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Space Optimization For Control Panels

WHITE PAPER

This white paper explores solutions from Panduit and Pentair that can help save up to 40% of control panel space in comparison to conventional approaches. It presents options for reducing enclosure size by fitting more equipment into existing enclosures, which provides greater design flexibility and cost savings to the equipment and panel builder.

Applying more effort in the beginning of the design process can result in significant space savings. Along with innovative products, both Panduit and Pentair offer CAD tools and 3D step files to help you through the design process. Both companies' products are also included in automation supplier configurators such as the Rockwell Automation® ProposalWorks and Integrated Architecture Builder (IAB) design tool.

Introduction

In manufacturing organizations, real estate is typically one of the biggest expenses associated with running the business. As a result, production facility managers are under pressure to manage their space in the most effective and efficient manner to minimize capital and operational expenses. This can mean placing as much equipment as possible into a given area in the facility, which challenges equipment designers and builders to reduce the size and footprint of the machines they create. This, in turn, challenges the controls engineers to design and build control panels within a smaller footprint or fit more equipment into an existing space.

There are many challenges associated with designing smaller control panels. Considerations for cable segregation, thermal management, cable entry, Electromagnetic Interference (EMI), cable bend radius, and space for future expansion must be addressed when attempting to reduce the size of control panels. In addition, safety considerations such as arc flash hazards, complying with codes and standards, and adhering to minimum separation requirements for electronic components all complicate a controls engineer's job. Whether you are designing a control panel for your own facility or for a customer, best practices and addressing design challenges with new tools and solutions should be considered before any build documents are issued to the panel shop.

Utilizing Three Dimensions for Control Panel Space Savings

An area that is almost never used in the control panel is the space between the enclosure door and the components mounted to the sub-panel in the rear of the enclosure, sometimes referred to as the three dimensional (3D) space. Both Panduit and Pentair offer products that help the designer tap into this space.

The Panduct® PanelMax™ DIN Rail Wiring Duct (Figure 1) has two separate wiring channels and enables the user to mount a DIN rail with components that would normally be installed directly to the sub-panel, thereby utilizing the 3D space. The Panduct® PanelMax™ DIN Rail Wiring Duct and Shielded Wiring Duct from Panduit have the potential to save up to 40% of the space on a sub-panel. Being able to fully utilize the 3D space inside an enclosure often means having the correct access to install or service the equipment inside. The ability to access the front and rear of the installed equipment reduces installation and service time.

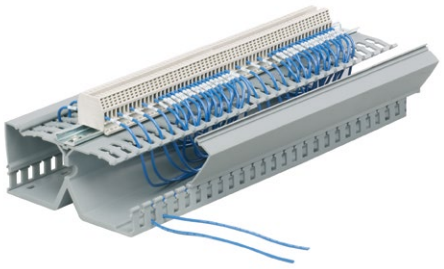


Figure 1. Panduct® PanelMax™ DIN Rail Wiring Duct.

The innovative PROTEK™ product by Pentair (Figure 2) utilizes a unique three-piece body and double-hinge design that allows the front door to open on hinges connected to the middle section, and the middle section to swing open on hinges connected to the rear section. Both the front door and the middle section are removable.

The separation of these sections allows for an easier installation because the unpopulated individual sections are much easier to manipulate. The installer can begin by mounting the rear portion of the enclosure to a wall or pole and then mount an already populated sub-panel into the rear section. Next, the installer can mount the middle section of the enclosure to the rear section and populate the EIA-310, 19" spaced rack angles with the active rack mounted equipment. Lastly, the installer can mount the front door onto the middle section to complete the installation.

Once the equipment is installed, the PROTEK™ design offers the service technician easy access to all sections of the control panel. Unlocking the front door allows access to the front of the rack mounted equipment. Releasing the latches in the middle section allows the middle section to pivot open from the rear section on a load bearing hinge. Once open, the middle section reveals access to the back of the rack mounted equipment in the middle section as well as access to the components mounted on the sub-panel in the rear section.

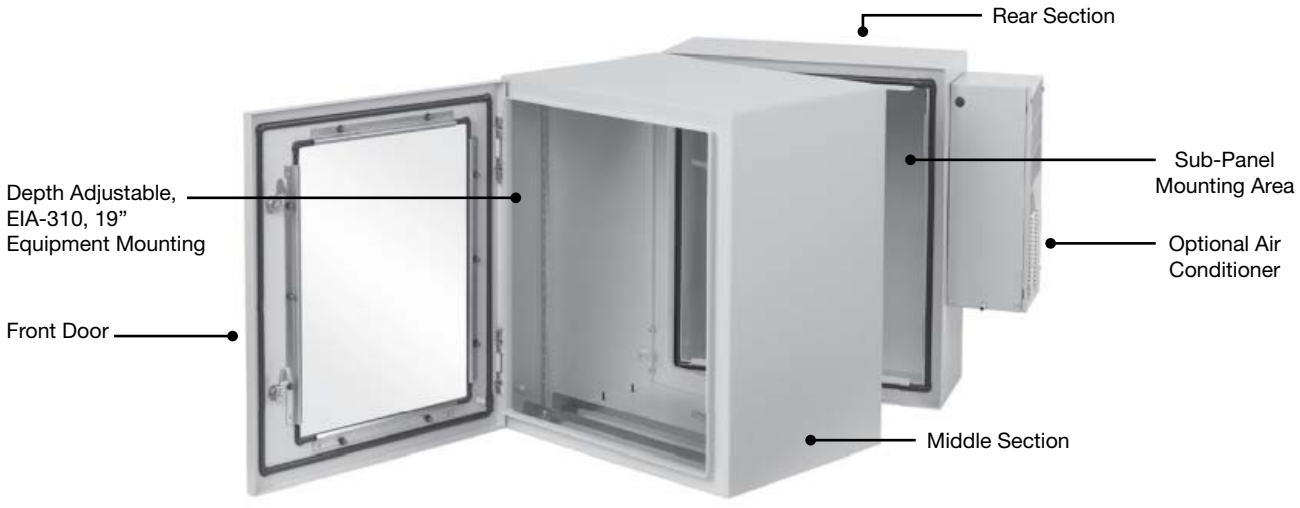


Figure 2. The PROTEK™ design allows the control panel designer to utilize the 3D space and combine both 19" rack mount equipment with sub-panel mount equipment into a succinct 3D-spaced system.

Various depths and adjustable rack angles allow the designer to choose the enclosure that houses the correct volume for the needed components and make all the space within the enclosure functional, as shown in Figure 2. The PROTEK™ product provides: (A) a 3D platform, allowing flexible design for the designer; (B) an easy to manage modular installation experience for the installer; and (C) easy access to the appropriate areas of the equipment inside for the service technician.

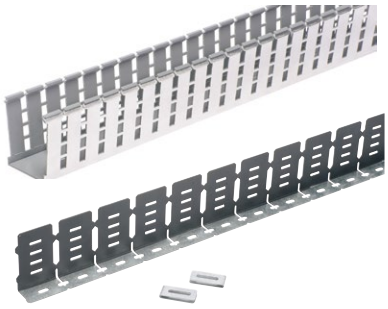


Figure 3. PanelMax™ Shielded Wiring Duct and Noise Shield with bonding clips.

Noise Mitigation Facilitates Space Savings

Products normally used for noise mitigation are not typically considered to be space saving tools. However, a fresh look at approaches to control panel layout can result in improved reliability and performance along with optimized usage of panel space. Bringing wiring closer together that normally would need to be separated by at least six inches of air space can be accomplished with the Panduct® PanelMax™ Noise Shield and Shielded Duct (Figure 3). Both products are effective as an EMI barrier and provide an equivalent of six inches of air space. Figure 4 illustrates how the noise shield and shielded duct can be used to separate noisy motors or drive cables from sensitive Ethernet or control cables. The noise shield can be used on its own, mounted and bonded to the sub-panel, installed in a conventional wiring duct with the included bonding clips, or used in conjunction with the shielded duct. A subsequent white paper from Pentair and Panduit will provide further information on noise mitigation within the control panel.

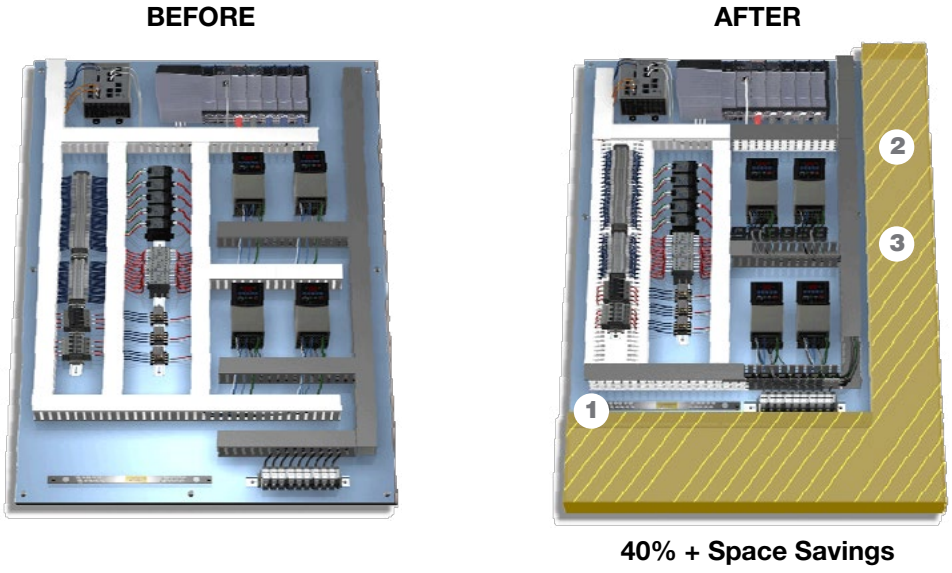


Figure 4. The effect of space saving solutions: A 40% or greater panel space savings is achievable with components that utilize 3D space such as (1) Panduct® PanelMax™ DIN Rail Wiring Duct to provide robust EMI noise protection with closer pathway placement, (2) Panduct® PanelMax™ Shielded Wiring Duct and (3) Panduct® PanelMax™ Noise Shield.

Enclosure Flexibility Maximizes Available Space

Selecting the proper control enclosure is an important factor when the objective is to optimize space. Enclosures are designed to support a variety of accessories that facilitate component mounting based on the targeted application. Different enclosure platforms can offer more flexibility and greater space saving capability when designed for a wider range of accessories.

Examples of enclosure platforms that afford greater space saving capability are those that allow full 3D utilization of the space inside versus only using the sub-panel of the enclosure. To accomplish this, the enclosure must be designed to accept supporting structural members along the sides, top and/or bottom of the enclosure and ideally, on the door as well. This offers the designer full use of the interior for component mounting and cable and wire management. With an enclosure platform designed for the purpose of flexibility and scalability, an engineer can create a customized packaging solution from standard components that optimizes the control panel space.

Pentair's FUSION product line is an example of an enclosure system that is designed to accept front and rear vertical mounting rails in addition to a rear sub-panel. The mounting rails can accept a wide variety of accessories for installing components in non-traditional locations.

Figure 5 shows the FUSION vertical mounting rails in the front and rear which can be used to support versatile side mounting rails, full and partial height side mounting panels, and DIN rail adapters. These accessories create an internal infrastructure that maximizes use of most surfaces inside the enclosure.

Figure 5. FUSION enclosure platform with internal grid system.

Figure 6. FUSION enclosure with a horizontal barrier installed.

This type of infrastructure can also be used to install barriers within the enclosure to separate it into multiple compartments which can isolate high voltage from low voltage, provide an additional panel mounting surface, or a shelf for batteries or power supplies, as shown in Figure 6.

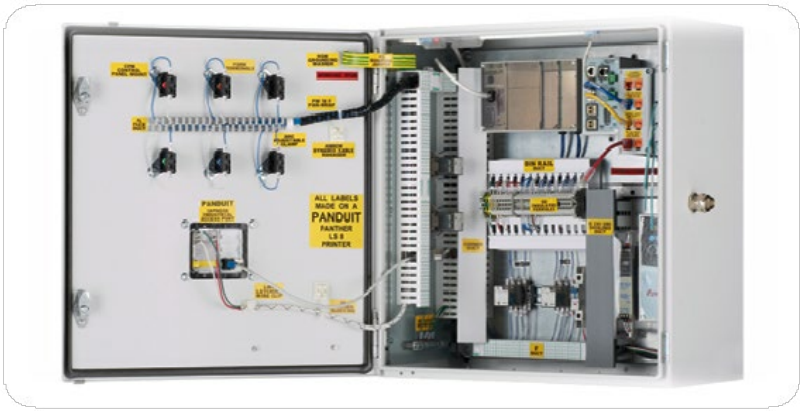


Figure 7. FUSION enclosure with a full side panel application.

In Figure 7, the FUSION enclosure includes a full side mount panel with additional wire duct, relays, and grounding provisions that traditionally would have been mounted on the rear sub-panel. This application allows the designer to save up to 20% of the wall or machine space when compared to a more common sub-panel mounting application.

Another enclosure platform that offers full 3D space utilization is Pentair's Proline G2 modular enclosure system. Proline G2 is designed for larger control system applications and is based on a strong, versatile frame (Figure 8) with a grid pattern and a wide range of accessories that enclose the frame and allow components to be mounted to the grid. Frames can be joined together to create multi-bay configurations that allow system expansion. A complete range of internal components such as rack angles, sub-panels, and grid mounting options is available to install equipment securely within the enclosure on several planes utilizing virtually all the interior space (Figure 9). Mounting options accommodate rack mount equipment, operator interfaces, industrial control equipment, and computer systems, as well as manage wiring and cabling (Figure 10).

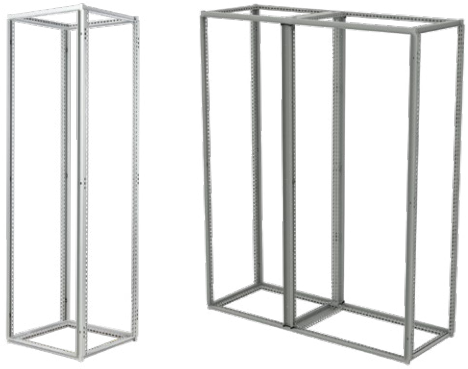


Figure 8. Basic Proline G2.

Figure 9. Proline G2 frame with doors, tops, and mounting panel assembled.

Figure 10. Proline G2 internal grid system with examples of accessories mounted to the grid.

In some cases customers utilize the enclosure door for mounting additional devices to optimize space. Examples include shelves, document storage, cable management, air conditioners, or partial mounting panels. The grid system included in the Proline G2 door adds strength to the door and accommodates a wide variety of accessories for device mounting and cable management.

Figure 11. Panduct® PanelMax™ DIN Rail Wiring Duct.

Utilizing the Enclosure Corner Space

There is space inside the control panel that goes unused in most traditional panel layouts. The Panduct® PanelMax™ wiring duct solutions (Figure 11) are designed to tap into that space. An example is the corner space which is either unused or underutilized in control panels that are using side equipment mounting plates. The Panduct® PanelMax™ Corner Wiring Duct is designed to fit into corners and utilize that space while providing good wiring transition from rear sub-panels to side sub-panels. Figure 12 shows how this space is reclaimed from the traditional panel layout, providing more room for more components or the ability to downsize an enclosure. **The Panduct® PanelMax™ Corner Wiring Duct has the potential to save up to 12% of space on the sub-panels and decrease the enclosure footprint by 18%.**

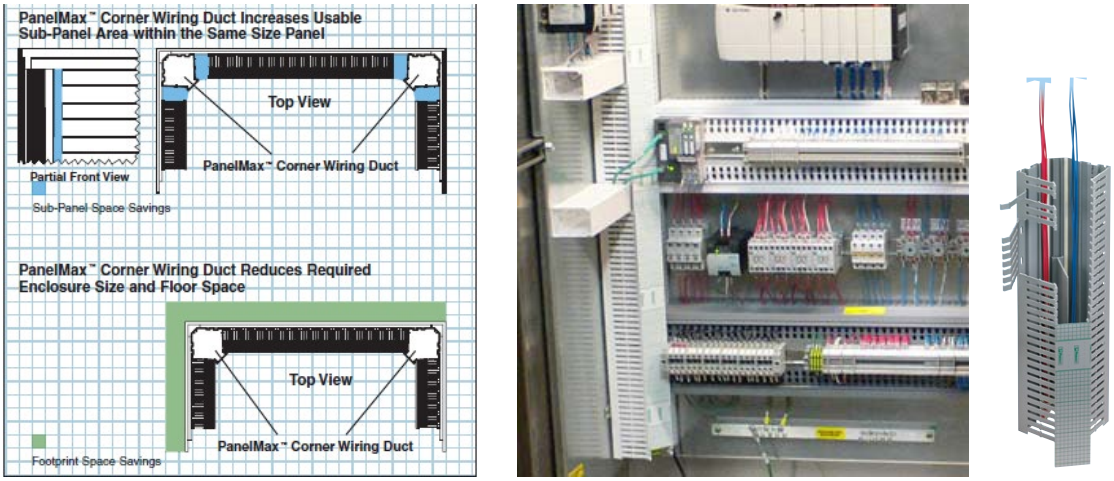


Figure 12. The Panduct® PanelMax™ Corner Wiring Duct is designed to fit into the enclosure corners and utilize this space while providing wiring transition from rear sub-panels to the side sub-panels.

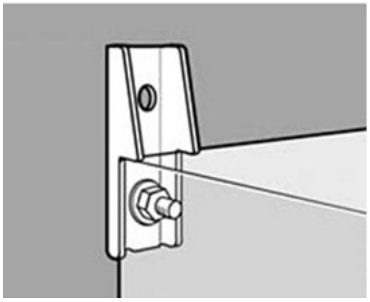
Saving Space Outside the Control Panel

While much can be done to maximize the space inside of the control panel, there are also considerations to be made that can minimize the external footprint. One consideration is how the control panel will be mounted to the floor, wall, or pole (Figure 13). The ability to be flexible with the mounting of the control panel allows the designer to put the control panel anywhere in the design, making the control panel enclosure part of the integrated system solution.

The use of an air conditioner or other added cooling device can affect the control panel footprint. While air conditioners might allow for a more compact control panel solution, they add space to the overall footprint of the control panel. Pentair offers a compact line of air conditioners with a minimal footprint. The small size of the compact air conditioners also allows them to be mounted onto smaller enclosures used in condensed control panel designs. Pentair's thermoelectric coolers allow you to cool small indoor or outdoor enclosures. Pentair thermoelectric coolers are an ideal solution for demanding or low-maintenance environments because they are compact and reliable, and require no refrigerant, compressors, or filters.

Figure 13. Enclosure mounting options from Pentair.

Pentair Enclosure Floor Stand Kit



Pentair Enclosure Wall Mounting Foot

Pentair Enclosure on Pole Mount Kit

Thermal Demands of a Compact Design

Saving space in a control panel often means mounting active heat generating devices in close proximity with one another, and putting them into a smaller, more compact enclosure. While this is desirable for saving space, it creates a problem for heat dissipation because there are more heat generating devices in a smaller enclosed space. Understanding the thermal needs of a control panel is a key component to control panel design. There are several levels of thermal management solutions, depending on the amount of heat being generated inside the panel, the environment the control panel is in, and the type and size of the enclosure being used for the control panel design. Table 1 summarizes the considerations and possible control panel design solutions.

Table 1. Guide for selecting cooling solutions under varying ambient conditions and active component densities.

<table>
<tr><td colspan="2"></td><td colspan="6">Enclosure Type – Component Density</td></tr>
<tr><td colspan="2"></td><td colspan="3">Type 1 (IP 20) or 3R (IP22)</td><td colspan="3">Type 12 (IP 55 or Type 4 (IP66)</td></tr>
<tr><td>Ambient Temp.</td><td>Active Component Heat Output</td><td>Low</td><td>Medium</td><td>High</td><td>Low</td><td>Medium</td><td>High</td></tr>
<tr><td rowspan="3">Room Temp</td><td>Low</td><td colspan="3" rowspan="3">Natural Convection (Vented Enclosure)</td><td colspan="3" rowspan="2">Natural Convection (Sealed Enclosure)</td></tr>
<tr><td>Medium</td></tr>
<tr><td>High</td><td colspan="2">Forced Convection Vented Enclosure with Fan)</td><td colspan="2">Forced Convection (Sealed Enclosure)</td></tr>
<tr><td rowspan="3">Warm</td><td>Low</td><td colspan="3" rowspan="2">Natural Convection (Vented Enclosure)</td><td colspan="2">Forced Convection (Sealed Enclosure)</td><td rowspan="4">Air Conditioner</td></tr>
<tr><td>Medium</td><td colspan="3" rowspan="4">Forced Convection (Vented Enclosure)</td></tr>
<tr><td>High</td></tr>
<tr><td rowspan="3">Hot</td><td>Low</td></tr>
<tr><td>Medium</td></tr>
<tr><td>High</td></tr>
</table>

Pentair offers several products that can help manage thermal demands on a control panel design. Fans mounted on an opening on the surface of the enclosure such as Pentair's 4" compact cooling fan which can move 118 CFM of air, internal circulation fans such as the Pentair fan which can move 500 CFM of air, and air conditioners such as the T-15 can remove 800 BTU/Hour (234 W) from a control panel. These are products that if used in the right application can allow the designer to fit more heat generating devices into a smaller space.

The topic of thermal design considerations will be covered in depth in the Environmental Protection white paper in this series, but it is mentioned here to highlight the need to consider the thermal impact of a more compact control panel.

Conclusion

Controls engineers must overcome a tremendous amount of complexity when designing control panels in today's industrial environments. Whether the application is in the oil and gas, food and beverage, automotive, water treatment, or pharmaceutical market, competing design criteria make decisions about optimizing the control panel critical to the success of the project. Working together, Panduit and Pentair solutions provide control panel optimization best practices that address emerging control system needs.

Hoffman

PENTAIR

About Pentair Equipment Protection

Pentair Equipment Protection, a Pentair global business unit, is the leading provider of worldwide product and service solutions for enclosing, protecting and cooling electrical and electronic systems. Its industry-leading brands – Hoffman*, McLean*, Schroff* - provide a broad variety of standard, modified and engineered solutions to the commercial, communications, energy, general electronics, industrial, infrastructure, medical, and security and defense markets.

PANDUIT®

Since 1955, Panduit's culture of curiosity and passion for problem solving have enabled more meaningful connections between companies' business goals and their marketplace success. Panduit creates leading-edge physical, electrical, and network infrastructure solutions for enterprise-wide environments, from the data center to the telecom room, from the desktop to the plant floor. Headquartered in Tinley Park, IL, USA and operating in 112 global locations, Panduit's proven reputation for quality and technology leadership, coupled with a robust partner ecosystem, help support, sustain, and empower business growth in a connected world.

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