

Enclosure Cooling – Selecting an Air-to-Air Heat Exchanger

Air-to-Air 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)

Delta T = 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.) = $2 [(H \times W) + (H \times D) + (W \times D)] / (144 \text{ sq. inches/sq. ft.})$

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

Heat Load Transfer (W/°F) = $0.22 \text{ W/°F sq. ft.} \times \text{surface area}$

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) = $\text{Internal Heat Load} / \Delta T - \text{Heat Load Transfer}$

Air-to-Air 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

Delta T:

$\Delta T (^{\circ}\text{F}) 104^{\circ}\text{F} - 90^{\circ}\text{F} = 14^{\circ}\text{F}$

Heat load transfer:

Surface Area (ft.2) = $2 [(30 \times 24) + (30 \times 12) + (24 \times 12)] / 144 \text{ sq. inches} = 19 \text{ ft.2}$
Heat Load Transfer = $0.22 \times 19 \text{ ft}^2 = 4.2 \text{ Watts/}^{\circ}\text{F}$

Cooling capacity:

Cooling Capacity = $345 \text{ Watts} / 14^{\circ}\text{F} - 4.2 \text{ Watts/}^{\circ}\text{F} = 20.4 \text{ Watts/}^{\circ}\text{F}$

In this example, you are able to determine that a heat exchanger, with a capacity of at least 20.4 Watts/°F is needed, such as a Stratus TE30-030-17-04 or a Saginaw Enviro-Therm SCE-HE24W120V.

*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.

Air To Air Heat Exchangers



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



Tall, compact, and deep body styles shown

Air to Air Heat Exchange

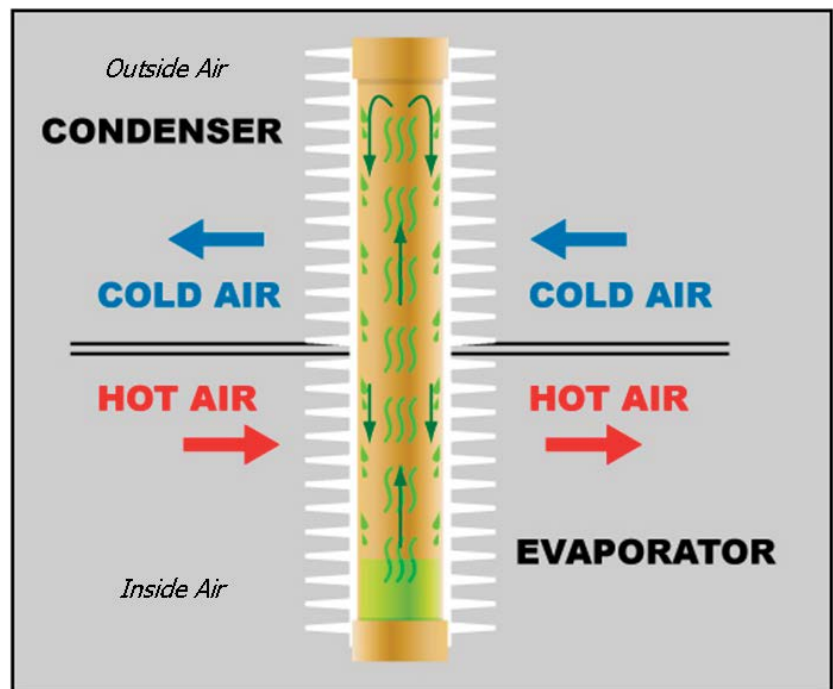
The Air to Air Heat Exchanger is a closed loop cooling system which employs the heat pipe principle to exchange heat from an electrical enclosure to the outside. Where ambient temperatures are suitable for heat pipes, they are the most efficient method of cooling as the waste heat is the engine which 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.

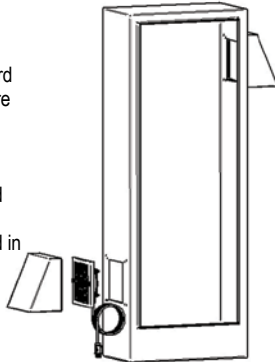
The units use aluminum end plates and baffles which improve conduction and reduce corrosion for longer life. The center aluminum baffle, which is swaged into the heat pipe coil, provides an air tight seal between the two air systems.



Air To Air Heat Exchanger Specifications



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 General Specifications

Part Number	TE20-015-17-04	TE20-015-17-4X	TE20-015-24D-04	TE20-015-24D-4X	TE30-030-17-04	TE30-030-17-4X	TE30-030-24D-04	TE30-030-24D-4X	TE40-050-17-04	TE40-050-17-4X	TE40-050-24D-04	TE40-050-24D-4X
Price	\$1,800.00	\$1,881.00	\$1,853.00	\$1,933.00	\$1,860.00	\$1,996.00	\$1,912.00	\$2,043.00	\$2,433.00	\$2,530.00	\$2,560.00	\$2,657.00
Operating Voltage Range (V)	± 10%											
Inrush Current (Start Up Current) (A)	1.92		3.90		1.92		3.90		2.59		9.70	
Loading Current (Running Current) (A)	0.37		0.80		0.37		0.80		0.47		1.94	
SCCR (Short Circuit Current Rating) (A)	Refer to Footnote 1											
Recommended Circuit Protection Device Rating (A)	1.5		2.5		1.5		2.5		2		6	
VA Rating (W)	42		20		42		20		56		47	
Refrigerant Type (oz)	Methanol (0.41)		Methanol (0.41)		Methanol (0.81)				Methanol (1.22)			
Watts/°C (F°)	22 (12)				44 (24)				71.6 (40)			
Free Air Flow (CFM)	131		127		131		127		211		235	
Weight Without Packaging (lbs)	16				19				32			
Body Style	compact				deep				tall			
Material Type	2CRS with ANSI 61 gray powder coat	3Stainless Steel	2CRS with ANSI 61 gray powder coat	3Stainless Steel	2CRS with ANSI 61 gray powder coat	3Stainless Steel	2CRS with ANSI 61 gray powder coat	3Stainless Steel	2CRS with ANSI 61 gray powder coat	3Stainless Steel	2CRS with ANSI 61 gray powder coat	3Stainless Steel
Voltage/Hz	120 VAC 50/60		24 VDC		120 VAC 50/60		24 VDC		120 VAC 50/60		24 VDC	
Maximum Ambient Temperature	160°F (71.1°C)											
Agency Approval	UL File: SA34086											

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.

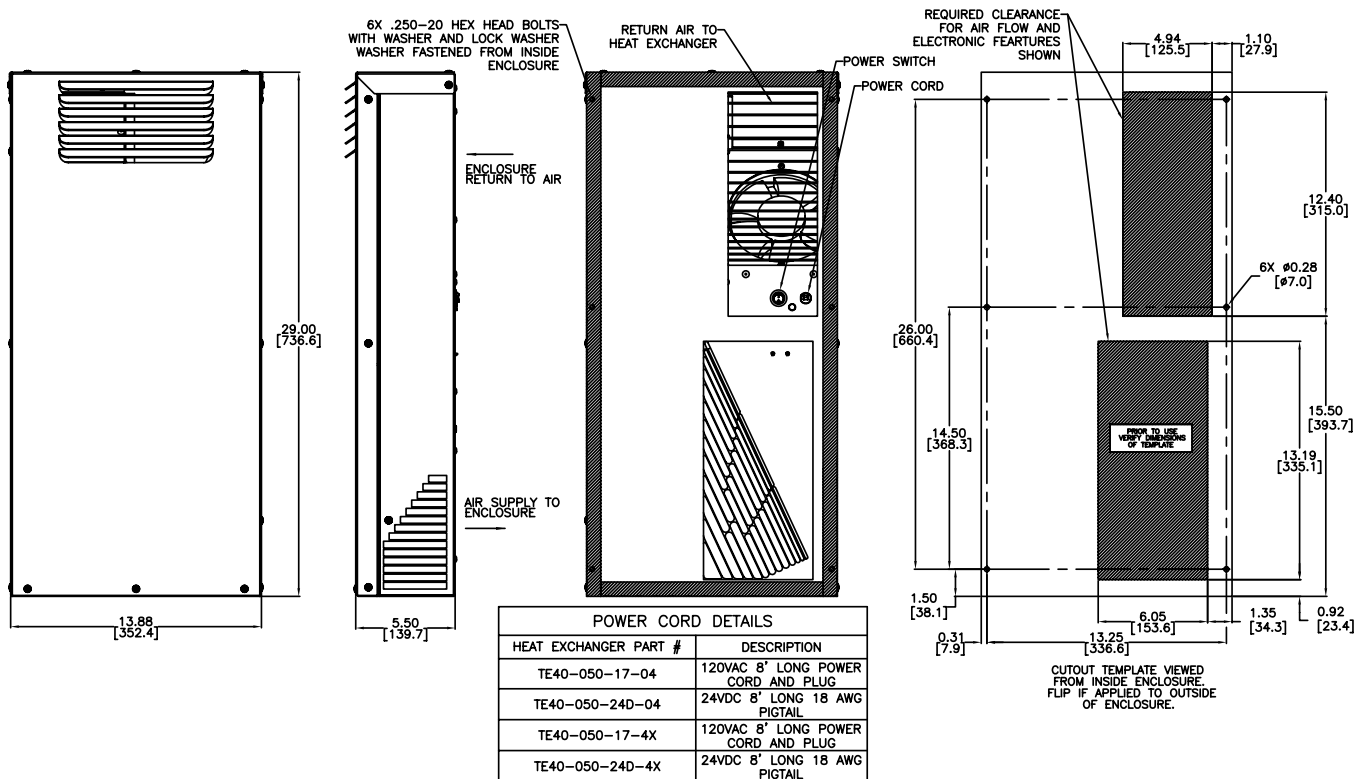
² Cold-rolled steel with ANSI-61 gray polyester powder coating inside and out.

³ Fabricated from 16-gauge 304 stainless steel.

Air To Air Heat Exchanger Dimensions



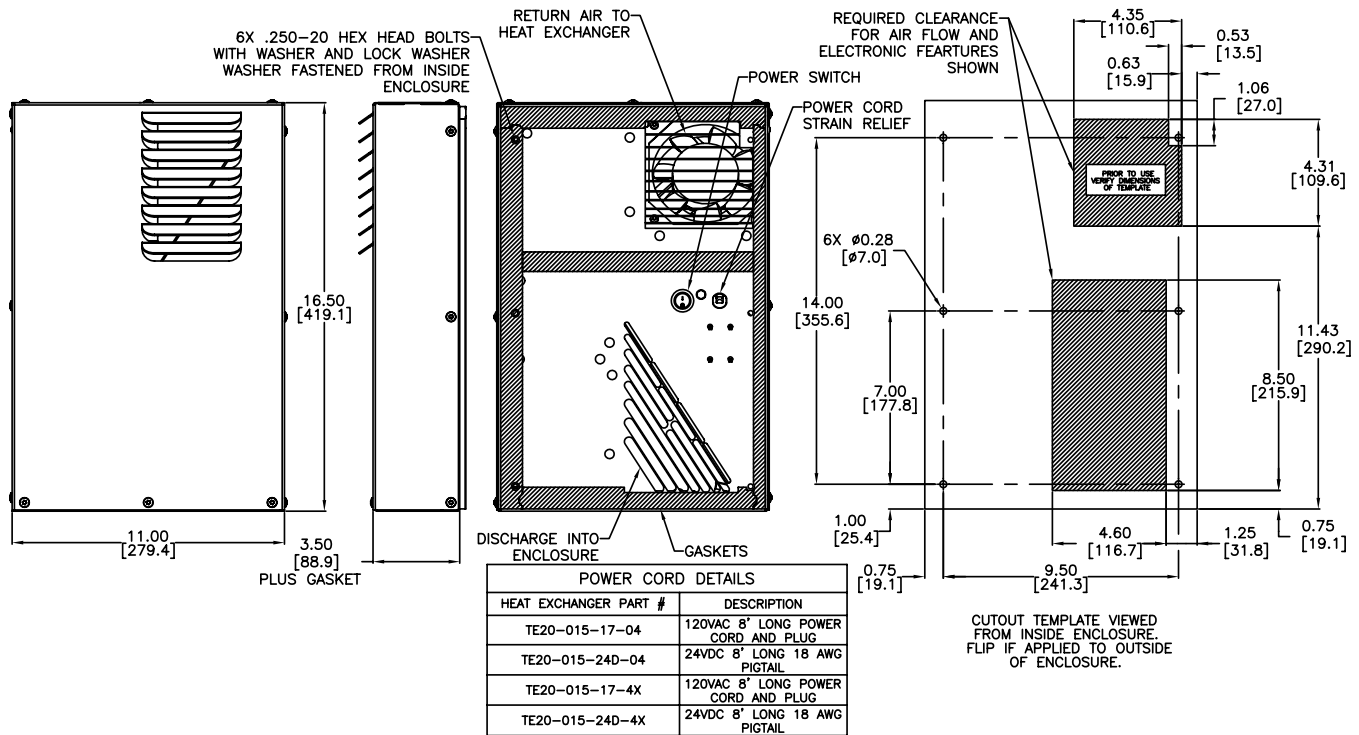
Dimensions - Tall



Air To Air Heat Exchanger

Dimensions

Dimensions - Compact



Dimensions - Deep

