	9	92 mA	8.8	6.5	33	14/131°F [-10/55°C]	50,000 h at 68°F	PDF
FF08A115ZN	$70.00	ANSI 61				92 mA						PDF
FF08A230UN	$66.00	RAL 7035		230 VAC	10	50 mA						PDF
FF08D24UN	$72.00	RAL 7035		24 VDC	2	85 mA	9.4	6.8	28		100,000 h at 77°F	PDF
FF08D24ZN	$77.00	ANSI 61				85 mA						PDF
FF12A115UF	$81.00	RAL 7035	4.88 x 4.88 [124 x 124]4.88 x 4.88 [124 x 124]	115 VAC	16	180 mA	29	20	62		57,000 at 77°F	PDF
FF12A115ZF	$83.00	ANSI 61				180 mA						PDF
FF12A230UF	$81.00	RAL 7035		230 VAC	17	100 mA						PDF
FF12D24UN	$86.00	RAL 7035		24 VDC	7	310 mA	27	19	58		100,000 h at 77°F	PDF
FF12D24ZN	$88.00	ANSI 61			7	310 mA						PDF
FF13PA115UF	$114.00	RAL 7035	6.97 x 6.97 [177 x 177]	115 VAC	19	202 mA	65	44	60		57,000 at 77°F	PDF
FF13PA115ZF	$121.00	ANSI 61				202 mA						PDF
FF13PA230UF	$114.00	RAL 7035		230 VAC	18	100 mA						PDF
FF13PD24UN	$164.00	RAL 7035		24 VDC	8	342 mA	59	45	62		100,000 h at 77°F	PDF
FF13PD24ZN	$174.00	ANSI 61				342 mA						PDF
FF15A115UN2	$159.00	RAL 7035	8.78 x 8.78 [223 x 223]	115 VAC	41	361 mA	155	120	184		40,000 h at 104°F	PDF
FF15A115ZN2	$169.00	ANSI 61				361 mA						PDF
FF15A230UN2	$159.00	RAL 7035		230 VAC		194 mA	159		195			PDF
FF15D24UF	$262.00	RAL 7035		24 VDC	31	1.30A	175	118	156		70,000 h at 104°F	PDF
FF15D24ZF	$278.00	ANSI 61		24 VDC		1.30A						PDF

Notes: 1.Performance data (current draw, power consumption, free airflow, airflow with grille and filters, sound level) for all 120VAC fans is based on 60Hz.
2.Free airflow and maximum static pressure are measured with fan only.
3.Airflow with grille and filters include entire system: complete fan assembly with filter and exhaust grille with filter.
4.Dimensions in inches [millimeters].

Virdis Series NEMA 12 Filter Fans

Virdis Series NEMA 12 Filter Fans

Part Number	Price	Color	Cutout Dimensions	Operating Voltage[1] (VAC)	Power Consumption[1] (W)	Current Draw[1]	FreeAirflow[1,2] (CFM)	Air Flow with Grille and Filters[1,3] (CFM)	Max. Static Pressure (Pa)[1,2]	Min/Max Operating Temp.	L10 Life Expectancy	Drawing Link
FF20A115UE1	$279.00	RAL 7035	11.46 x 11.46 [291 x 291]	115	83	730 mA	297	209209 CFM	145	14/131°F [-10/55°C]14/131°F [-10/55°C]	63,000 h at 77°F	PDF
FF20A115ZE1	$296.00	ANSI 61										PDF
FF20A230UE1	$254.00	RAL 7035		230	116	350 mA						PDF
FF20GA115UE1	$313.00	RAL 7035		115	156	1.37A	436	253	170		53,000 h at 77°F	PDF
FF20GA115ZE1	$332.00	ANSI 61										PDF
FF20GA230UE1	$290.00	RAL 7035		230	158	690 mA	450	277	210			PDF

Notes: 1.Performance data (current draw, power consumption, free airflow, airflow with grille and filters, sound level) for all 120VAC fans is based on 60Hz.
2.Free airflow and maximum static pressure are measured with fan only.
3.Airflow with grille and filters include entire system: complete fan assembly with filter and exhaust grille with filter.
4.Dimensions in inches [millimeters].

Virdis Series NEMA 3R Filter Fans

Fandis

Applications

NEMA 3R filter fans are specifically designed to preserve the integrity of components housed within an electrical enclosure located outdoors, providing a degree of protection from falling dirt, dust, rain, sleet and from damage caused by the formation of ice.

NEMA 3R filter fans are constructed to ensure greater resistance to degradation due to environmental factors, including a durable plastic construction that allows direct sunlight or water exposure without the risk of premature aging.

Fan airflow direction is from outside to inside. A grille or roof vent with an equal or larger cutout is required to exhaust the warm air from the inside of the enclosure.

Features

- Available in RAL9005 Black
- Average arrestance: 85% with included G3 (coarse) filter
- Connection Type- 8.8-9.4 CFM units are 22AWG flying leads, all others are 20-14AWG screwless cage clamps
- G3 (coarse) and G4 (coarse) replacement filter mats available

Agency Approvals

- All models: IP54 and UL Type 12 when using supplied filter
- UL Recognized File E237844
- UL Listed File E500932
- CSA Certified File 260922

Virdis Series NEMA 3R Filter Fans

Part Number	Price	Cutout Dimensions	Operating Voltage[1]	Power Consumption[1] (W)	Current Draw[1]	FreeAirflow[1,2] (CFM)	Air Flow with Grille and Filters[1,3] (CFM)	Max. Static Pressure (Pa)	Min/Max Operating Temp.	L10 Life Expectancy	Drawing Link
FF08A115NN3	$117.00	3.62 x 3.62 [92 x 92]	115 VAC	9	92 mA	8.8	6.5	33	14/131°F [-10/55°C]	50,000 h at 68°F	PDF
FF08D24NN3	$126.00		24 VDC	2	85 mA	9.4	6.8	28		100,000 h at 77°F	PDF
FF12A115NF53	$149.00	4.92 x 4.92 [125 x 125]	115 VAC	16	180 mA	23	15	51		57,000 h at 77°F	PDF
FF12D24NN53	$167.00		24 VDC	7	310 mA	21	14	51		100,000 h at 77°F	PDF
FF15A115NF53	$228.00	8.78 x 8.78 [223 x 223]	115 VAC	31	260 mA	112	81	131		40,000 h at 104°F	PDF
FF15D24NF53	$331.00		24 VDC		1.30A	135	91	150		70,000 h at 104°F	PDF
FF20A115NE531	$364.00	11.46 x 11.46 [291 x 291]	115 VAC	83	730 mA	235	162	125		53,000 h at 77°F	PDF
FF20GA115NE31	$472.00			156	1.37A	436	253	170		63,000 h at 77°F	PDF

Notes: 1.Performance data (current draw, power consumption, free airflow, airflow with grille and filters, sound level) for all 120VAC fans is based on 60Hz.
2.Free airflow and maximum static pressure are measured with fan only.
3.Airflow with grille and filters include entire system: complete fan assembly with filter and exhaust grille with filter.
4.Dimensions in inches [millimeters].

Virdis Series NEMA 12 or 3R Exhaust Grilles

Applications

Grilles may be used for: warm-air exhaust when paired with a filter fan, make-up air intake when paired with a reverse-flow (exhaust) filter fan or a roof-mount fan, and free flow ventilation when used as a standalone item.

Grilles are typically mounted on the side or the door of an enclosure, but can be mounted on the bottom surface of a wall-mounted enclosure. They should never be mounted on the roof of an enclosure Grilles may be used in NEMA 4 and/or NEMA 4X applications with the addition of a fan hood.

Features

- Cover slides open for easy filter change without tools
- Quick, tool-free mounting
- Availibe in RAL 7035 Light Gray, ANSI 61 Gray and RAL 9005 Black

Standards

- IP54 and UL 12 and 3R when using supplied filter (outdoor models IP55)
- UL E234324
- UL Listed File E500932
- CSA Certified File 260922

Virdis Series NEMA 12 or 3R Exhaust Grills

Part Number	Price	Color	Cutout Dimensions	NEMA Rating	Drawing Link
FF08U	$21.00	RAL 7035	3.62 x 3.62 [92 x 92]	12	PDF
FF08Z	$22.50	ANSI 61		12	PDF
FF08N3	$52.00	RAL 9005		3R	PDF
FF12U	$23.50	RAL 7035	4.88 x 4.88 [124 x 124]	12	PDF
FF12Z	$25.00	ANSI 61		12	PDF
FF12N53	$61.00	RAL 9005	4.92 x 4.92 [125 x 125]	3R	PDF
FF13U	$28.00	RAL 7035	6.97 x 6.97 [177 x 177]	12	PDF
FF13Z	$30.00	ANSI 61		12	PDF
FF15U	$34.50	RAL 7035	8.78 x 8.78 [223 x 223]	12	PDF
FF15Z	$36.50	ANSI 61		12	PDF
FF15N53	$85.00	RAL 9005		3R	PDF
FF20U	$56.00	RAL 7035	11.46 x 11.46 [291 x 291]	12	PDF
FF20Z	$59.00	ANSI 61		12	PDF
FF20N53	$117.00	RAL 9005		3R	PDF

Note: Dimensions in inches (millimeters).

Virdis Series NEMA 12 Roof Fans and Vents

Fandis

Applications

Roof exhaust units are commonly used in restricted spaces to dissipate hot air that is extracted from the top of enclosures.

These units can be provided with an exhaust filter for either convection cooling or forced air-cooling in combination with a fan.

Roof Fans

Roof fans provide an alternative where a conventional side-mounted filter fan is impractical due to tight spaces in or around the sides of the enclosure. Fan airflow direction is from inside to outside. A grille with an equal or larger cutout is required to provide make-up air to replace the warm air exhausted by the fan.

Roof Vents

Roof vents are used for exhaust of hot air from inside the enclosure where tight spaces in or around the sides of an enclosure preclude the use of a grille. Roof vents may provide natural convection ventilation when used alone, or facilitate forced air cooling when paired with a filter fan.

Features

- Mate with any plate thickness via eight mounting screws.
- Colored RAL 7035 Gray
- Permanent Polyurethane sealing gasket

Standards

- UL recognized — file: E234324
- UL Listed File E500932
- CSA Certified File 260922

Virdis Series NEMA 12 Roof Fans

Part Number	Price	IP Rating	Cutout Dimensions	Operating Voltage1 (VAC)	Power Consumption1 (W)	Current Draw1 (MA)	FreeAirflow1,2 (CFM)	Air Flow with Grille and Filters1,3 (CFM)	Max. Static Pressure (PA)	Min/Max Operating Temp.	L10 Life Expectancy	Drawing Link
TP19U115B541	$336.00	IP54	6.89 x 6.89 [175 x 175]	115	97	850	288	259	480	14/131°F [-10/55°C]	48,000 h at 77 °F	PDF
TP19U115B1	$317.00	IP24		115	97	850	338	297	565		70,000 H AT 77 °F	PDF
TP19U230B1		IP24		230	81	360	338	297	465		62,500 H AT 77 °F	PDF

Notes: 1.Performance data (current draw, power consumption, free airflow, airflow with grille and filters, sound level) for all 120VAC fans is based on 60Hz.
2.Free airflow and maximum static pressure are measured with fan only.
3.Airflow with grille and filters include entire system: complete fan assembly with filter and exhaust grille with filter.
4.Dimensions in inches [millimeters].

Virdis Series NEMA 12 Roof Vents

Part Number	Price	IP Rating	Cutout Dimensions	Drawing Link
TP19U551	$188.00	IP55	6.89 x 6.89 [175 x 175]	PDF

Note: Dimensions in inches (millimeters).

Virdis Series Replacement Filters

Fandis

Filters

- The filter media are made of high performance nonwovens produced from elastic, break-resistant polyolefin fibers with thermal bonding.
- Rating: G3 (coarse), and G4 (coarse)
- The filter media can be cleaned, up to 10 times, by careful washing, blowing dry and lightly beating

Applications

- Replacement filter mats for Fandis Virdis series filter fans and grilles

Virdis Series Replacement Filters

Part Number	Price	Use With Filter Fan Part Number	Use With Grille Part Number	Filter Rating	Average Arrestance (Filtering Level)	Filter Density g/m2	Pieces per Package
M08FPFK	$11.50	FF8A115UN, FF8A115ZN FF8A115NN3, FF8A230UN FF8D24UN, FF8D24ZN, FF8D24NN3	FF08U, FF08Z, FF08N3	G3 (coarse)	85%	600 g/m2	6
M12FPF5K	$17.00	FF12A115UF, FF12A115ZF FF12A115NF53, FF12A230UF, FF12D24UN, FF12D24ZN FF12D24NN53	FF12U, FF12Z, FF12N3	G4 (coarse)	94%		6
M12FPFK	$15.00	FF12A115UF, FF12A115ZF, FF12A115NF53, FF12A230UF, FF12D24UN, FF12D24ZN FF12D24NN53	FF12U, FF12Z, FF12N3	G3 (coarse)	85%		6
M13FPFK	$20.00	FF13PA115UF, FF13PA115ZF FF13PA230UF, FF13PD24UN FF13PD24ZN	FF13U, FF13Z	G3 (coarse)	85%		6
M15FPF5K	$29.50	FF15A115UN2, FF15A115ZN2, FF15A115NF53, FF15A230UN2 FF15D24UF, FF15D24ZF FF15D24NF53	FF15U, FF15Z, FF15N3	G4 (coarse)	94%		6
M15FPFK	$26.00	FF15A115UN2, FF15A115ZN2, FF15A115NF53, FF15A230UN2 FF15D24UF, FF15D24ZF FF15D24NF53	FF15U, FF15Z, FF15N3	G3 (coarse)	85%		6
M20FPF5K	$39.50	FF20A115UE1, FF20A115ZE1 FF20A115NE531, FF20A230UE1	FF20U, FF20Z, FF20N3	G4 (coarse)	94%		6
M20FPFK	$34.00	FF20A115UE1, FF20A115ZE1 FF20A115NE531, FF20A230UE1	FF20U, FF20Z, FF20N3	G3 (coarse)	85%		6
M20FPF-EU3RMK	$75.00	FF20GA115UE1, FF20GA115ZE1 FF20GA115NE531, FF20GA230UE1	FF20U, FF20Z, FF20N3	G3 (coarse)	85%		2