
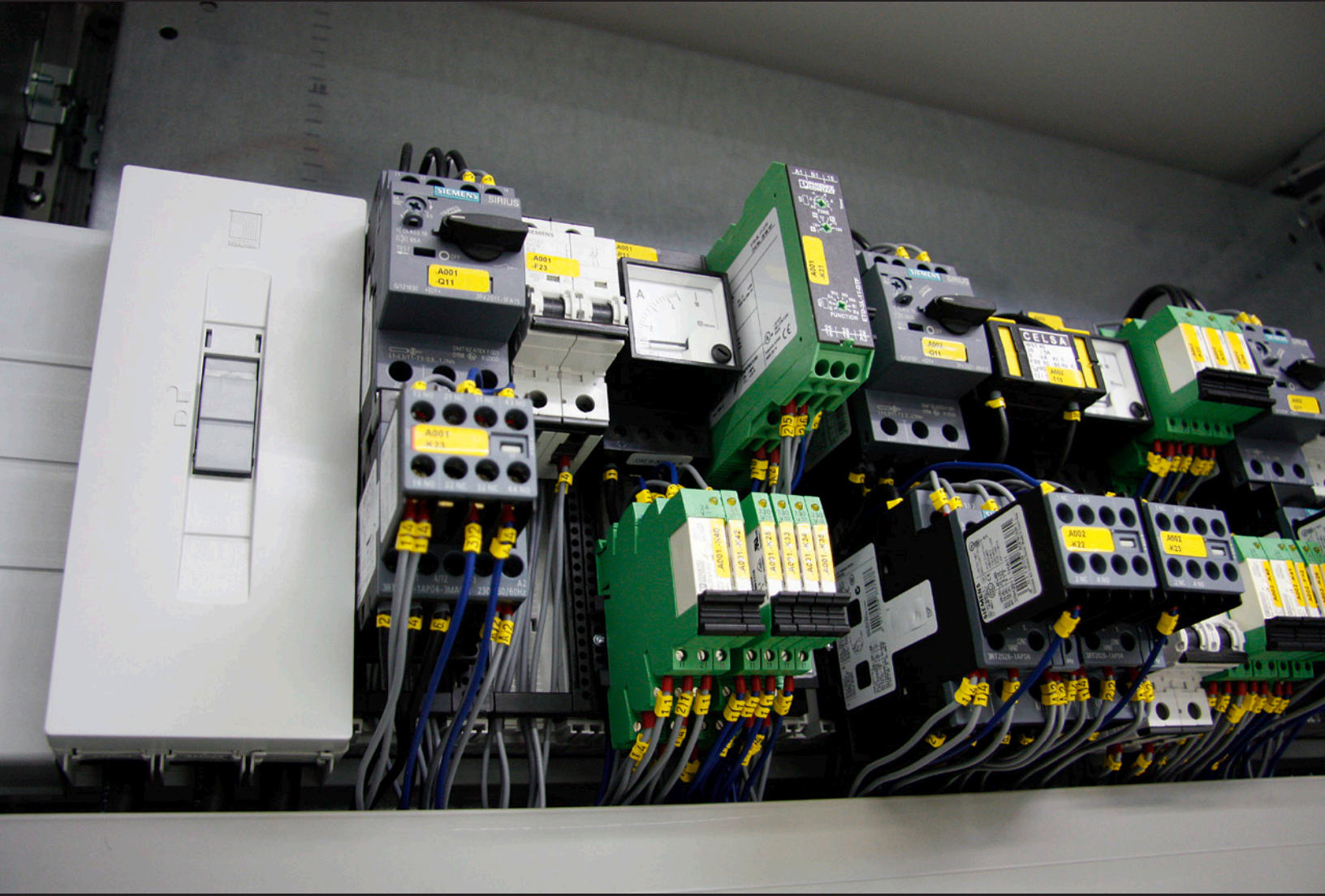


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 **WHITE PAPER: Reducing Control Panel Costs Using IEC Devices and Busbar Systems**



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Executive Summary

Since their introduction into the US just a few decades ago, IEC devices have slowly taken over the controls market that NEMA devices once dominated. Designers, integrators, and original equipment manufacturers (OEMs) each acknowledge the benefits realized through the use of IEC devices including lower costs and greater safety. The next evolutionary step in refining control panel design is through the use of busbar. Busbar provides these same designers, integrators, and OEMs similar benefits with the primary goal of optimizing control panel design to reduce costs.

An IEC plus busbar combination can reduce costs by two methods – reduction in labor and a reduction in component cost. Designers can use the standardized metric sizing offered by IEC control devices (and their associated busbar adapters) to more efficiently layout panel drawings and make changes from one application to the next. Panel integrators save labor through easier installation methods. OEMs save on capital equipment costs by utilizing the cheaper IEC components as well as the lower enclosure cost provided by the smaller panel layout.

NEMA vs. IEC

The National Electrical Manufacturers Association (NEMA) provides standards for the manufacture of electrical components used in North America. Industrial control and systems equipment is manufactured under NEMA ICS 2, Standard for Industrial Control and Systems, and is generally 3rd party certified under UL 508, Industrial Control Equipment. The equivalent global standard is written by the International Electrotechnical Commission (IEC) – IEC 60947, Standards for Low-Voltage Switchgear and Control gear.

Within the US, IEC devices are now the first choice for most designers in the automation industry. UL 508, the primary industry standard to which the devices are certified in the US, will soon harmonize with IEC 60947 to become UL 60947. Effective 2017, UL 60947 will further cement IEC devices as the industry standard for years to come.

There are many reasons why the IEC equipment has surpassed NEMA equipment in the US. It is easiest to understand the reasons by first understanding the two different philosophies between NEMA and IEC. NEMA standards are more generalized, resulting in robust controls that are built to handle any application – this makes it a little easier on the designer as there aren't as many parameters to consider. IEC standards are more specific, resulting in components built to save space and cost – this is done by providing more precise controls for the given application.

NEMA devices are designed to meet standard size ratings (00, 0, 1, 2 ... 9). This gives the device a longer life span but means that most NEMA devices are often overbuilt for their application. For example, a NEMA Size 0 contactor is rated 5 HP at 460V giving a full load current (FLC) of 8A. This same contactor has a continuous current rating of 18A, more than double the full load current.

IEC components are not defined by standard sizes but instead are application rated, i.e. they have continuous current ratings much closer to their switching capacity. An IEC contactor equivalent to the NEMA size 0 is also rated 5 HP at 460V (with 8A FLC), however it only has a continuous current rating of 9A. Because of this tighter tolerance, IEC controls are typically offered in twice the number of sizes as opposed to their NEMA-approved counterparts. This allows for more precise arrangements, reduces waste, and saves cost.

Smaller Size of IEC Devices

In addition to lower acquisition costs, IEC devices save enclosure and panel costs due to their reduced size. In general, IEC motor controls less than 100A (more than 80% of the market) are 30-70% dimensionally smaller than their equivalent NEMA controls.

The major factor attributing to the smaller IEC size is improved arc suppression. Every time a contactor closes or opens an arc will form that slowly degrades the metal contacts. NEMA contactors have large conducting surfaces to account for this. Better arc suppression in IEC contactors means less material is needed, thus reducing size. The larger NEMA units do allow for a greater life span, as both the rated mechanical and electrical operations are higher than equivalent IEC units. However, the IEC has identified different ‘utilization categories’ which define contactor and relay electrical load and duty cycles, making it easier to select the proper controls for a given application.

Motor Protection Circuit Breakers

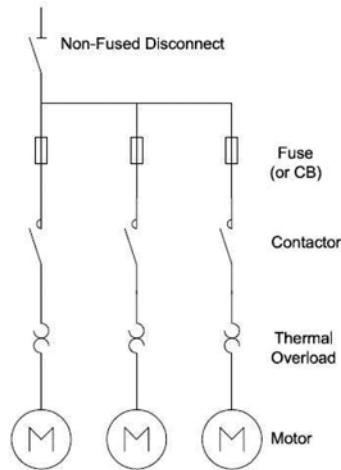
Overload relays and contactors used for motor control do not provide short-circuit protection. In NEMA panels the branch circuit short-circuit protection is typically achieved with the addition of fuses or molded case circuit breakers (MCCB). With IEC panels a motor protection circuit breaker (MPCB) can achieve the same thing and more. MPCBs can not only provide a disconnecting means and short-circuit protection with magnetic instantaneous trips, but also provide manual motor control and overload protection with thermal trips.

There is no NEMA equivalent to an IEC MPCB and they cannot be used as a replacement for a UL 489 MCCB or as a UL 98 disconnect switch per the NEC. As such, UL classifies these products simply as manual motor controllers. Also known as manual motor protectors (MMP) or motor starter protectors (MSP), a common application for these devices is in a group motor installation. Group motor installations do not require short-circuit protection for each individual motor circuit. There are restrictions that must be followed, but NEC Article 430 (Motors, Motor Circuits, & Controllers) and subsequently UL 508A (Industrial Control Panels) each provide exceptions to allow several motor loads on one branch circuit.

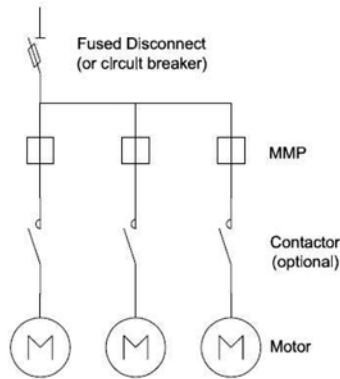
Additional testing of an IEC motor protection circuit breaker allows UL 508 listing as a type of combination motor controller (CMC). This listing allows the CMC to function as a branch circuit protection device for motor loads, eliminating the need for a UL 489 MCCB or fuses. These CMCs are generally defined as a ‘Type E Manual Self-Protected Combination Motor Controller’. The ‘self-protected’ designation ensures it has been tested to function reliably after a short circuit, something even a UL 489 MCCB does not have to pass. The addition of a contactor for remote motor control creates a ‘Type F Combination Motor Controller’. These CMCs allow circuits similar to a group motor installation but without restrictions.

Replacing single function devices with MMPs or CMCs can save both panel space and wiring labor resulting in significant cost savings.

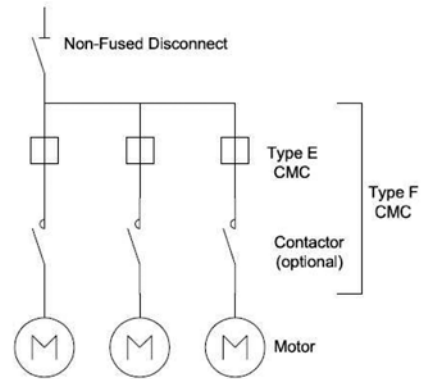
Traditional Motor Circuit



Group Motor Circuit



Type E/F Motor Circuit



Standardized Metric Sizing and Installation

Any increase in time spent on design work to configure the more application-specific IEC components is offset by a reduction in the time it takes to layout the panel. IEC components have a standardized modular design with widths consistent along product lines. For example, a 2-pole miniature circuit breaker is twice the width of a 1-pole, while a 3-pole version is three times the width. In general, motor starters rated 37A and below are 45 mm wide; between 40A and 55A are 54 mm wide; 60A to 100A are 72 mm wide. In addition, most accessories like auxiliary contacts can be used with devices regardless of rating (size). This standardization allows designers to configure panel layouts across various device manufacturers much easier.

Another benefit to IEC controls is a dual-mounting feature. Like NEMA devices, IEC controls can be panel mounted individually using two or four mounting holes. Unlike some NEMA devices however, virtually all IEC controls are designed to mount to a standard 35 mm DIN rail. This means that instead of drilling and tapping many holes for individual installation of NEMA controls, a panel integrator can install an entire row of IEC devices with just a few screws to support the DIN rail.

Additional Benefits of IEC Devices

The NEMA devices that have long dominated the North American motor control landscape, are giving way to IEC-approved equipment, not just for panel size but other benefits as well.

Overload Relay Performance

An estimated 30% of all motor failures can be attributed to overload conditions. Most IEC overload relays are 'Class 10' units, which have a 10-second tripping time. Typical NEMA relays are 'Class 20' units, which have a 20-second tripping time, making the IEC units twice as fast. NEMA controls are overbuilt for general purpose while IEC components must be more carefully chosen for the given application. One concern IEC critics pose is increased nuisance tripping – a phenomenon where the relay will trip the motor during peak current draw (usually start-up). However, this problem is vastly overstated as virtually all modern motors will reach operating speed before the 10 second tripping time. Those special applications that require more time can be equipped with Class 20 overload relays.

An estimated 15% of all motor failures can be attributed to single phasing. Single phasing usually occurs when an up-stream single phase load causes an imbalance in a down-stream three phase load. Bi-metallic IEC overload relays are designed with phase loss sensitivity in mind. In the event of an electrical imbalance, a differential tripping mechanism essentially makes the overload relay more sensitive by lowering the trip point. Note, even with this feature it is possible for damage to occur after extensive single phasing of a motor whose load is still not high enough to trip the relay. Those who are concerned with true phase loss protection should invest in solid state (electronic) overload relays or separate phase monitors.

The temperature of a motor is dependent on two factors. The first factor is the heat generated with normal operation of the motor – magnetic and current effects. The second factor is the ambient temperature condition where the motor operates. The overload relay protecting the motor from overheating needs to do so within varying temperature conditions. To make matters worse the relay may even have its own set of variable ambient temperatures that is different from that of the motor. On a cool morning the overload relay will have a longer tripping time, while hot summer conditions will decrease tripping times. Temperature compensation isn't available for most NEMA overload relays but is a standard feature of most IEC versions. These relays have mechanical means to reduce temperature effects and maintain trip times regardless of conditions..

Enhanced Safety

IEC devices are equipped with measures to prevent accidental contact with live parts. Ingress protection (IP) ratings defined within IEC 60529 consists of two numerical digits. The first shows criteria for protection against contact with a foreign body and the second digit shows criteria for protection against water. IEC devices feature IP20 bodies, whereby objects 12.5 mm (1/2") and greater are unable to contact the live terminals of the device. There is no such NEMA standard although some NEMA device manufacturers have designed their equipment with this feature.

Another safety measure missing from NEMA devices but incorporated into IEC equipment design is more specific short-circuit performance criteria. This criteria, specified by IEC 60947, outlines differences between those devices that are allowed to show damage after a short-circuit and those that are not. 'Type 1 coordination' devices are allowed to show damage and are thus not suitable for re-use without repair or replacement of parts. 'Type 2 coordination' devices are not allowed to show damage and are considered suitable for re-use after a short-circuit fault. In addition to providing enhanced safety by eliminating the possibility of a dangerous arc flash, a Type 2 device also saves downtime and increases productivity since the panel doesn't require repair or replacement of damaged components.

Global Market Acceptance

IEC motor controls are readily available throughout the world and typically carry both a CE mark for the European market as well as a UL mark for the North American market. This combination is a powerful one-two punch for global manufacturers such as those in the automotive industry. It not only provides a common platform for machinery, ensuring that parts can be easily sourced anywhere in the world, but also ensures all installations will conform to electrical codes set by local jurisdictions.

Busbar Applications

A busbar is defined as an electrically conductive strip or bar used to distribute power to multiple circuits in parallel. Busbar can also be used as a common tapping point for multiple ground or neutral terminals. The use of busbar for switchgear goes back to the dawn of electricity generation and has continued to be used in both residential and commercial applications.

Residential load centers in the US generally have four busbars for single phase (two-wire) service – two 120 volt (hot) bars, one neutral bar, and one ground bar. Small circuit breakers snap into place creating multiple 120 or 240 volt branch circuits throughout the home to be used for lighting, HVAC, and appliances. The whole system is contained within a NEMA 1 enclosure with dead-front accessibility – the circuit breakers are acces-

sible for switching but no live electrical parts are exposed. 100-200 amp installations are typical.

Commercial applications are much more varied and can reach 6000 amps and above. They can be used for switchgear, control gear or general power distribution applications. The traditional commercial application of busbar is in a motor control center (MCC). MCCs consist of multiple enclosed sections of motor controllers (contactors, combination motor starters, etc.) powered by one common bus.

Another type of busbar can be found in the form of busway. Electrical power can be distributed via busway in lieu of multiple conductors running along cable trays or conduit. The term busway refers to lengthy runs of modular, pre-fabricated busbar within an enclosure or wire way. Advantages include easier, less costly installation and expansion procedures. Along with typical factory or industrial installation, busway can be found in data centers offering plug and play capability as well.

We can see that busbar is typically used in residential applications 200A and less and commercial power applications 1600A and above. Busbar is used within control cabinets (200 to 1600A) by panel builders and OEMs but it isn't always the first option for several reasons.

1. Busbar systems are not cost effective unless the system is of a sufficient size. It is difficult to identify the tipping point, but busbar systems are ideal when there are multiple quantities of motor starters and motor starter protectors. The more branch circuits there are the more effective a busbar system will be in terms of panel space and cost savings. Of course if saving space is paramount at any cost, a busbar system will achieve this for virtually any application.
2. Residential load centers are basically made the same, even among different manufacturers. A 200 amp load center will have a thicker bus with more terminals but the basic design is the same as a 100 amp load center. Likewise, the modular capabilities of most MCCs means the basic design is similar regardless of the application. In contrast, a control panel is purpose-built and it is unlikely that any two are exactly the same. This makes it difficult for the panel builder and/or designer of motor control cabinets to standardize on any control panel installation technique.
3. The use of IEC devices in the US only became common-place in the last ten years. Although they can be used with NEMA devices, busbar systems for control panels were designed in Europe for use with IEC equipment. Many North American designers and panel builders simply haven't been exposed to these busbar systems, to realize the benefits they provide

Busbar Misperceptions

In the past, busbar was utilized in single-use systems fabricated for a specific application. Even today only a few manufacturers are making standardized modular busbar systems which are suitable for control panel use. Still, common misperceptions exist due to lack of knowledge concerning these systems. The two most common are listed here:

Busbar systems are more dangerous due to difficulty making touch-safe installations.

Traditional busbar installations such as load centers and MCCs offer touch safety with the use of dead front panels where the power connections are only accessible in the rear of the enclosure. The newest modular systems designed for use with control panels incorporate touch-safe terminals and covers built into the system. Also, since these control panel busbar systems are designed to eliminate terminal blocks altogether they can be considered safer than many typical block and cable installations.

Busbar systems require complex fabrication and integration techniques.

In the past, many switchgear installations using busbar required bending, drilling and tapping of the copper bus. With newer standardized modular busbar systems there is no need to bend, drill, tap, or otherwise modify the bus other than cutting it to length. Even then, cutting the bus to length may not be necessary depending on the installation. All connections to the bus are done via adapters which are held in place with set screws or spring clamps.

Typical Busbar Components

Modular busbar systems consist of pre-engineered components designed to make power connections with common solid copper conductors. The system can be configured in varying sizes and lengths, optimizing the panel space for a given application. Typical parts comprising a busbar system for control panels are as follows.

- Copper busbar and splice connectors.
- Busbar supports.
- Cover system for contact hazard protection.
- Connection accessories such as connection adapters, cable clamps, and plate clamps.
- Component adapters for items that mount to DIN rail.
- Circuit breaker adapters.
- Fuse base adapters.
- Insulated flexible busbar.

Busbar Features and Benefits

Busbar systems for control panels are much more likely to be used in Europe where they were invented. European panel designers are, in general, more concerned with saving panel (enclosure) space. Now, with American panel designers using more IEC equipment in their designs the next logical step is to follow the European lead by utilizing busbar systems to further reduce panel space and lower costs.

IEC devices provide reduced component costs and less labor to install. Busbar systems replace parts of a traditional control panel so acquisition costs are not much of a factor, beyond the ability to use a smaller enclosure. Much of the costs saved using a busbar system is derived from easier installation and reduced labor.

There are three main parties involved in creating a control system from inception to adoption. The panel designers are responsible for specification work, bills of material (BOMs), drawings, and in some cases procurement of the individual parts. Panel integrators are primarily responsible with using the specifications and other documents written by the designers to physically put the system together. End users will put the system in use but may need to occasionally provide maintenance or expand the system based on growing demands. All of these parties can benefit in some way from using busbar systems.

Busbar Features and Benefits – Panel Space Savings

At its core, a busbar system is designed to replace all of the line side wiring and associated accessories of an electrical panel. After the main feed (and usually the main overcurrent protection device) large high amperage cables are run to power distribution blocks (PDBs). These PDBs convert the large high amperage cables into multiple smaller low amperage cables. The multiple smaller cables are run within wire tray to each individual device. The busbar can replace all of these parts as well as offer several key advantages over a traditional block and cable design.

Except for rare main lug only (MLO) applications, most control panels will have a main overcurrent protective device (OCPD) within the cabinet. This can be a circuit breaker or a fused disconnect. In most installations the main OCPD is panel mounted with the controls and control wiring (line-side wiring, distribution blocks, and wire duct) placed under it. However, if the main OCPD is small enough (generally 600A or less) it may be possible to mount this directly onto the bus. This means the OCPD is located on the same row as the control devices, again saving valuable panel space.

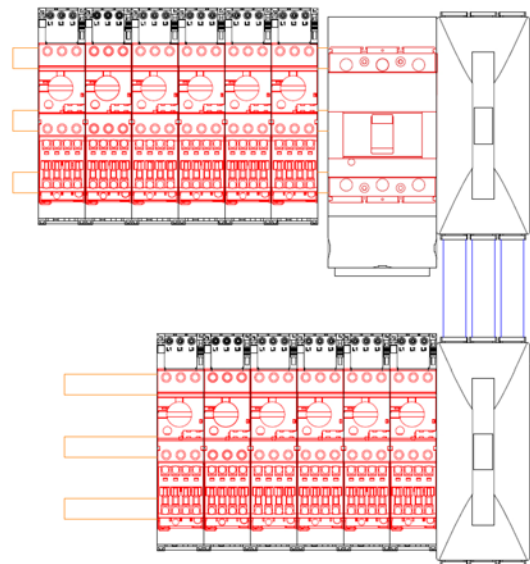
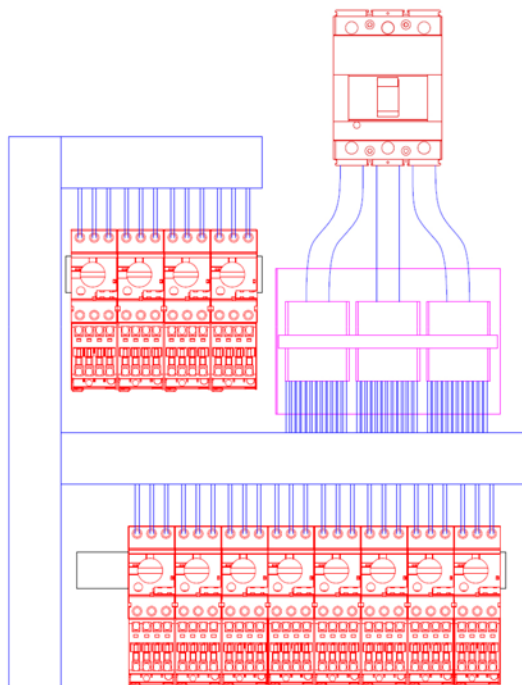
If the OCPD is too large or otherwise incapable of mounting directly to the busbar (via an adapter), it is necessary to energize the bus with feed cables. Larger installations such as these usually require multiple cables per phase. Insulated flexible busbar can replace these cables with a single conductor. The flexible busbar carries all necessary certifications and ratings to facilitate an easy transition from standard round cable. Featuring a wire bend radius as little as 1/8-inch, flexible busbar saves panel space as well as integration time cutting and stripping multiple cables.

The elimination of line-side wiring, PDBs, and wire tray can help offset much of the cost of a busbar system. Further costs can be eliminated through the reduction of enclosure size, or in the case of larger systems, perhaps the removal of an entire enclosure. All parties can benefit from these reduced acquisition costs as they are passed down from designer to integrator to end-user. If space is at a premium, the smaller footprint on the factory floor may be an even more attractive selling point than the saved acquisition costs..

Traditional Wiring System

vs.

Busbar System



- 12 motor starter application.
- Same 20-inch panel width.
- Busbar system has smaller footprint with room for expansion.

Busbar Features and Benefits – Design

Busbar systems based on a modular platform can simplify bills of material (BOM) for different applications. For instance, a modular busbar support is designed to work with copper busbar of different cross-sectional areas (height x thickness). The component adapters are also designed to attach to busbars with different cross-sectional areas as well. A single circuit breaker adapter may be designed to work with as many as ten different circuit breakers of different makes and models. All of this modularity makes it possible for an existing BOM to be revised or a new BOM to be created with minimal part changes.

Designed to meet the rigorous demands of a global marketplace, typical modern busbar systems conform to a wide array of internationally accepted standards. Most will possess third party certifications such as UL/cUL (Underwriters Laboratories) for the North American market and CE for the European markets.

Article 409 of the National Electric Code (NEC) mandates all industrial control panels to be marked with a short circuit current rating (SCCR). Modular busbar systems will come with SCCR for all of the individual adapters. This data makes it possible to easily calculate the system SCCR using the most accepted industry methods such as UL 508A Supplement SB4.

Busbar Features and Benefits – Integration

Many of the physical acts to put together a control system are very labor intensive and can be simplified with the use of busbar. This labor savings includes not only the total elimination of parts but also the ease with which the wires can be terminated to control equipment. Much of the labor savings from using a busbar system is the result of less required modifications to the mounting panel. Accurately drilling and tapping many holes isn't much of a problem for a CNC machine but doing so without can be a monumental task. Even if a CNC machine is available the fewer hole locations afforded by a busbar system will result in less wear on tooling and faster turnaround time.

Power distribution Blocks

PDBs are usually installed with at least two mounting screws per phase. This means a typical three phase application will require at least six holes to be drilled and tapped into the mounting panel. In addition, each end of the feed cables needs to be terminated into the block and OCPD. Wire sizes are constrained and there is limited or possibly even no room for future expansion.

Line-side wiring

The process of completing the line side wiring of a control panel can require a considerable amount of time. For example, a typical three phase 300 amp application with twelve motor starters could mean 36 cables for these devices, plus another three for the feed. Each of these cables must be measured, cut, stripped, routed, labelled (identified), and terminated on both the line and load sides.

Wire duct

All line and load wiring is typically routed along wire duct. The wire duct must be measured and cut to size. The panel is then either drilled and tapped to receive the wire duct fastening screws or just drilled to accept rivets. Typical mounting interval is four inches, so as many as eight holes may be required for each row in a 32-inch wide enclosure with a 28-inch wide mounting panel. Additional caution must be used since the installation needs to take into account wire fill capacity of the duct as well as wire bend radius of the cable. A busbar system cannot replace all wiring duct but it can eliminate the need for the line side wiring duct, saving panel space and installation costs.

Main overcurrent protective device

Like the other line side components, the main overcurrent protective device will also require mounting screws to be drilled and tapped into the mounting panel. As previously mentioned, it is possible for some installations to mount the main OCPD directly to the bus, eliminating the need for these mounting screws and saving panel space.

Installation of miscellaneous control devices

Typical IEC control devices 100 amps and less install to standard 35mm DIN rail. This DIN rail must be fastened to the panel, once again necessitating the drilling and tapping of the mounting panel. Screw intervals are generally in the four- to eight-inch range, meaning as many as eight holes need made per row of controls in a typical 32" wide control panel enclosure. Each MCCB requires at least two of their four holes (3-pole) to be used for direct panel mounting. Elimination of these holes can save significant labor costs.

Certification

Starting in November 2014, busbar systems for use in control panels will fall under the new standard IEC 61439 (Low Voltage Switchgear and Controlgear Assemblies). The components must pass requisite tests in a process known as 'design verification' (formerly referred to as 'type testing'). Like the IEC devices it is designed to be used with,

the busbar system will come off the shelf with the requisite 3rd party certifications. For North America, these systems are designed with UL 508A certification in mind and nearly all parts within the assembly are listed (vs. recognized) to this standard. This means that the UL panel shop integrators are able to use virtually all of the parts without the need to describe them in their procedure, as necessary with recognized products.

Busbar System Installation Procedures

As discussed, the replacement of the line side wiring and accessories with busbar will save a great deal of labor used to both modify the mounting panel and actually install the components. Some of this saved labor is spent in the installation of the replacement busbar, however it is much simpler. For instance, the plastic insulating supports that fix the busbar to the panel only require two mounting screws per support. A typical 32-inch wide enclosure with 28-inch mounting panel would likely have three supports, needing just six holes to drill and tap.

Most IEC devices less than 100A can be mounted on top of small component adapters. These adapters have integrated DIN rail and are pre-wired such that the integrator can bench-wire the device onto the adapter. This also leaves open the possibility to incorporate the kitting of common devices to further streamline the installation process. Adapters such as these are modular, allowing the installation of add-on strips for wider devices or the tying of two adapters together for a reversing starter application. Lastly, smaller busbar adapters such as these often feature tool-less installation, whereby the integrator can simply snap the adapter onto the bus without the need to fix set screws.

Busbar systems for control panels also feature adapters for mounting molded case circuit breakers up to 600 amps. These circuit breaker adapters are usually available with conductors to easily make the electrical connection to the MCCB. These adapters can accommodate top or bottom fed installations.

The other two common adapters available for busbar systems are connection adapters and fuse base adapters. Various size connection adapters take bare cables and make connections to and from the bus. The fuse base adapters are designed to accommodate the most popular fuses used in control panel installations – Class J fuses for North America and Class NH fuses for Europe and elsewhere in the world. Both types of adapters can accommodate top or bottom fed installations.

In the example above, the six holes for busbar supports can replace all of the panel holes used to mount the OCPD, PDB(s), DIN rail, MCCBs, fuse bases, and line side wire duct.

The only additional labor involved is the tightening of set screws to fix the bus to supports and adapters themselves to the bus, as necessary.

Number of Holes to Drill/Tap		
	Block & Cable	Busbar
OCPD	4	6
PDB	6	
Wire Duct	8	
DIN Rail	8	

Busbar Features and Benefits – End-use

A big negative of power distribution blocks is that many are not touch-safe, making the chances for a dangerous arc flash more likely. Modular busbar systems designed for control panels specifically address this issue with a variety of touch safe covers for adapters, their terminals, and the bus itself. When properly integrated, the busbar systems can be 100% touch safe, eliminating the risk associated with stray fasteners, dropped tools, or body parts coming into contact with the bus.

In a traditional control panel, wire sizes are constrained and there is limited or possibly no room for future expansion. Even if expansion is an option, it is often only achieved through very difficult and messy means – larger devices need the mounting panel drilled and tapped. A modular busbar system designed with future expansion in mind is able to be modified to accept additional control components without the need to drill and tap.

In addition to expansion, a control panel utilizing busbar can be easily retrofit to accommodate a completely different application. Since none of the devices are screwed into the panel, each component can be easily removed and swapped with new hardware as needed. As an extreme example, even if the service life of the enclosure is finished it is possible to remove and repurpose the busbar into a new enclosure. This change would be considerably easier than doing so with a traditional block and cable design.

Maintenance and troubleshooting of a system utilizing busbar is far more efficient. Line side wiring does not need to be traced and components can be quickly replaced from their adapters. As with IEC devices, global availability of busbar components provides the end-user with a sense of assurance, knowing that replacement parts can be easily sourced if necessary.

Conclusions

IEC devices have gained acceptance in the North American market for their many advantages over comparable NEMA components. The use of modular busbar systems in place of traditional wiring methods is the next logical step toward the further optimization of control systems since many of the same advantages are achieved. These include reduced cost, easier integration, and enhanced safety, among others. These benefits are realized by each of the parties involved in creating and using the control system.

Control panel designers benefit from the standardized metric sizing of IEC devices. Since standard busbar components for control panels were designed to work primarily with IEC components, the busbar adapters provide the same standardized metric platform to choose from.

A combination of IEC and busbar components allows integrators of control panel systems to complete systems easier. Reduced installation complexity can allow for easier builds across many applications. Production processes can be further streamlined through the kitting of common parts. This kitting not only increases productivity but does so with the use of a labor force that doesn't necessarily need to be proficient with electrical equipment, further saving installation costs.

End-users benefit from the global market acceptance of IEC components. Likewise modular busbar systems possess most of the critical certificates necessary for worldwide installations. The reduced labor costs associated with integration and reduced acquisition costs associated with panel savings can result in a significant cost reduction for the end-user.

All of the above advantages make the IEC-busbar combination the ideal choice for control panel systems. This internationally accepted power distribution technique can be utilized to provide viable and competitive system solutions across a wide spectrum of markets.

	NEMA	IEC	IEC + Busbar
Panel Size	good	better	best
Standardized Sizing	good	better	better
Mechanical Lifespan	best	better	better
Electrical Lifespan	best	better	better
Cost	good	better	best
Performance	good	better	better
Safety	good	better	best
Certifications	good	better	better
Design	good	better	best
Integration	good	better	best
Maintenance	good	better	best

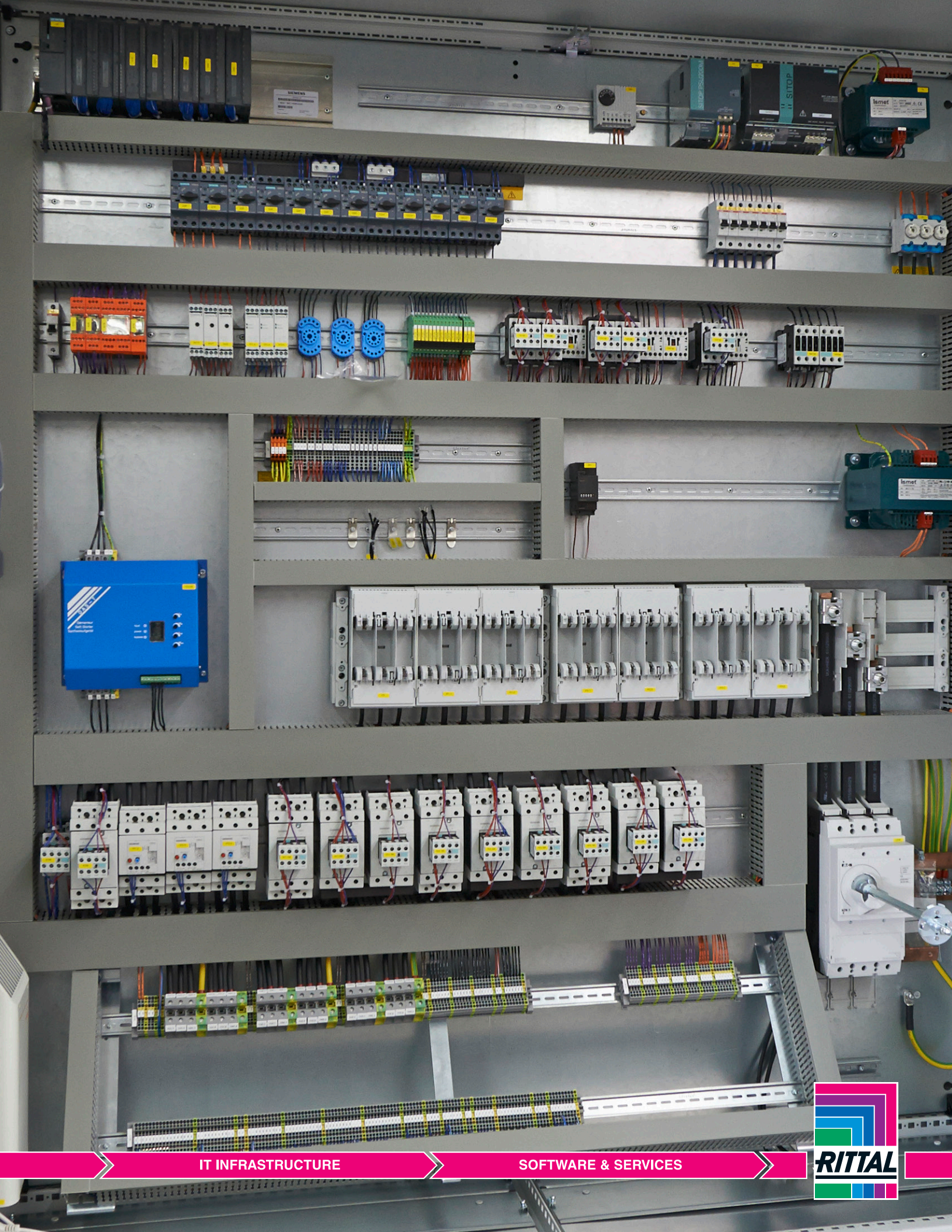
About the Author

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