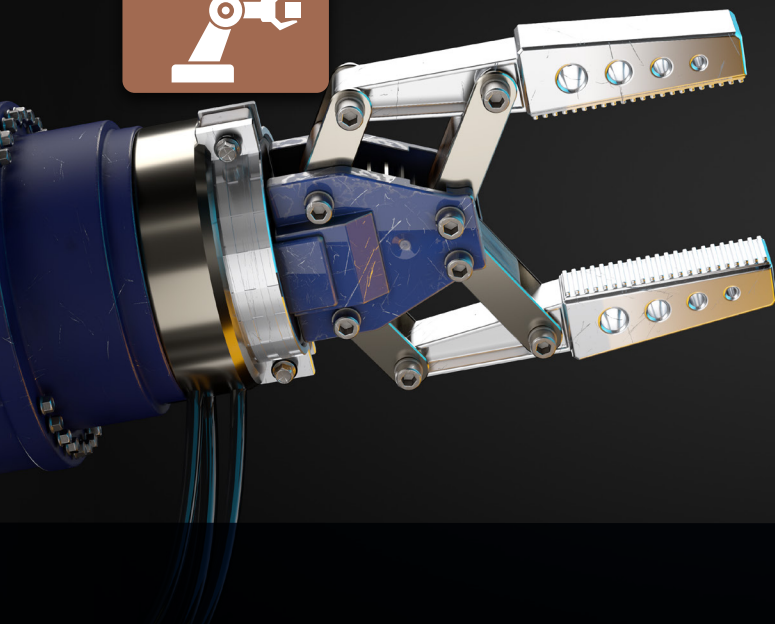




Whitepaper

Industrial



How to tackle the increasing density of electronic systems and control equipment on the factory floor

Executive Summary

Manufacturers seeking to increase automation face a competition for factory floor space between their new machinery and the necessary control equipment. The answer is to fit more into the control cabinet, but that raises problems. This whitepaper explores those issues and highlights today's solutions.

Key challenges of increased component density include heat management, for which in-cabinet cooling systems are available. Approaches to making better use of cabinet space in all dimensions, without overcrowding, are discussed.

For every category of control panel component, new designs are saving space through more compact dimensions and often through improved tolerance of close packing. These advances are complemented by the latest concepts in connecting components, which further reduce space needs and simplify control panel engineering. The market is surveyed for good examples of space-saving products in all categories.

Introduction

As manufacturing operations become increasingly automated, electronic systems and control equipment are competing with production equipment and personnel for valuable factory floor space. To limit that conflict, more and more controllers, power supplies and other electronic components are being squeezed into a single control cabinet.

Eventually, as the automation trend continues, control cabinets will have to increase in size and footprint to cope with extra equipment – unless their space can be used more efficiently.

Every step we take toward the connected, digital, automated world of Industry 4.0, and its smart factories, intensifies that requirement. Consider the increase in communication and interaction between machines, computers and staff via the Industrial Internet of Things. Look at the vast amounts of Big Data we will be collecting for analysis – often via automatic sensors.

Think of the growing use of artificial intelligence and machine learning, enabling factory systems to understand processes and make decisions. These developments all add to the need for electronic equipment and control.

The space challenge

Today's control panels and cabinets are already quite full. Typical contents include surge suppressors, AC and DC power distribution, power supplies, PLCs (programmable logic controllers), terminal blocks and relays. The usual layout approach is to mount equipment on a series of DIN rails attached to the cabinet's back plate.

It may be tempting to save space by simply cramming these components more tightly together, but that can cause problems. It makes them harder to access and maintain, so maintenance work may take longer and be less effective. It creates cabling difficulties, in terms of entry, segregation and achieving the correct cable radius. Insufficient separation may also lead to electromagnetic interference (EMI) effects and arc flash hazards.

A key challenge when packing control cabinets more densely is excess heat. More of the heat generated by a component is passed to its neighbours when distances are reduced. A smaller cabinet has less space inside for heat dissipation and less surface area to dissipate heat externally. Even if a cooling system is fitted, excessively dense packing limits its ability to circulate air.

Cool solutions

When specifying components, check their thermal efficiency and choose those which generate less heat. Compact products, as described later, allow for more surrounding air space. Where possible, select items with a uniform height to minimise interruption of air flows.

If necessary, install a cooling system in the cabinet. Some very compact systems are now available. In a reasonably cool factory, the air driven by an in-cabinet filtered fan may be enough to remove unwanted heat. In dirty or polluted environments, a closed-loop heat exchanger is a good option. For hot conditions, an air conditioning system for the cabinet will be more appropriate.

In a cooled cabinet, the components producing most heat should be close to the cooling device. It also makes sense to position cable harnesses away from cooling air inlets and outlets, and away from air passages.

In addition to allowing a smaller and more densely packed cabinet, effective heat management extends equipment service life, improves reliability and lowers the frequency of product failure.

Compact layouts

Bare cabinets – or enclosures – for assembly of control equipment come in a variety of sizes, shapes and designs. Aside from choosing compact components and managing heat, there are other fundamental ways of making full use of their space.

One is to design the layout in three dimensions. In most control cabinets, components are set out in rows on the back plate. Consider whether the top, bottom and side panel surfaces of the enclosure, and the inside of its door, can be utilised in addition.

Some specialised enclosures expand 3D possibilities further by having a middle section, for rack-mounted equipment, as well as the conventional rear panel with its rows of components. A double-hinged structure allows the middle section to be swung open for access to all areas.

Another approach to using 3D space is found in the wiring duct range from Panduit. Its PanelMax DIN Rail Wiring Duct, with two separate wiring channels, enables a DIN rail to be mounted with equipment which would otherwise be applied directly to the back plate.

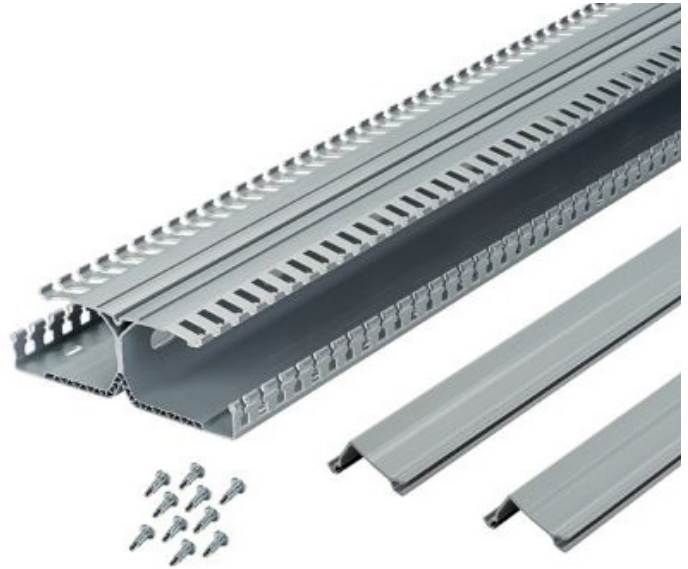


Figure 1. PanelMax DIN Rail Wiring Duct (source Panduit)

The same range includes two novel aids to increasing the density of wiring which would normally be separated to avoid electrical noise. The PanelMax Shielded Wiring Duct and Noise Shield provide the same EMI barrier effect as six inches of air space.

Before installing a cabinet, think about where and how it should be positioned. Different floor, wall and pole mounting kits give flexibility to place the cabinet wherever it fits best into the factory's overall equipment layout.

Compact components

Equipment manufacturers have developed slimline components which significantly reduce space needs. In the IDEC range, for instance, there are relays as narrow as 6 mm. Matched components can often be positioned side by side, with little or no intervening space.

On-panel products are fitted to the cabinet door so their displays and switches can be seen and operated from outside while their body occupies space inside. IDEC for example supply a range of push button switches for control panels.

A further consideration when selecting components is multi-circuit functionality, which can cut down the total number of devices needed. Whatever products you are considering, look for easy push-in connecting options to make their installation and maintenance easier in a small space.

Product choices

From a multitude of space-saving solutions on the market, the following examples have been selected to give an idea of what is practically possible.

Surge protection

Components must be defended against lightning strikes and other power surges. A variety of compact, DIN rail-mounted surge protective devices for different situations are available from Bourns and other specialist manufacturers.

Distribution

Traditional arrangements typically contain power distribution blocks (PDBs) with large conductors entering on one side and small ones leaving from the other. One labour-saving and space-saving alternative for distributing power is a modular busbar system, mounted to the back plate.

The many individual insulated conductors running from the PDB to the controls can be replaced by one simple busbar, and components are then simply snapped onto it. Unused sections of its length can be insulated with protective covers for safety.

Flat, flexible busbars can be added to the modular system for use in tight spaces. Their permissible bending radius is much smaller than that of conventional conductors used in the same application. Examples include the Triton flexible bus bars now available from Molex. Constructed from plated copper braid or copper rope, they are available in wire sizes from 14 ga to 500 MCM.

Figure 2. The Molex Triton flexible bus bar solution (source Molex Triton)



Figure 3. The Mean Well HDR-15-12 DIN Rail Power Supply (source Mean Well)



Power supplies

Advances in lithium-ion battery technology have played a large part in reducing size and weight in UPS devices while extending their capabilities and service life. The resulting DIN rail-mounted products take up substantially less space.

Standard switch mode power supplies are also smaller now, and by choosing a model with an integral transformer you can often eliminate the need for a separate transformer in the control circuit. An example of an extremely slim AC/DC 15 Watt DIN rail-mounted power supply is the Mean Well HDR-15-12 – see Figure 3. Measuring just 17.5 mm in width and has a no load power consumption of less than 0.3 Watt.



Figure 4. The IDEC RV8H interface relay (source IDEC)

The Panasonic IO-LINK range of sensors use laser-based, fibre optic connectivity that helps avoid electrical interference as well as providing isolation.

Terminals and connections

In the area of interconnect products, the market offers huge choice. Take, for instance, the Brad M8 and M12 Passive Signal and Safety MPIS (multi-port interconnection system) boxes from Molex, which replace the conventional hard-wired junction box with a simple-to-connect, space-saving alternative. They provide reliable connection of high-density industrial signal I/Os and allow two sensors to be connected per port. These cost-effective but high-performing connectors seamlessly integrate connectivity within the cabinet.

Relays

Sensata Crydom offers powerful and highly versatile Nova 22 Solid State Relays with a 22.5 mm package width. AC and DC models are available, with DIN rail or panel mounting and a unique range of connections.

IDEC's RV8H Interface Relays, measuring 6 mm wide and 70 mm deep, are ideal for high-density mounting. They fulfil various general-purpose relay needs in applications requiring high switching capability in small spaces.

Also worth mentioning are IDEC's X6 Series 16 mm Emergency Stop Switches. These compact e-stops take up just 19.5 mm x 16 mm of space inside the cabinet.

Signal conditioners

Automated industries have a high demand for monitoring and control of process parameters. This increases the need for conversion and/or isolation of signals before they are passed to the PLC analogue input channels. It means many more signal conditioners are required in the control cabinet.

Older signal conditioners tend to be much larger and, worse still, they require air gaps between each unit to avoid overheating. Thankfully, there are now much slimmer models with better energy efficiency.



Figure 5. Molex M12 distribution box (source Molex)

Another Molex offering is the D-Sub Mixed Layout series of connectors, providing for high-power, high-voltage, pneumatic and coaxial contacts in a variety of designs.

TE's communication products include the Industrial Mini I/O Connector. At a quarter of the size of a conventional RJ45 plug, it enables substantial flexibility and space saving on PCBs (printed circuit boards). Key features include a unique locking system which connects easily and strongly resists unintended disconnection.

TE also offers the extensive Elcon range of signal and power connectors using the blind-mating 'drawer' principle – designed so that closing a cabinet drawer connects the mating surfaces. Elsewhere in the TE catalogue are card edge connectors for a variety of applications.

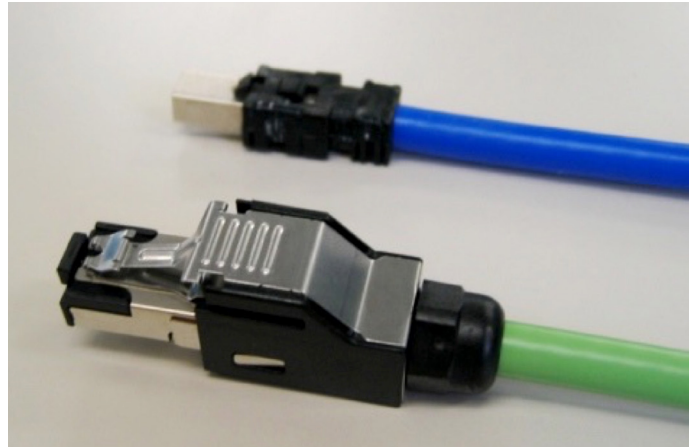


Figure 6. TE Connectivity Mini I/O Connector (source TE)

Amphenol uses an integral push lock mechanism for blind mating in its LTW X-Lok series of connectors, which are suitable for power and data applications. Its range covers a wide variety of receptacles, cable assemblies, connector sizes and pin configurations.

For advanced automation applications, including those with self-diagnosis functions, manufacturers can turn to the IO-Link universal communication protocol. Panasonic, for example, is now using this in a range of sensors, and it can also be used to communicate with actuators.

Conclusion

If you are running out of space in your control cabinet, and increasing its share of the factory floor is not an option, there are solutions. Denser packing of components could lead to overheating problems, but cooling systems will answer that in many cases. Fuller use of all dimensions and surfaces, in and on the cabinet, will help avoid wasted space. The next step is to choose modern compact components, designed to work in densely packed control panels. TTI Europe will be delighted to show you the market's best products.



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European Headquarters:

TTI, Inc.
Ganghoferstr. 34
82216 Maisach-Gernlinden
Germany
Tel.: +49 (0)8142 6680 – 0
Fax: +49 (0)8142 6680 – 490
Email: sales@de.ttiinc.com
www.ttieurope.com

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