



## Network Zone Systems Thermal Management

Network enclosures are widely used both indoors and outdoors to secure a wide range of electronic equipment such as: switches, routers, gateways, power supplies, etc. These enclosures are used in a wide range of markets including: hospitals, manufacturing plants, refineries, stadiums, etc. Therefore, these enclosures are exposed to a wide variety of ambient conditions.

Such enclosures (figure 1) can have strict ingress ratings such as NEMA 4/4X, IP54/55, etc. These ratings, while protecting the equipment from some environmental conditions (dust, water spray, etc.), also effectively trap the heat dissipated by the active equipment inside the enclosure. This air, that has increased in temperature, must still provide adequate cooling for the components mounted inside the enclosure.

This application guide gives an overview of key design considerations for thermal management solutions to mitigate these thermal factors for Panduit's zone enclosures. The capabilities of the various thermal management solutions are discussed and guidelines for recommended solutions are provided.

### Introduction

Most of the power consumed by electronic endpoint devices is dissipated as heat, this is especially true of IT equipment (switches, servers, routers, etc.). To avoid equipment overheating or even failure, the cooling of this equipment should be considered as part of the deployment plan. When an enclosure is placed in a high ambient temperature environment this choice further increases the need to consider cooling options for any enclosure. Given the stringent sealing requirements for NEMA 4 enclosures, the air inside is completely enclosed severely limiting the options for cooling the air. Some of the current cooling solutions in the market use fans and vents, small enclosure mounted air conditioners, liquid cooled heat exchangers, compressed air vortex tubes, etc. In the solutions section of this document some of the more practical thermal management solutions will be considered for Panduit Zone Enclosures.



Figure 1: Z23U-624 Enclosure



## Solutions

The air temperature surrounding the active equipment is affected not only by the heat load (power used) of the active equipment, but the size of the enclosure, the thermal resistance between the chassis of the active equipment and the air, the construction material of the enclosure and the air temperature surrounding the outside of the enclosure. Several cooling techniques are discussed from the simplest to the more complex. Depending on the cooling option selected (passive cooling solution, fan assisted cooling solution or AC unit cooling solution) additional penetrations to the enclosure and power sources for the cooling unit may be required.

## Information Gathering

To properly select any thermal solution some basic information about system (enclosure and the equipment it will house) must be collected. Most of this information is available from the equipment vendor in the form of data sheets, specifications, instruction manuals, deployment guides etc. Below is a bullet list of the information required to apply **any** of the cooling solutions.

### 1. Maximum Ambient Air Temperature.

This is air temperature that will surround the exterior of the enclosure.

### 2. The Internal Heat-Load.

This is the sum of the power consumed by the equipment mounted inside the enclosure.

### 3. Maximum Desired Internal Enclosure Temperature.

The equipment with the lowest maximum temperature limit will dictate the maximum allowable internal temperature for the enclosure. Likewise, the highest minimum temperature limit will dictate the minimum allowable internal temperature for the enclosure.

### 4. Two of the first three data points must be known to allow the third data point to be determined from the charts in the cooling solutions.

### 5. Enclosure dimensions.

The height, width and depth of the nearest inch (Z23: 36" x 24" x 12").

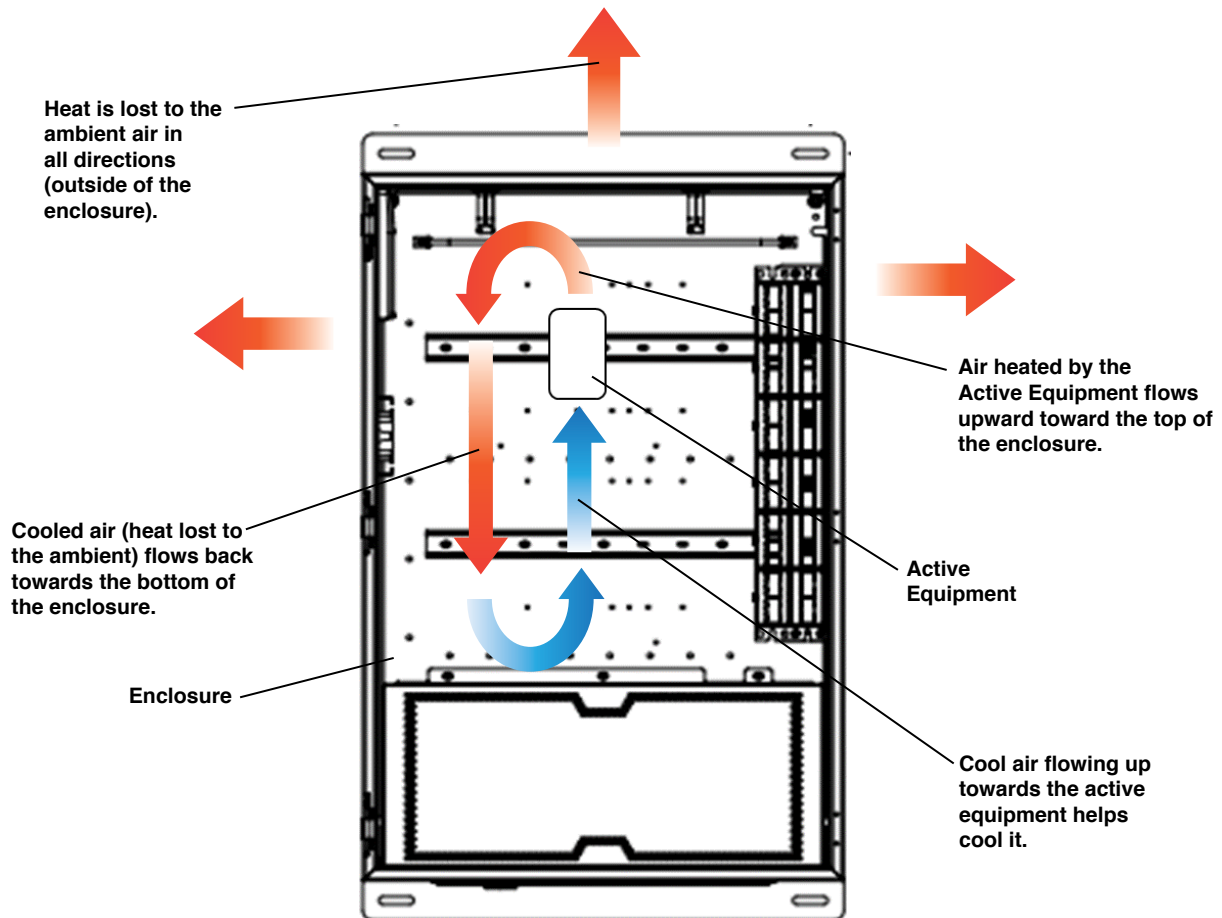
### 6. Enclosure Material.

The solutions below are for enclosures constructed from steel (the type of steel e.g. stainless or mild will have a minimum impact on these calculations).

### 7. Indoor or Outdoor.

The charts to follow apply only to an enclosure not exposed to direct sunlight.

## Passive Natural Convection Cooling (Sealed Enclosure)



**Figure 2:** Idealized thermal (aka natural) convection cooling. Enclosure is 12" deep. The door has been removed to see inside the enclosure.

During normal operation, the active equipment dissipates heat to the air inside the enclosure which in turn increases the air temperature inside the enclosure. The air then transfers this heat to the exterior of the enclosure through convection, conduction and radiation (figure 2). A minor amount of the heat is transferred directly to the enclosure from the active device through conduction since the equipment is in contact with the mounting (DIN) rail. Heat flows from high temperature to low temperatures. So, the air temperature inside the enclosure will increase until it exceeds the temperature outside of the enclosure. After a period (typical < 48 hours under continuous operation) a steady state temperature is reached inside the enclosure. This internal air temperature must be at or below the operating temperature specified for the components installed inside the enclosure. Since hot air is more buoyant it will rise towards the top of the enclosure this creates a temperature gradient inside the enclosure. The bottom area of the enclosure will be near the outside ambient temperature and the top area can be 10°C to 20°C higher than the bottom of the enclosure.

## Recommendations for Sealed Systems Z23x

1. Follow vendor recommendations for minimum clearances around active equipment (e.g. typically 2" for convection cooled switches).
2. Mount equipment with lower recommended operating temperatures on the lower DIN rails.
3. When possible stagger switches to avoid placing a switch directly below another switch as the lower switch can increase the air temperature significantly for the upper switch.
4. Figure 3 provides a guide for a sealed Panduit Z23 enclosure heat dissipation for various external ambient temperatures
5. For outdoor deployments a 150-watt heater will increase the internal temperature of a sealed Panduit Z23 enclosure by 15°C above the external ambient temperature.

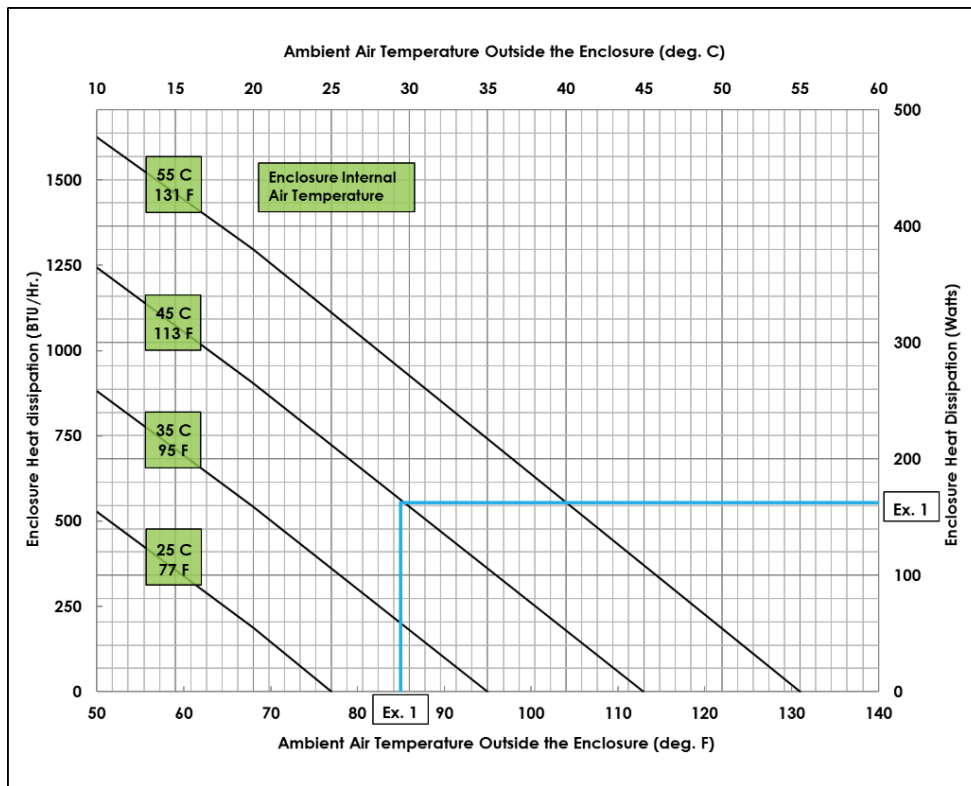


Figure 3: Z23 Enclosure Thermal Guideline – Sealed

**Example 1:** Determine the heat load allowable for an 85°F ambient temperature and an internal enclosure temperature of 113°F.

**Answer:** The maximum allowable power draw for the equipment inside the enclosure is 162 watts.

**How to:** Find the 85°F point on the bottom horizontal axis. From that point draw a vertical line to the sloped 113°F internal air temperature line. Then draw a horizontal line to the right hand vertical axis.

**Example 2:** Determine the size of a heater required to maintain an internal temperature of 15°C when the enclosure is exposed to a -15°C outside ambient temperature and the power draw of the active equipment inside the enclosure is 150 watts. The enclosure is not exposed to direct sunlight.

**Answer:** A single 150-watt heater is needed to maintain the internal temperature at 15°C.

**How to:** Apply recommendation #5 to the problem. The Z23 enclosure internal temperature will be 15°C greater than the ambient temperature for every 150-watts of heat dissipation. The power draw of the active equipment plus the heater 150w + 150w = 300w = a 30°C temperature increase so -15°C (ambient) + 30°C (from the total heat load) = 15°C inside the enclosure.

## Fresh Air/Vented Cooling System Z23x

### Introduction

As can be seen in the examples above exceeding the capability of natural convection cooling is quite possible especially in increased ambient temperature environments. A possible next step in cooling management is to provide ventilation to the zone enclosure with the addition of fans and vents. Fans will still result in a higher internal temperature than the ambient air temperature outside the enclosure, however, the difference in temperature between the external ambient temperature and the internal temperature is reduced. But, the addition of outside ventilation will reduce the enclosure ingress rating to IP54. Some of the recommendations will be like the sealed enclosure but to stress their importance they will be repeated as appropriate.

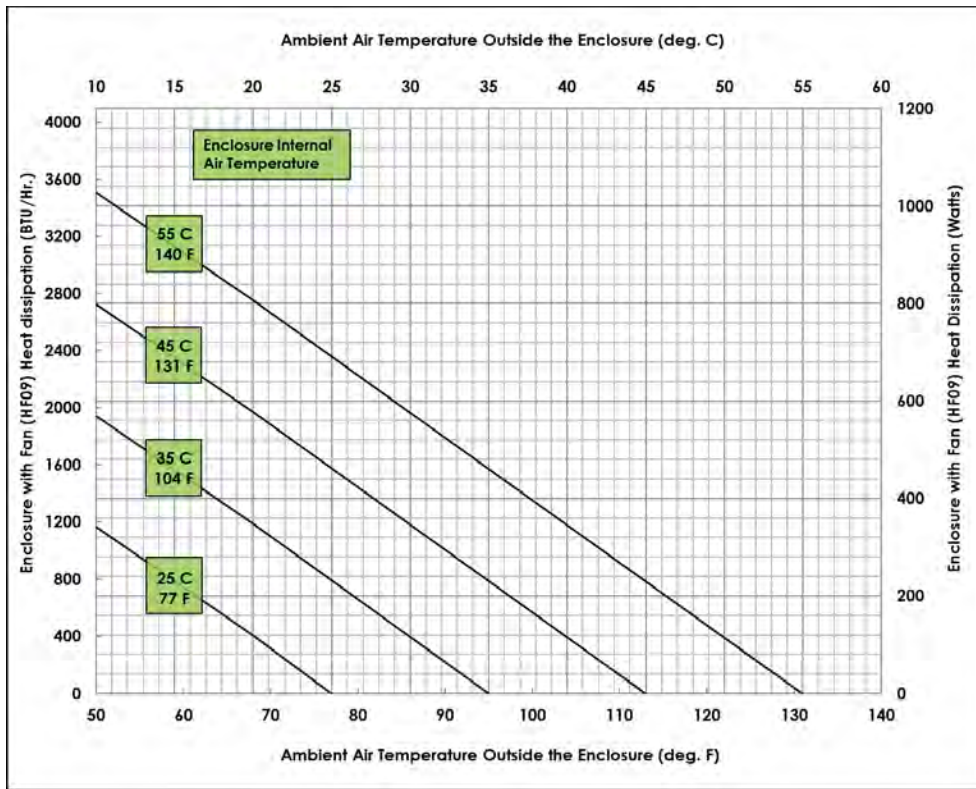
The cooler air brought into the enclosure by the fan allows the hot air to exhaust from the enclosure. Without the vent the fan would stall, and no air would be brought into the enclosure. Therefore, two openings need to be created on the enclosure, one for the fan and one for the exhaust vent. The fan should be mounted low on the non-hinge side of the Z23 enclosure. The vent should be mounted high on the door of the enclosure. Figure 7 (fan HF09) and figure 10 (fan HF05) show the location for a fan and a vent.

Two different fan sizes are available for the enclosure. HF09 fan is for deployments WITHOUT A POWER SHIELD and the larger fan provides 42 CFM of airflow to cool the equipment inside the enclosure. Figures 5, 6 and 7 provide the fan dimensions (HF09) and enclosure cutout dimensions.

The smaller HF05 fan provides 24 CFM of airflow to cool the equipment inside the enclosure. A similar mounting location is recommended for the HF05 fan and figures 9 and 10 show the dimensional information.

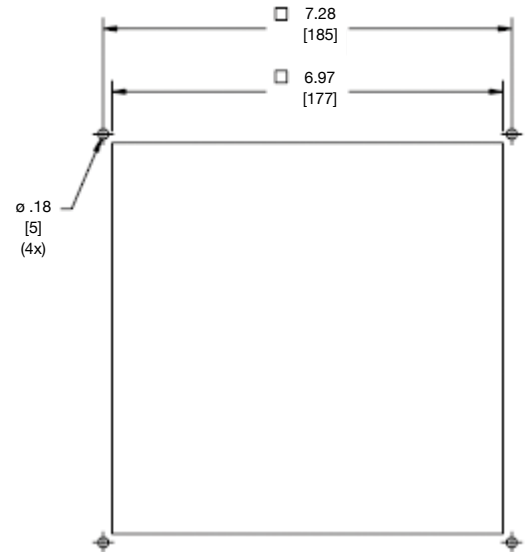
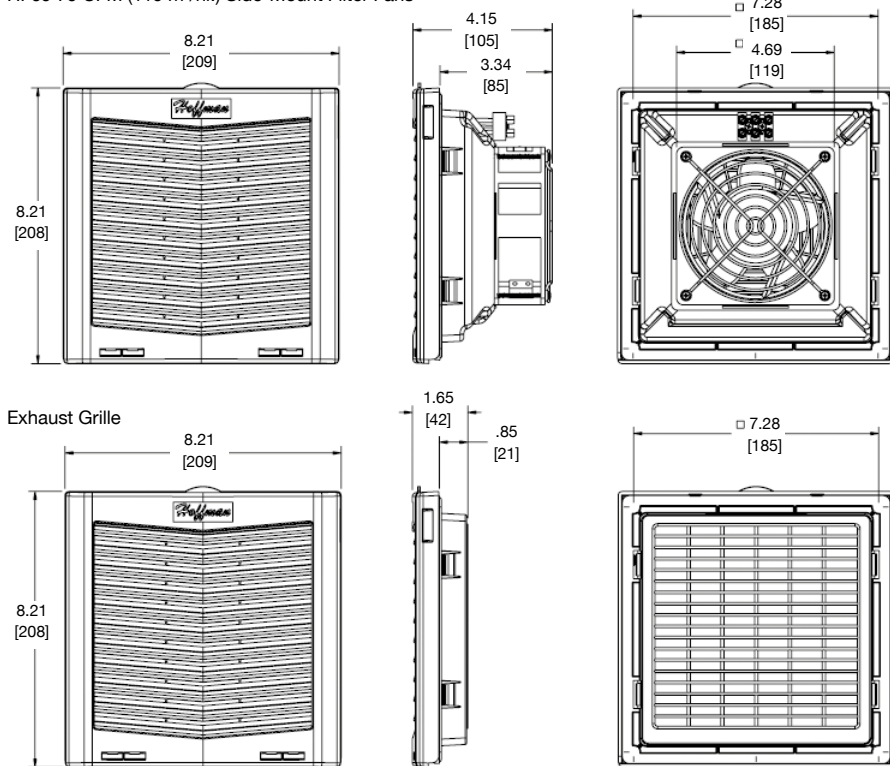
### Recommendations for Fan Assisted Systems Z23x

1. Follow vendor recommendations for minimum clearances around active equipment (e.g. 2" for convection cooled switches) mounted in the enclosure.
2. Read the instruction manual available from the vendor for the fan. A hyperlink to the manual is provided at the end of this document.
3. Follow vendor recommendations for minimum clearances around fans and filters (e.g. 7" for HF09 fan on the outside of the enclosure).
4. Mount equipment with lower operating temperatures on the lower DIN rails.
5. On the lowest din rail, space needs to be left for the fan on the non-hinge side (see figures below).
6. On the highest din rail, space needs to be left for the vent mounted on the door to when installing equipment. (e.g. switch patch cords extend beyond the face of the switch towards the door of the enclosure and could affect a potential vent location).
7. Figure 4 provides the heat dissipation guide for a Panduit Z23 enclosure heat dissipation with a HF09 fan for various external ambient temperatures with the IP54 filter kit.
8. Figure 8 provides the heat dissipation guide for a Panduit Z23 enclosure with a power shield and an HF05 fan with the IP54 filter kit.



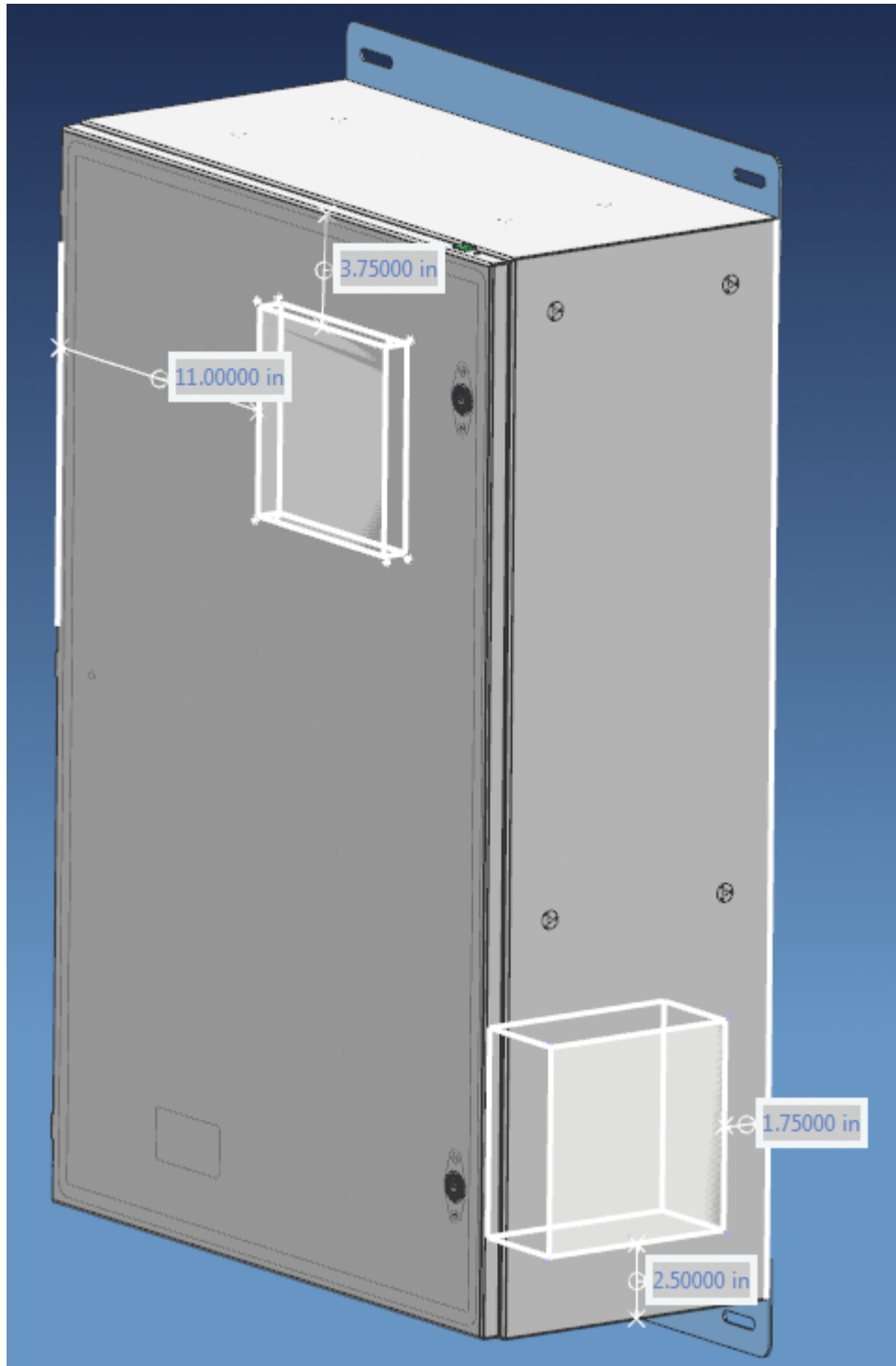
**Figure 4:** Z23 enclosure thermal guideline – fan assisted. The HF09 Fan is available separately from Pentair.

HF09 70 CFM (119 m<sup>3</sup>/hr.) Side-Mount Filter Fans



**Figure 5:** Dimensions of a HF09 exhaust fan and exhaust vent.

**Figure 6:** Cutout dimensions for HF09 fan.



**Figure 7:** Approximate location for the HF09 fan and vent cutouts. The white lines give a relative indication of the space required for the fan and the dimensions show the location for the cutouts to install the fan and vent.

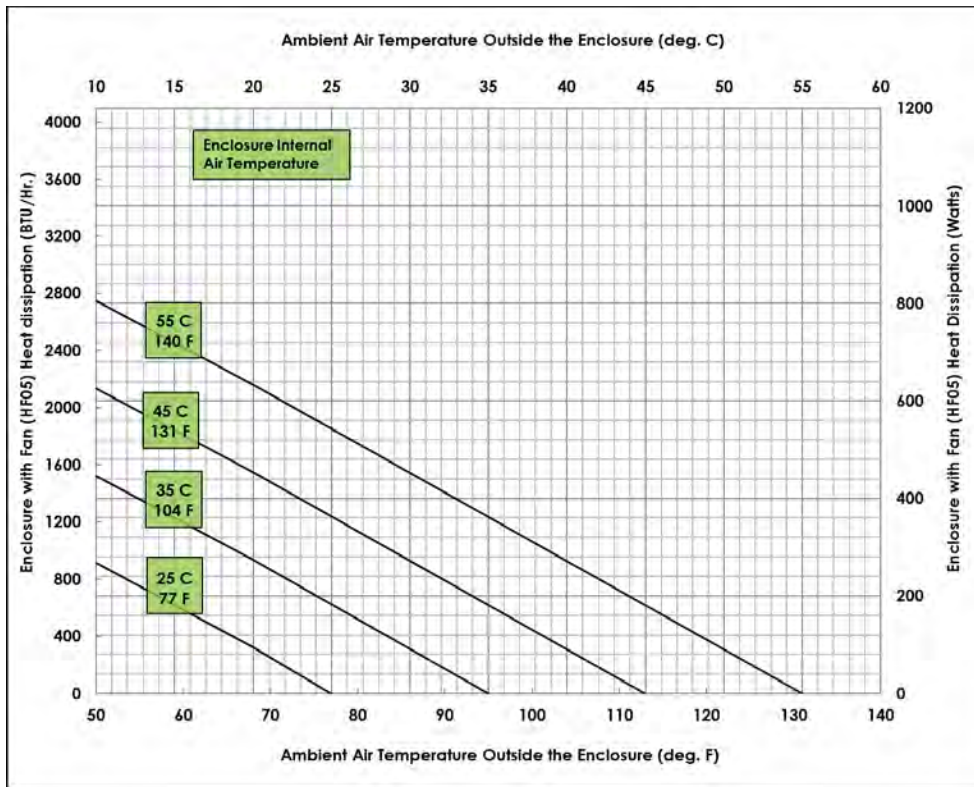


Figure 8: Z23 enclosure thermal guideline – fan assisted. The HF05 fan is available separately from Pentair.

HF06 35 CFM (59 m³/hr.) Side-Mount Filter Fans

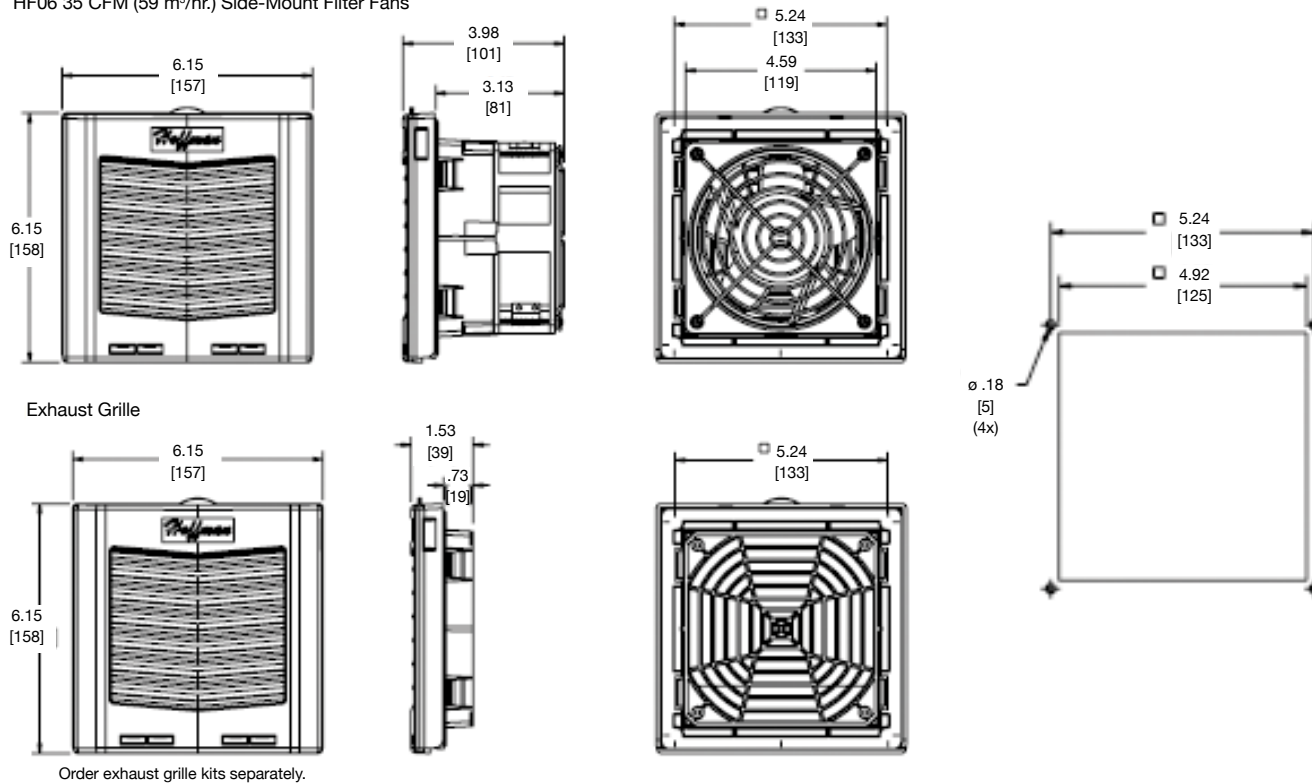
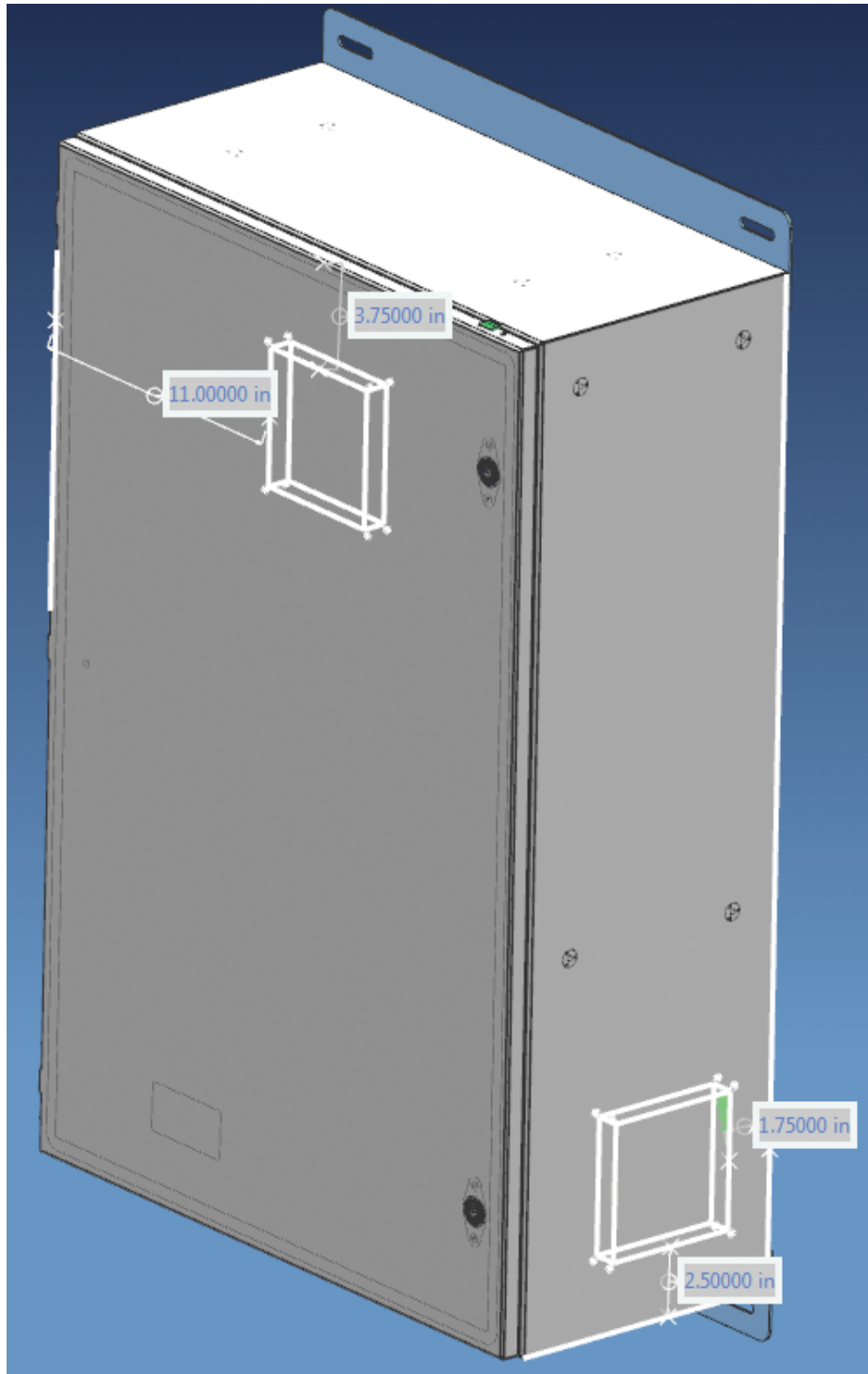


Figure 9: Dimensions of a HF05 exhaust fan and exhaust vent and cutout dimension.





**Figure 10:** Approximate location for the HF05 fan and vent cutouts. The white lines give a relative indication of the location for the fan and the dimensions show the location for the cutouts to install the fan and vent. The starting location is the same as the HF09 fan only the hole dimensions are smaller.



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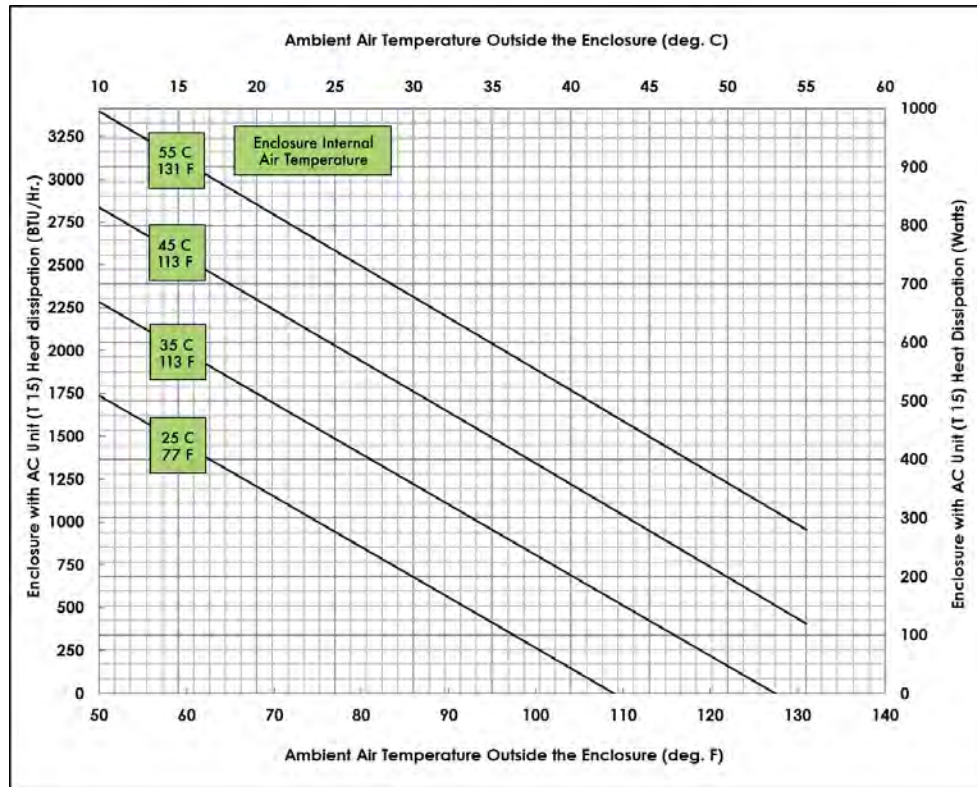
## Closed Loop Cooling System (AC Unit) Z23x Enclosures

### Introduction

When it becomes necessary to have a lower internal temperature than the external ambient temperature around the enclosure, then an air conditioner (AC unit) is required. The AC unit will result in an increase in the average heat dissipation of a Z23 enclosure and therefore it may allow more equipment to be deployed. The T15 AC unit can be used with or without a power shield and provides 30 CFM of 75°F air to cool the equipment inside the enclosure. Figure 12 provides the T15 cutout dimensions required to externally mount it on a Z23 enclosure. The unit should be mounted on the hinge side of the enclosure (figure 13). Figures 14 and 15 provide additional aids in locating the cutouts on a Z23 enclosure.

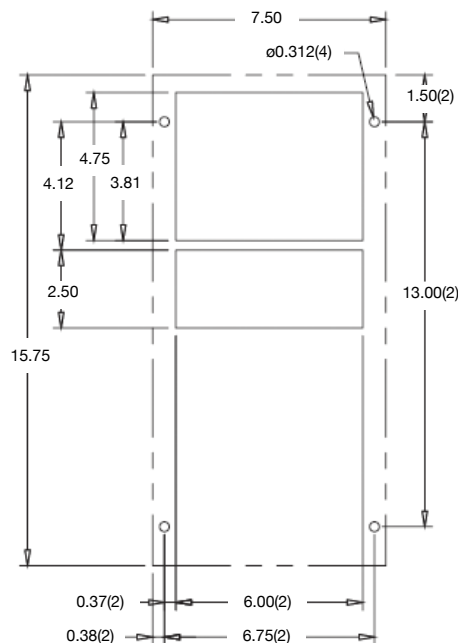
### Recommendations for Closed Loop (with AC Units) Z23x

1. Follow vendor recommendations for minimum clearances around active equipment (e.g. 2" for convection cooled switches).
2. Read the instruction manual available from the vendor for the T15 AC Unit. A hyperlink to the manual is provided at the end of this document.
3. Follow vendor recommendations for minimum clearances around exterior of the AC unit.
4. Mount equipment with lower operating temperatures on the lower DIN rails.
5. When possible stagger switches to avoid placing a switch directly below another switch as the lower switch can increase the air temperature significantly for the upper switch.
6. The graph following (figure 11) provides a heat dissipation guide for a Panduit Z23 enclosure with a T15 air conditioner.
7. For outdoor deployments a 150-watt heater will increase the internal temperature of a Panduit Z23 enclosure by 15 °C above the external ambient temperature. Depending on ambient conditions and equipment specifications an additional heater may be required. Outdoor models of the T15 unit include a 150-watt heater.



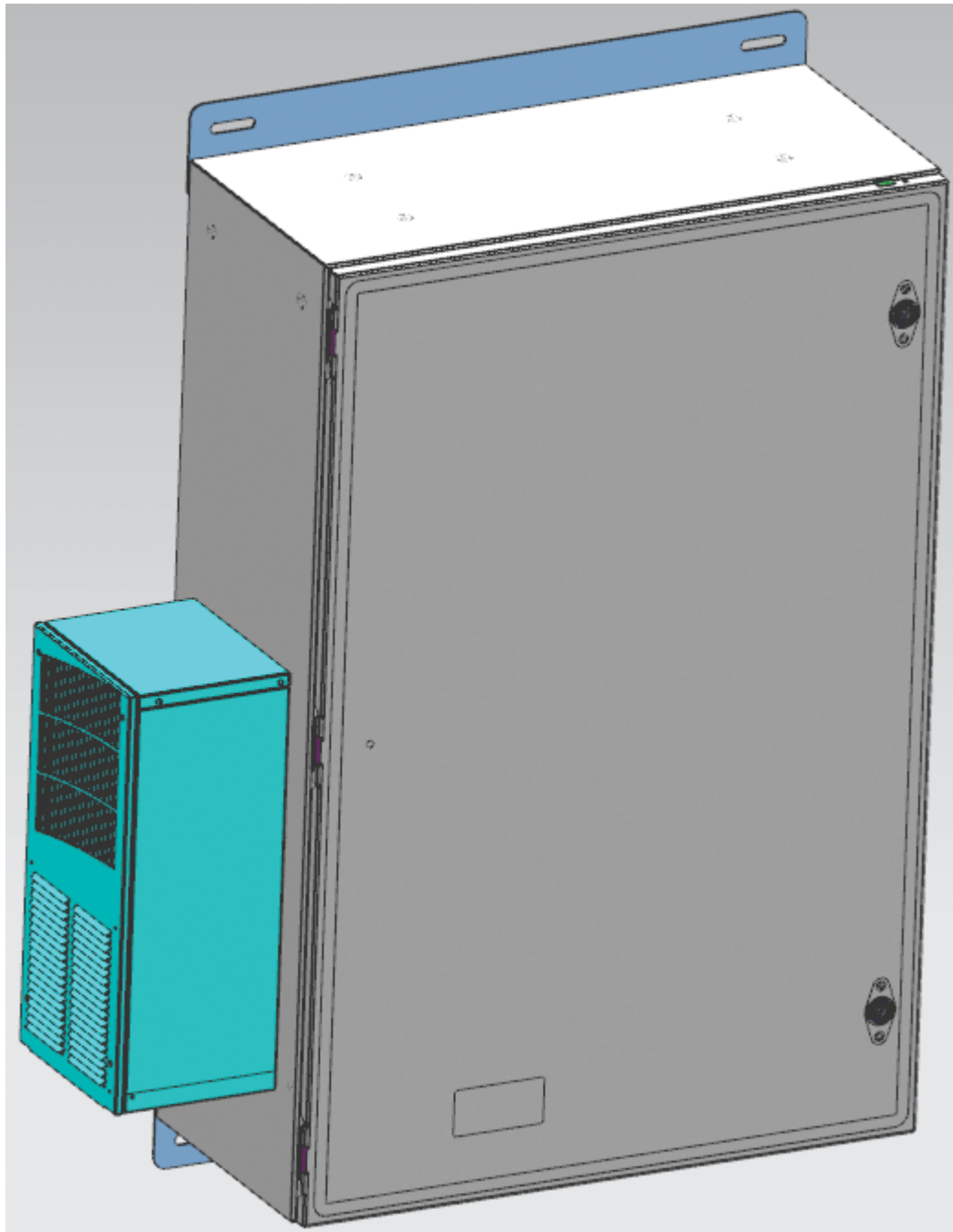
**Figure 11:** Z23 enclosure thermal guideline – T15 air conditioner is available separately from Pentair. The outdoor model is equipped with a 150-watt heater. The maximum ambient operating temperature for the T15 is 55°C. Therefore the upper curves truncate at 55°C outside ambient temperature.

### Mounting Cutout Dimensions

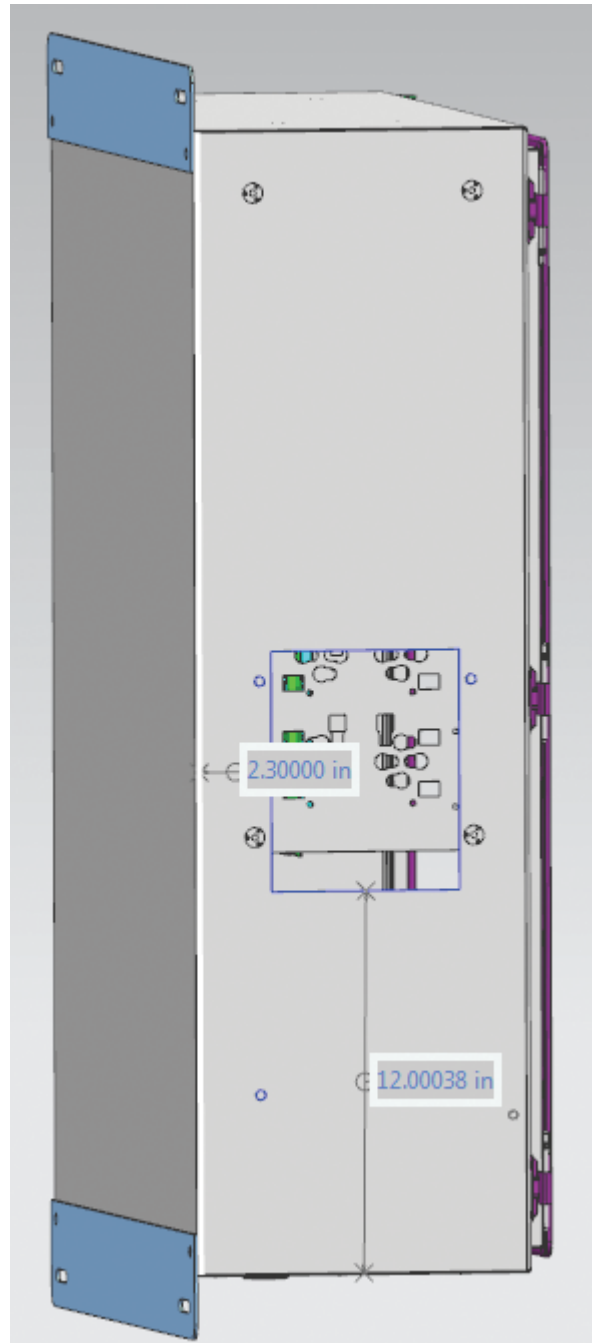


**Figure 12:** Cutout dimensions for the T15 AC unit as viewed from the outside of the enclosure.  
**Note:** Phantom lines represent air conditioner. The small web between the cutouts can be eliminated for convenience as the discharge of the T15 is ducted away from the intake.

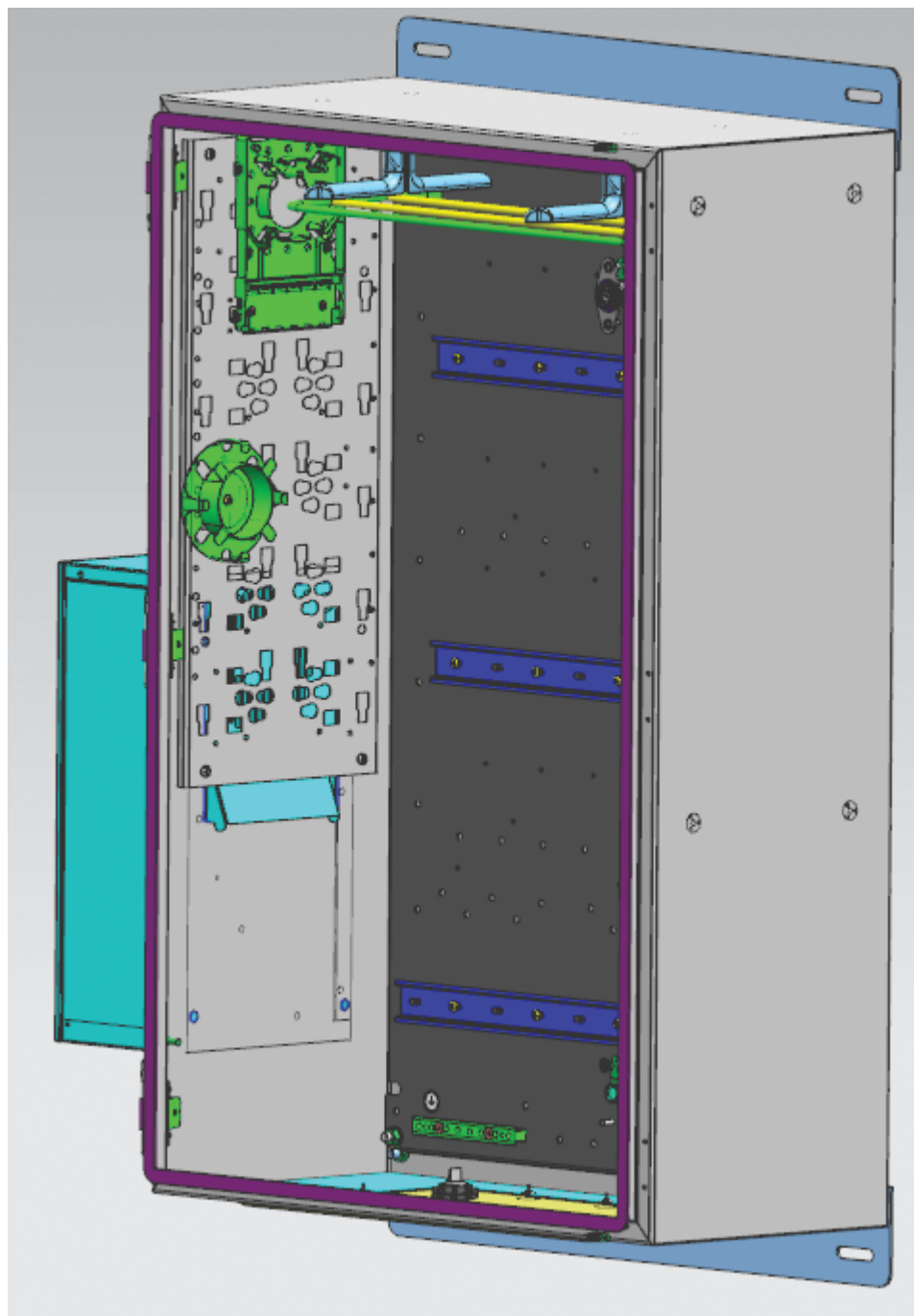
Externally Mounted



**Figure 13:** Z23 shown with T15 AC unit. Note the recommended mounting location low, on the hinge side.



**Figure 14:** Shows the location of the cutout for the T15 AC unit on the Z23 enclosure. The cutout starts approximately 12 inches from the bottom of the enclosure to allow the discharge duct to just clear the accessory bracket above it and the power shield below (not shown). This location will allow the power shield to be removed from the enclosure with the T15 unit installed.



**Figure 15:** Interior view showing the location of the T15 discharge with the mounting bracket on the interior of the Z23 enclosure. The bracket needs to be removed to access the upper mounting holes for the T15. The discharge duct sits above the power shield (not shown).

## Smaller Zone Enclosure Z22x

The Z22 enclosure's compact size limits the amount of equipment that can be deployed inside it. These physical space constraints render supplemental cooling with fans or AC units moot.



Figure 16: Z22U Enclosure

### Recommendations for Sealed Systems Z22x

1. Follow vendor recommendations for minimum clearances around active equipment (e.g. 2" for convection cooled switches).
2. Figure 17 provides a guide for a Panduit Z22x enclosure heat dissipation for various external ambient temperatures.

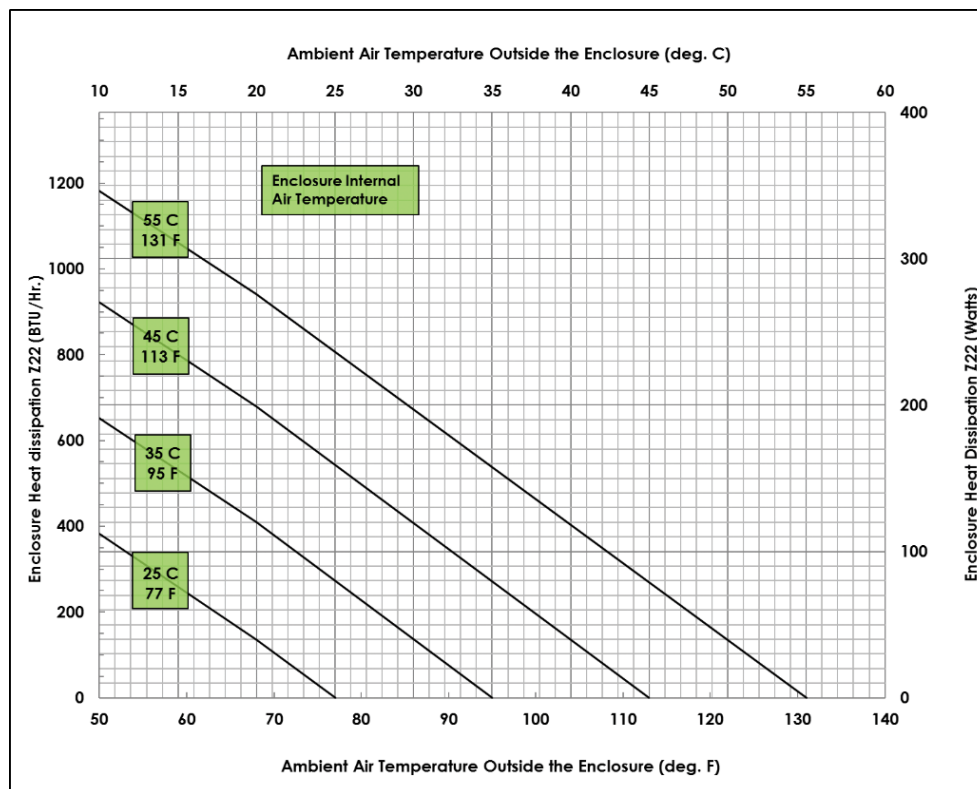


Figure 17: Z22 enclosure thermal guideline – sealed.



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## Panduit Difference

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## References

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2. <https://www.pentairprotect.com/wcsstore/ExtendedSitesCatalogAssetStore/Attachment/HoffmanProductAttachmentsInstructionManuals/89134973.pdf>
3. <https://www.pentairprotect.com/wcsstore/ExtendedSitesCatalogAssetStore/Attachment/HoffmanProductAttachmentsSpecSheets/Spec-00733.pdf>
4. <https://www.pentairprotect.com/wcsstore/ExtendedSitesCatalogAssetStore/Attachment/HoffmanProductAttachmentsInstructionManuals/10-1008-194.pdf>

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