

Automation NOTEBOOK

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How Power Monitoring Can Equip You to Cut Costs, Boost Reliability, and Turbocharge Productivity

Student Spotlight: Student Engineering Team Creates Straw Panel Manufacturing Solution PG. 4

Feature Story: 5 Circuit Protection Mistakes That Could Cost You Big PG. 8

Tech Brief: Electrical Circuit Protection Essentials PG. 20

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November 2025

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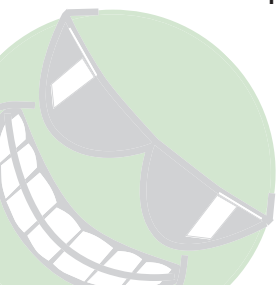
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Don't Let Power Problems Plague Your Plant



Stephanie Neil

Stephanie Neil
VP, Editorial Director
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When it comes to keeping the plant running efficiently, there's an element that is always present but often overlooked. It's the power and current that runs through machines. And all that needs to be managed and protected.

In this issue of **NOTEBOOK**, we explore all aspects of this invisible force, exploring the need for tools that can help engineers and operators avoid common power problems that may result in unplanned downtime.

Our two main feature stories tackle this topic from different angles: Power monitoring tools and circuit protection.

If your facility is experiencing high energy costs or machine failures, the right tools can collect the right data to make decisions that will save money, reduce equipment failures, and even minimize the money lost during unscheduled repairs. In the article "How Power Monitoring Can Equip You to Cut Costs, Boost Reliability, and Turbocharge Productivity," we outline the tools, techniques, and corrective actions you need to take to keep everything running.

A second story, "Circuit Protection Mistakes That Could Cost You Big," will help you understand the consequences that could result from not having the right devices in place. The story starts out with a very real scenario of a control panel going up in flames due to an undersized circuit protection device that couldn't handle the available fault current. An issue that could have been easily solved.

In addition, a tech brief digs deeper into the mystery of power supply by looking at surge suppression. In the age of connected digital systems, surge protection is no longer a nice to have, it's a must-have, especially as it relates to regulatory requirements.

A second tech brief provides some essentials for designing a safe and reliable panel design for electrical circuit protection.

Straw and sugar

Also, in this issue we have two amazing stories that spotlight how ingenuity translates to innovation.

A student spotlight focuses on engineering teams from the University of Massachusetts Amherst that created an automated compressed straw panel manufacturing solution.

Two teams of mechanical engineering students from the Mechanical and Industrial Engineering department were assembled to create a machine that turns waste straw from wheat harvests into efficient insulated building panels that are "locally available, inexpensive, and environmentally friendly."

The teams turned to AutomationDirect for PLC, HMI, and other control elements to design a flexible hydraulic press producing sustainable and cost-effective building insulation production.

And our customer story highlights M.A. Patout & Son sugar mill in Louisiana which has a unique challenge in that during the four months of processing, the plant must run! They too turned to AutomationDirect to use reliable control and automation technologies to keep production up and running during the critical production time.

Turn the pages to get deeper into all these stories — and more!

More power to you. ▼

Stephanie Neil

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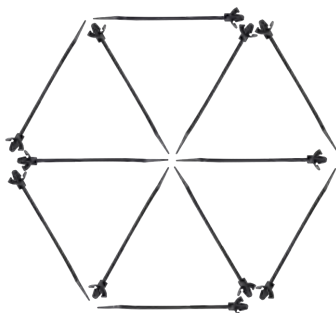
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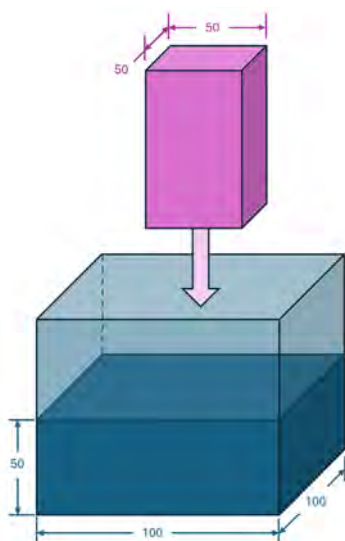


We've recently added a number of additional specialty cable ties and cable tie mounting products including the "winged push-in panel ties" show in this puzzle. Check them out here: go2adc.com/sapiselco



Do Your Level Best

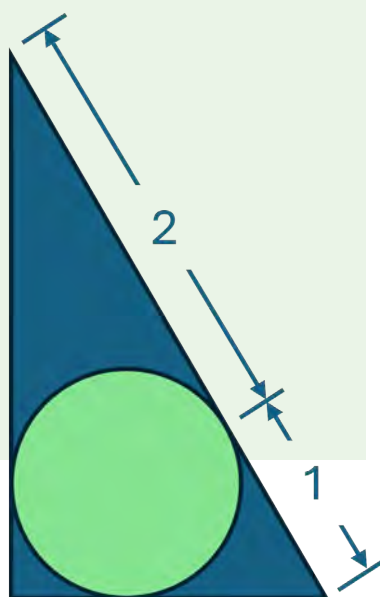
The liquid level in the 100 x 100 unit square tank in initially 50 units deep. How much will the liquid level increase if a 50 x 50 block is lowered into the tank? (The block is tall enough that the liquid will not over-top it)



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Triple Tangency

The image shows a right triangle with an inscribed circle. Each side of the triangle is tangent to the circle. The length of the hypotenuse is given on each side of the tangency point. What is the area of the triangle?



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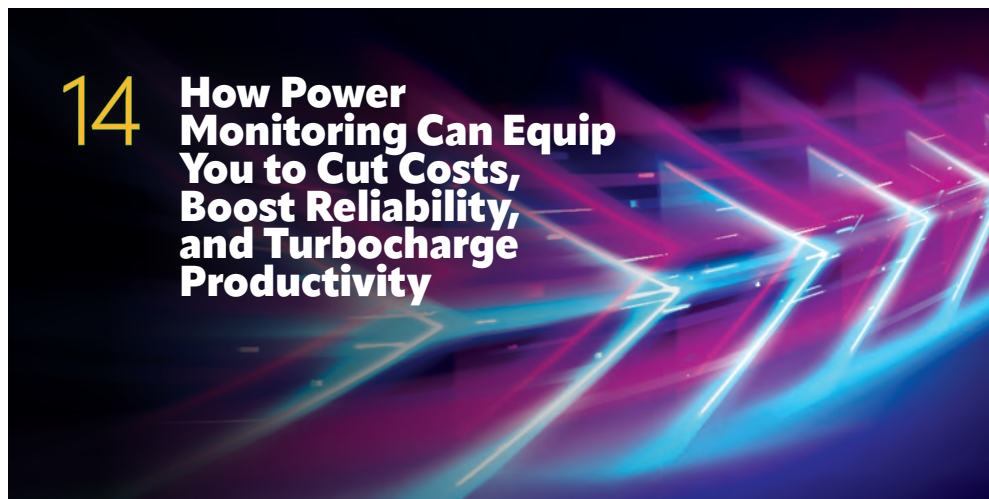
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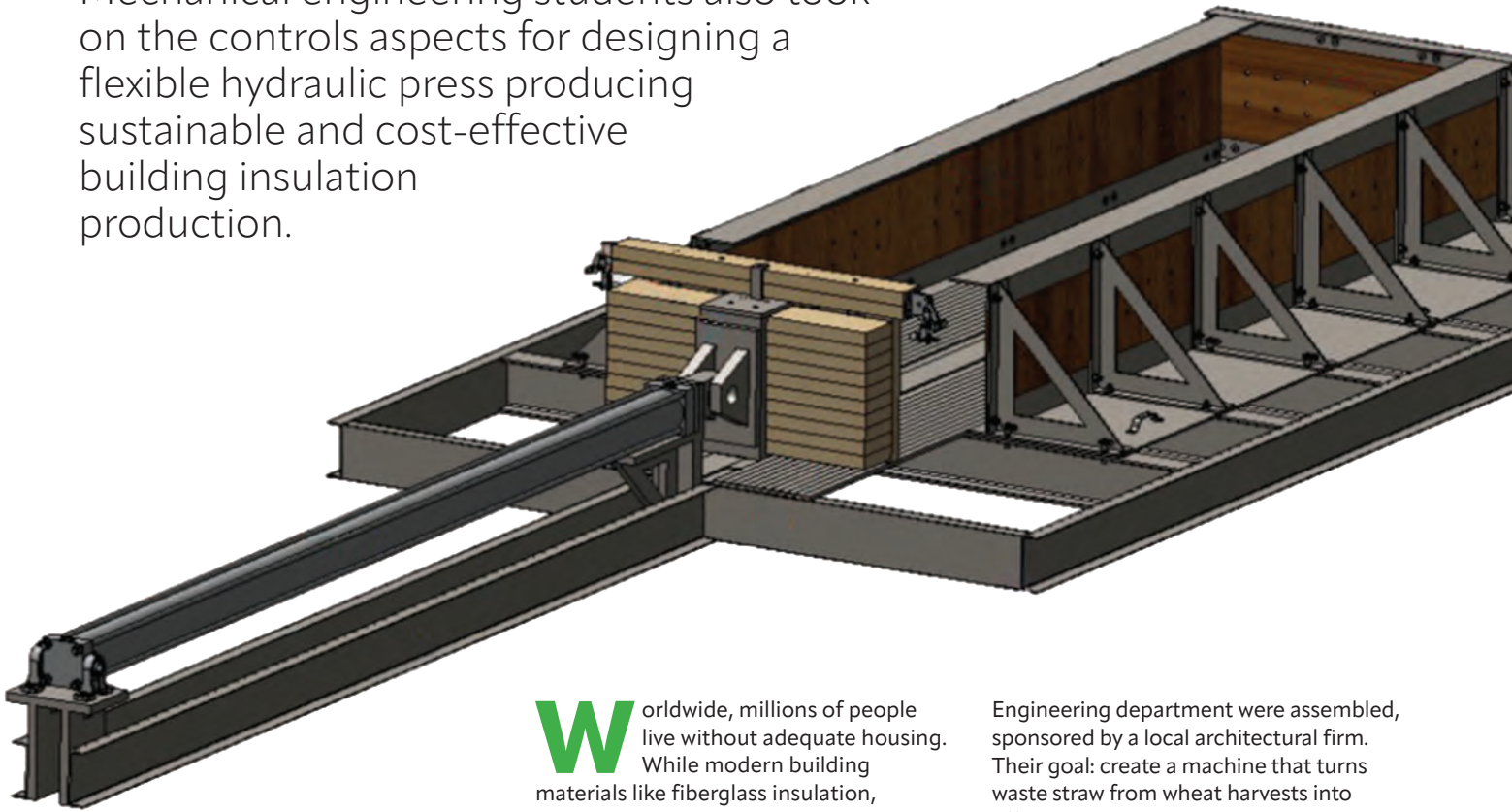
Because the sugar mill operates in overdrive production for just four months out of the year, and recovers for the other eight months, reliable products are essential for maximizing uptime during the busy season.

| NEW PRODUCTS |

University Student Engineering Team Creates Automated Compressed Straw Panel Manufacturing Solution

BY BEN ZAMACHAJ,
UNIVERSITY OF
MASSACHUSETTS AMHERST

Mechanical engineering students also took on the controls aspects for designing a flexible hydraulic press producing sustainable and cost-effective building insulation production.



Worldwide, millions of people live without adequate housing. While modern building materials like fiberglass insulation, moisture wrapping, and even the humble cinderblock have markedly improved construction standards over the past century, there remain many places without access to these — figurative and even literal — building blocks. New methodologies and locally accessible materials can help create housing that is both adequate and accessible.

Ideally, any new manufacturing process would also be sustainable and environmentally friendly. To meet this seemingly impossible challenge, two teams of mechanical engineering students from the University of Massachusetts Amherst (UMass) Mechanical and Industrial

Engineering department were assembled, sponsored by a local architectural firm. Their goal: create a machine that turns waste straw from wheat harvests into efficient insulated building panels — locally available, inexpensive, and environmentally friendly (Figure 1).

Our team focused on the project's controls, while a second team worked in parallel on the device's mechanical structure. This two-team project structure mirrors the interdisciplinary nature of most equipment and automation projects, giving students important real-world experience.

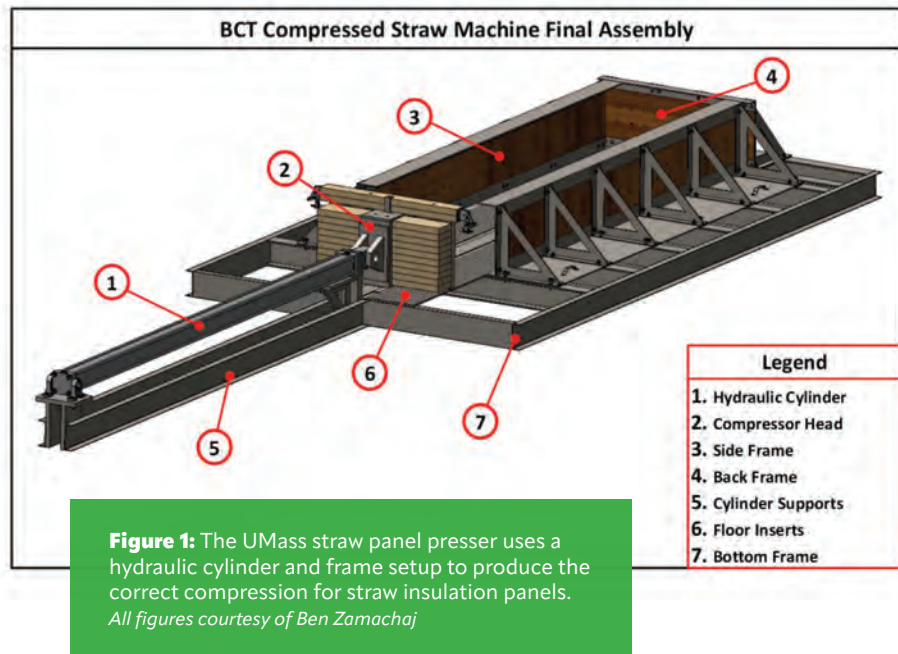
Compressed straw thermal insulation: the theory

Fiberglass — today's de facto building insulation standard — works very well for keeping excess cold and heat at

bay. However, producing it requires specialized processes that are not accessible everywhere, and that may not be environmentally friendly. At the same time, humans have been using straw as insulation — for example, in the form of thatched roofs — for millennia. Today, wheat harvests yield leftover straw, which is burned off as waste, or used as mulch. Using it instead as insulation not only provides an inexpensive source of this critical building component, but keeps carbon sequestered rather than releasing it into the atmosphere.

If this sounds too good to be true, there are two main challenges with using straw as a building material. First, straw is quite flammable in its natural form. Second, while straw may fall nicely in line as a traditional roof material, more modern construction methods demand it to be presented as uniform insulation panels.

To meet these challenges, the two engineering teams implemented a hydraulic press with a wooden frame to hold the straw in place, an AutomationDirect C-more CM5 series touch screen human-machine interface (HMI), and a CLICK stackable micro brick programmable logic controller (PLC), along with other AutomationDirect-source components, to automate the panel presser system (Figure 2).



Processing also includes a subsequent step of applying a vapor barrier wrap. It was especially important and challenging for the controls-focused team to produce the proper pressure needed to achieve the target optimal straw compression. Under-compression of straw degrades the fire resistance, while over-compression is detrimental to heat insulation properties. To properly compress the straw without crushing it, multiple press cycles are used to construct each panel.

Pressing automation into practice

While the frame analysis, design and assembly were underway by the mechanical team, our team implemented controls, sensors, and supporting electronics sourced from AutomationDirect. After reviewing the website and evaluating the project requirements, we selected components including:

- CLICK PLC, C0-12DD1E-1-D Ethernet analog 24VDC
- C-more CM5 touch screen HMI, 10-inch
- Stride industrial unmanaged Ethernet switch
- Wenglor OPT2011 laser distance sensor
- Various control enclosure, terminal blocks, safety relays, proximity switches, and wire management products
- Pull-cable-type emergency stop switch and accessories

Care was taken to include extra space allowing for future expansion and modification as required (Figure 3).

Originally, the project was envisioned to have a more mechanical/manual focus, but when our team members completed Professor Jim Lagrant's course on Industrial Automation we decided to switch to a PLC- and HMI-based system, we found that the free CLICK ladder programming and C-more HMI configuration software and concepts were intuitive and easy to learn. >>



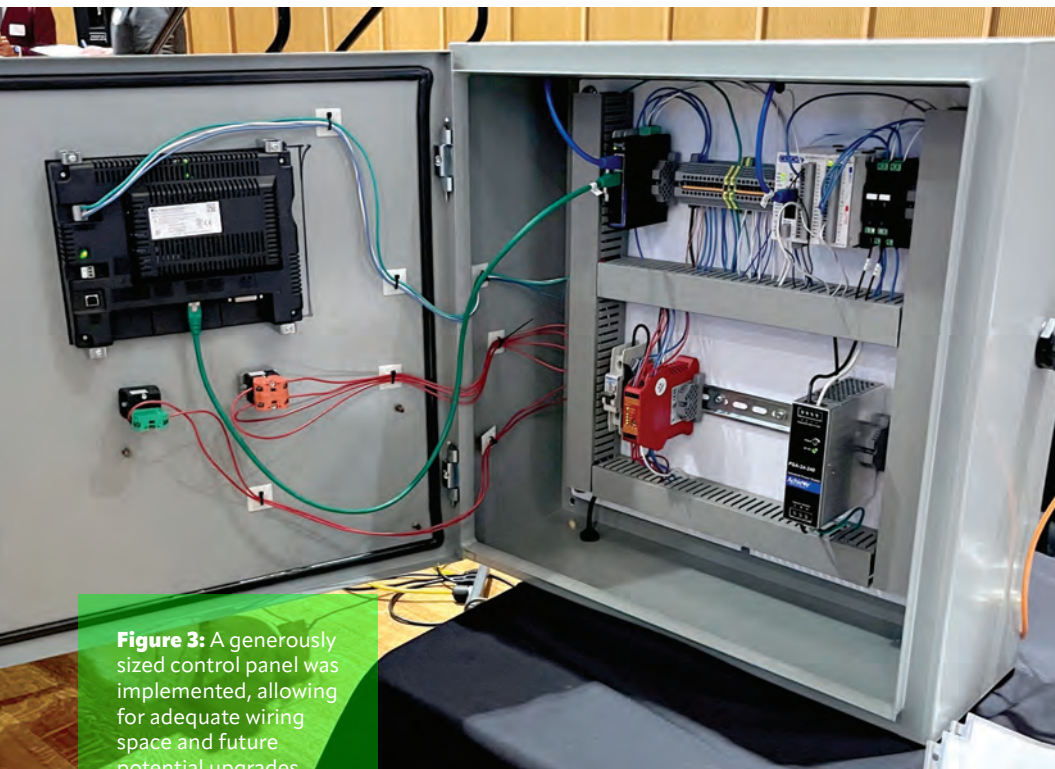


Figure 3: A generously sized control panel was implemented, allowing for adequate wiring space and future potential upgrades.

AutomationDirect offers many support options on the website, including manuals, data sheets, and videos. They also offer responsive phone support, and even provided a bit of welcome pushback at times if we had not fully performed our homework before calling. AutomationDirect's online leadership in offering a range of support options helps users of all types engage in the ways that are most helpful for them.

The entire team contributed to specifying sensors and wiring the panel wiring, while my focus included writing the control program. Using interposing relays, the PLC controls a third-party hydraulic power pack and associated cylinder solenoids. The PLC also monitors the hydraulic pressure and the equipment position.

The 10-inch touchscreen allows users to set up the extension and retraction, visualize pressure and distance readings, and receive message indications. A physical cable pull switch around the machine and an emergency stop (e-stop) button provides a way for users to initiate an e-stop wherever they are. A 240VAC disconnect switch for the hydraulic power

pack is also implemented to ensure that this subsystem is disengaged when needed. Together, these components allow for expedient control of the machine while keeping operators and equipment safe.

Quality equipment and controls yields reliable results

The UMass straw panel machine uses its 120-inch stroke, 4-inch bore hydraulic cylinder, along with sensor data to compress panels to a uniform density at the target value. Machine settings are adjustable via the system's HMI, which shows process results in real-time.

While other systems have been designed to produce straw panel insulation, the UMass approach is much more affordable than alternate solutions. Furthermore, this machine enables the project's sponsor to research the performance of compressed panels made from waste straw — and potentially other recycled materials — with a flexible finished panel size and compression process. Having all these options together, while being more affordable than competitors, enables further development without significant budget constraints.

The overall sponsor of this project was an architectural firm, and with this new process for making compressed straw insulation, they plan on building a home with it in Holyoke, Massachusetts. From there, one could see this insulation technology used to help create affordable, quality housing, with sustainable materials, in the United States and beyond.

Our team appreciates the support of AutomationDirect with the PLC, HMI, and other control elements. With a wide array of product offerings, along with excellent phone and online support, AutomationDirect is a proven partner for those getting started with automation, and well as those who have been at it for decades.

Since completing this project, I have graduated with a mechanical engineering degree and now work as an automation engineer. Working with AutomationDirect products has springboarded my post-graduation career. Similarly, team members Samira Lopez, Graham Buckton, Peter Chen, and Om Naik, gained valuable insights into the world of PLC automation, hydraulic power... and even how straw behaves in compression. This project will serve as valuable experience as they move on to the next phase in their careers! ▼



University of Massachusetts Amherst (UMass) mechanical engineering students (pictured left to right: Samira Lopez, Graham Buckton, Peter Chen, Om Naik, and Ben Zamachaj) formed one of the two teams executing this straw insulation and recycling project. Ben Zamachaj was controls team lead, and after graduating with his mechanical engineering degree he now works as an automation engineer at TTM Technologies in Stafford, Connecticut. Jim Lagrant, Professor of Practice in Manufacturing and director of the Masters of Manufacturing Engineering Program at UMass acted as the advisor for this project. (Credit: Jon Crispin)

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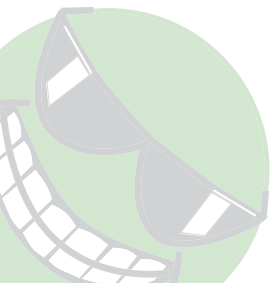
The XMC controllers offer extremely fast processing capabilities, with a scan time of 6.25ns for basic commands, 5ns for motion commands, and 30ns for arithmetic commands. EtherCAT-based high-speed communication cycle times are 0.5/1/2/4ms.



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5 Circuit Protection Mistakes That Could Cost You

BIG

BY BILLY SONNENTHAL, AUTOMATIONDIRECT

When a plant's main control panel went up in flames, it wasn't a lightning strike or a voltage surge that caused the damage. The root cause was far more preventable and far more common: an undersized circuit protection device that couldn't handle the available fault current. The result was catastrophic. The customer lost the entire enclosure, suffered extended downtime, and even named the device's supplier in a lawsuit, simply because their sticker appeared on the panel.

According to Billy Sonnenthal, Technical Marketer at AutomationDirect, that scenario underscores why

getting circuit protection right isn't just a matter of compliance. "With the correct protection in place, maybe you lose one component and swap it out. Without it, you might lose everything," he says.

Circuit protection is about more than breakers and fuses — it's about ensuring personnel safety, preserving equipment, and minimizing downtime when things go wrong. Yet even experienced engineers can make costly assumptions. In this article, we'll explore five of the most common circuit protection mistakes — and what engineers can do to avoid them.

(continued on page 11)



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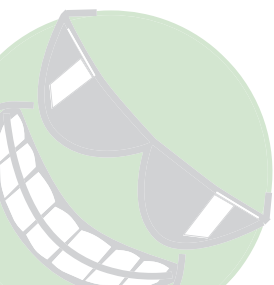


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(continued from page 8)

Mistake #1: Underestimating Available Fault Current

It's easy to think of a fuse or breaker as a magic switch that instantly shuts off current the moment something goes wrong. But, in reality, protection devices operate within a brief but critical time window. If a device's interrupting rating is lower than the available fault current (AFC) at the point of installation, it can fail to operate safely, resulting in an arc flash, equipment damage, or worse.

"Many people assume circuit protection devices just stop the current," Sonnenthal says. "But they must survive the fault condition long enough to open the circuit — and that depends on the available fault current. If it's too high, and your protection can't handle it, you might have catastrophic failure."

This is especially true for industrial environments with high-capacity feeds and/or in close proximity to large transformers. In those cases, fault currents can exceed 20, 30, or even 65 kiloamps. Standard protection devices won't cut it.

The fix: Always calculate or obtain (via an engineering study, if required) the available fault current at the panel or load location and compare it with the interrupting rating of your protection device.

For high-AFC applications, use current-limiting fuses or fast-acting breakers at the service entrance to reduce the fault current reaching downstream devices. This allows downstream equipment to have lower interrupting ratings and SCCRs while still being protected.

Remember, all protection devices allow some fault current to pass through before they interrupt the circuit. If the let-through current exceeds what downstream components can safely handle, you'll need a current-limiting fuse or breaker to reduce the energy exposure.

Learn more:
What Type of Circuit Protection Do I Need?
wtwh.me/circuitprotection1

Mistake #2: Using Supplementary Protectors Instead of Branch Circuit Protection

One of the most common errors Sonnenthal sees is the misapplication of UL 1077 supplementary protectors in place of UL 489 branch circuit breakers. While they may look similar — and often cost

less — these two types of protection serve very different roles.

"Supplementary protectors are meant for internal use, downstream of a proper branch circuit breaker," says Sonnenthal. "In the control circuit, they're fine for relays, PLC I/O, or other low-load devices. But they aren't rated or approved for branch circuit protection and don't meet NEC requirements when used as the sole protective device. They don't have the interrupting capacity to handle a serious fault. If someone puts one in where a UL 489 breaker should be, it can fail explosively under a fault condition."

UL 1077 devices typically offer interrupting ratings from 1 to 10 kA. By contrast, UL 489 breakers are tested and rated for much higher fault currents — commonly 10 kA up to 65 kA or more — and can serve as the primary overcurrent protection in a panel.

The fix: Know which circuits require full branch protection and which are supplementary. If there's any uncertainty, default to a UL 489 breaker. "When customers ask what they should use," says Sonnenthal, "I always tell them: 'If you're not sure, go with the UL 489. That will protect you either way.'"

Learn more:
Branch or Supplementary Circuit Protection?
wtwh.me/circuitprotection2

Mistake #3: Oversizing Fuses or Breakers "Just to Be Safe"

It's a tempting shortcut: a breaker keeps tripping, so an electrician installs a higher-rated one to "fix" the nuisance. Problem solved — until it isn't.

"Everything in the system — the wires, the load, the devices — is sized based on a certain current," says Sonnenthal. "If you increase the breaker size without ensuring the wiring and equipment are rated to safely carry the higher current, you risk exceeding their design limits. That's a fire risk."

Oversizing protection devices defeats their primary purpose. In overload situations, excessive current can heat conductors and insulation, degrade components, and in extreme cases, ignite surrounding materials. It also increases the chance that the protective device won't trip when it should, allowing damage to escalate.

The fix: Investigate the root cause of the nuisance tripping before reaching for a larger breaker. In many cases, inductive

loads such as motors, solenoids, and transformers produce temporary inrush currents that momentarily exceed the trip curve of a standard breaker. The solution? Increase the breaker's time-delay setting if available or use a time-delay fuse or breaker with a slower trip curve, one that's designed to handle brief inrush events without sacrificing overload protection.

As Sonnenthal puts it, "It's not about making the breaker stop tripping — it's about making sure it's tripping for the right reasons, and at the right time."

Learn more:
10 Reasons Why Fuses are Essential for Overcurrent Protection
wtwh.me/circuitprotection3

Mistake #4: Inadequate Motor Circuit Protection

Motors are the muscle behind most industrial processes, requiring more than basic overcurrent protection. A common mistake is to size circuit protection devices based solely on the motor's full-load amps (FLA) without accounting for startup inrush current, thermal overload risk, or phase-related issues. The result? Frequent nuisance trips, motor damage, or premature failure.

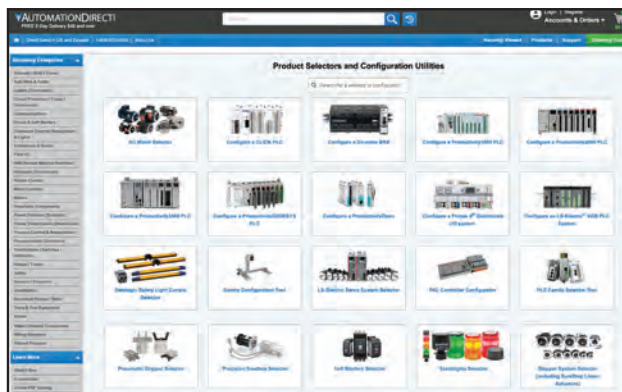
"Motor circuits are tricky," says Sonnenthal. "You need to allow for the high inrush current during startup without oversizing your short-circuit protection. But you also need overload protection that detects prolonged, moderate overcurrents — like those caused by a failing bearing or continuous mechanical strain — which wouldn't trip short-circuit protection but can still damage the motor over time."

Effective motor protection typically involves three layers:

- **Short-circuit protection**, usually provided by time-delay fuses or motor circuit protectors (MCPs) rated to handle inrush current without nuisance tripping, yet capable of clearing short circuits quickly.
- **Thermal overload protection**, which monitors current over time to detect overheating conditions caused by prolonged overloads, preventing insulation damage.
- **Voltage and phase monitoring**, to detect phase loss, undervoltage, phase imbalance, or phase reversal — conditions that generally won't trip overcurrent devices but can cause winding damage or premature motor failure. >>

Need help finding the right part?

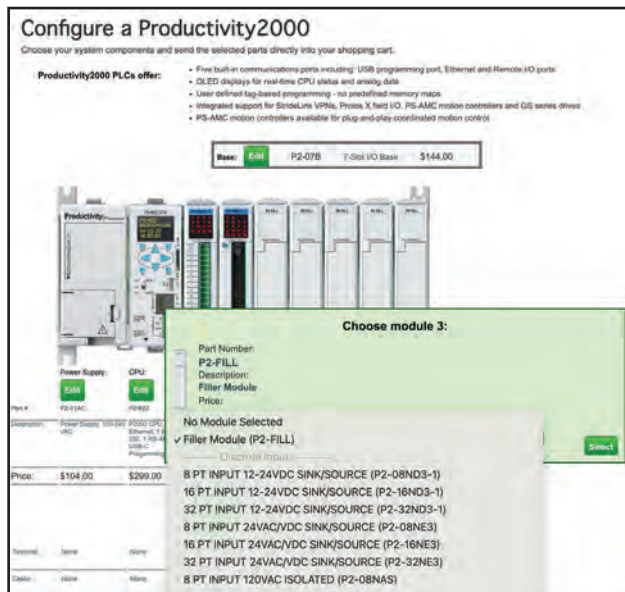
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CIRCUIT PROTECTION

Some of this protection may come bundled in a motor starter or built into a VFD, but that doesn't make external coordination unnecessary. In fact, for critical or expensive motors, Sonnenthal recommends adding current sensors, temperature monitoring, or phase relays to support predictive maintenance and early fault detection.

"A failed motor isn't just a parts problem," he says. "It's a downtime problem. Motors are heavy, hard to replace, and often take days to reinstall. A little extra protection can save a lot of pain."



Learn more:
[Group Motor Protection | White Paper](#)
wtwh.me/circuitprotection4

Mistake #5: Ignoring Lockout/Tagout and Multiple Power Paths

Circuit protection isn't just about components—it's also about people. One of the most overlooked hazards in control panels is the presence of multiple power sources. A technician may shut off the main disconnect and assume the panel is safe, unaware that backup power, UPS feeds, or auxiliary circuits may still be energized.

"I've seen panels where the main disconnect only shuts off the primary circuit," says Sonnenthal. "Auxiliary circuits such as lighting, ventilation, and PLC power often remain energized from separate sources. Failing to identify and disconnect all power sources or hazards inside an electrical panel can put anyone working on it at serious risk."

This makes proper lockout/tagout (LOTO) procedures essential—not just for compliance but for life safety. OSHA requires that all hazardous energy sources be isolated and locked out before maintenance is done. That means using physical padlocks and labeled tags, not just flipping a switch and walking away.

In fact, safety codes require all such panels to be properly labelled. Pay close attention to any warning labels during a LOTO session. One final warning is temporary power used during maintenance. Introducing an outside power source for testing after a LOTO session is common and very dangerous if not communicated and done properly.

"In a plant environment, it's common to see multiple technicians working on the same equipment," Sonnenthal explains. "Each one should apply their own lock, and the machine shouldn't be restarted until every lock is removed. That's how you avoid tragic accidents."

Beyond electrical hazards, improper LOTO can expose workers to kinematic risks—rotating shafts, gears, or actuators unexpectedly re-engaging during repair or inspection. A simple oversight can turn into a catastrophic injury.

The fix: Always identify and label every external and internal power source. Use lockable disconnects and OSHA-compliant tags with the technician's name and warning information.

After lockout, always verify that all circuits have been de-energized using an appropriate test instrument.

Don't rely on memory or convenience — build LOTO into your standard operating procedures and maintenance training.

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Conclusion

When designed and applied correctly, circuit protection devices quietly safeguard people, equipment, and operations. But when misunderstood or misapplied, they can become weak links that expose plants to unnecessary risk, from equipment loss and unplanned downtime to serious safety incidents.

"The key is not just having protection but also having the right protection, properly sized and correctly placed," says Sonnenthal.

As industrial systems become more automated, compact, and interconnected, the margin for error shrinks. Engineers must account for factors like fault current, trip curves, motor inrush, and human factors like LOTO compliance. And in the face of evolving standards and increased system complexity, taking shortcuts — whether to save time, reduce nuisance trips, or cut upfront cost — can have outsized consequences.

The good news? Most of the mistakes covered here are preventable with careful planning and a basic understanding of protection fundamentals. Take the time to get it right. Because when the unexpected happens — and it always does — solid circuit protection helps you recover quickly, safely, and without burning down your bottom line. ▼

Want to go deeper?

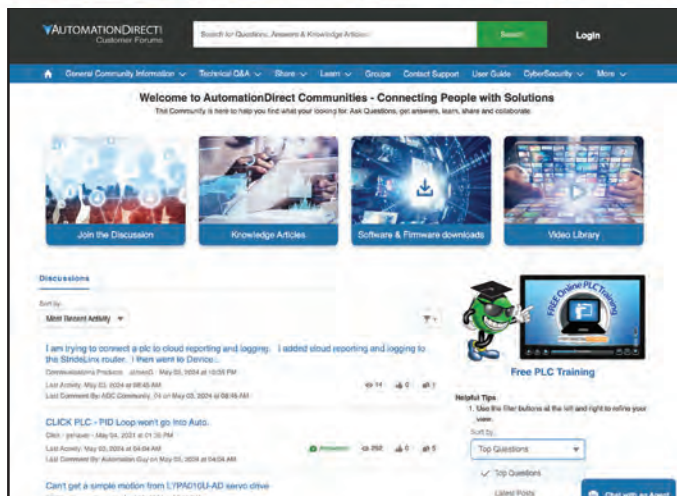
For a more detailed breakdown of protection types, device ratings, and application guidance — including illustrated charts comparing UL 489 vs. UL 1077 devices — download AutomationDirect's *Circuit Protection Overview*. It's a free, engineer-focused resource that expands on the concepts discussed here. View the guide at wtwh.me/circuitprotectionguide.



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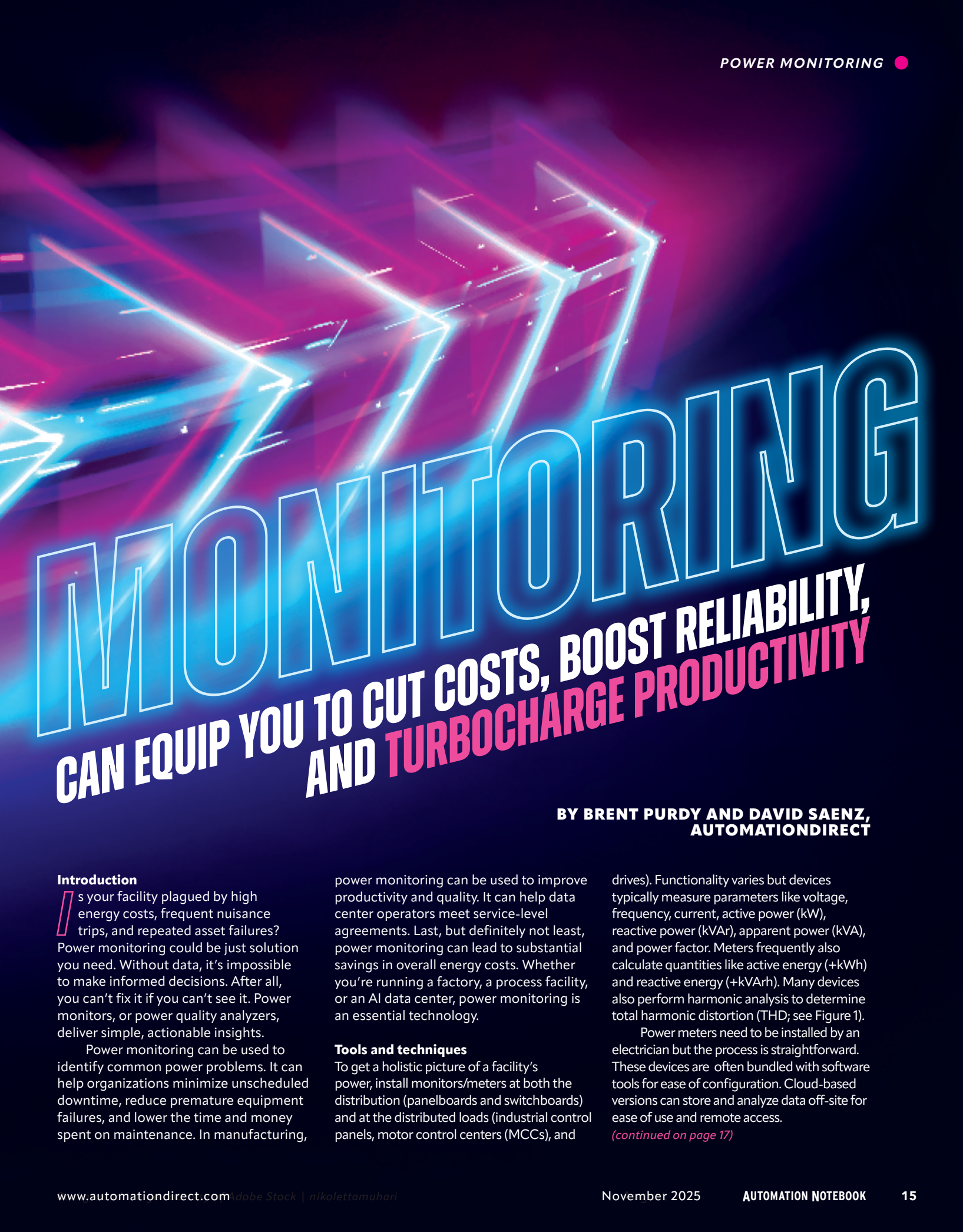
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HOW POWER



● **Figure 1:** The Socomec DIRIS A20 is a configurable panel-mounted power meter that gives easy access to key metrics like current, voltage, power factor, energy, and THD.



MONITORING

CAN EQUIP YOU TO CUT COSTS, BOOST RELIABILITY, AND TURBOCHARGE PRODUCTIVITY

BY BRENT PURDY AND DAVID SAENZ,
AUTOMATIONDIRECT

Introduction

Is your facility plagued by high energy costs, frequent nuisance trips, and repeated asset failures? Power monitoring could be just solution you need. Without data, it's impossible to make informed decisions. After all, you can't fix it if you can't see it. Power monitors, or power quality analyzers, deliver simple, actionable insights.

Power monitoring can be used to identify common power problems. It can help organizations minimize unscheduled downtime, reduce premature equipment failures, and lower the time and money spent on maintenance. In manufacturing,

power monitoring can be used to improve productivity and quality. It can help data center operators meet service-level agreements. Last, but definitely not least, power monitoring can lead to substantial savings in overall energy costs. Whether you're running a factory, a process facility, or an AI data center, power monitoring is an essential technology.

Tools and techniques

To get a holistic picture of a facility's power, install monitors/meters at both the distribution (panelboards and switchboards) and at the distributed loads (industrial control panels, motor control centers (MCCs), and

drives). Functionality varies but devices typically measure parameters like voltage, frequency, current, active power (kW), reactive power (kVAr), apparent power (kVA), and power factor. Meters frequently also calculate quantities like active energy (+kWh) and reactive energy (+kVArh). Many devices also perform harmonic analysis to determine total harmonic distortion (THD; see Figure 1).

Power meters need to be installed by an electrician but the process is straightforward. These devices are often bundled with software tools for ease of configuration. Cloud-based versions can store and analyze data off-site for ease of use and remote access.

(continued on page 17)

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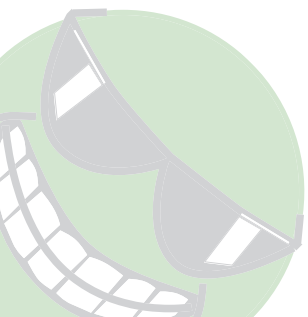
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(continued from page 15)

Power monitoring in action Idle/standby energy waste

One of the easiest and most effective applications of power monitoring is to identify equipment that is kept running continuously, even when not performing work. Think pumps or fans left on overnight, or air compressors running unloaded. Idle/standby energy waste is frequently caught by energy monitoring during audits and can add up to big savings. This represents low hanging fruit that can provide some easy wins to help build momentum for implementing more broadly across the facility.

What you see: Significant energy consumption (kWh) during nights/weekends

Corrective actions:

- Implement shutdown procedures for idle equipment.
- Add automatic controls (timers, occupancy sensors, PLC interlocks, etc.).
- Use variable frequency drives (VFDs) to match the operation of pumps, fans, and compressors to demand, rather than running them at top speed and using a mechanical valve/choke to adjust output. VFDs can extend motor lifetime and provide energy savings when sequenced effectively.

Inrush current on motor startup

Current draw in the first few milliseconds of AC induction motor operation, while windings are being energized, can be up to 10 times as high as steady-state current. High inrush current on large inductive loads can lead to voltage sags that can impact other equipment throughout the facility.

What you see: High current (A) inrush events recorded during startup

Corrective actions:

- Add soft starters or VFDs. These devices suppress inrush current, decreasing the magnitude of the voltage sag seen by other devices.
- Oversized motors, a common design flaw, draw excessive current. Check motor specifications with your vendors to be sure that they are sized appropriately.

High peak demand/load profile spikes

Utilities frequently scale energy rates for industrial customers by maximum peak demand for a given time interval. Depending on the circumstances, just a few load spikes could affect energy pricing for an entire quarter.

What you see: Demand graph showing sharp peaks during shift start, motor startups, or batch processes

Corrective actions:

- Stagger equipment startup times.
- Use soft starters/VFDs on large motors to reduce inrush currents.
- Apply demand control systems to shed or shift non-critical loads to off-peak hours with lower rates.

Poor power factor (Low PF < 0.9)

Power factor (PF) is the ratio of the real power absorbed by the load (kW) to the apparent power flowing in the circuit (kVA):

$$PF = kW/kVA$$

Power factor is essentially a measure of how effectively an electrical system converts power into work. A good analogy for power factor is a glass of beer. The total glass of beer represents the apparent power – the total power supplied by the utility. The beer in the glass represents real power – the part that does useful work (like quenching your thirst). The foam symbolizes the reactive power – it takes up space in the glass, adding to apparent power, but does no useful work.

Power factor is a key metric for assessing efficiency. A power factor $PF < 0.9$ means that the electrical system is wasting power, which affects utility costs in two ways. First, there's the obvious expense of inflated apparent power, but in addition, utility companies typically assess a surcharge on facilities with power factors below a specified level, to compensate for the cost of supplying excessive reactive power. The lower the power factor, the higher the surcharge; depending on the operation, this recurring surcharge can be substantial.

Low power factor stresses equipment, shortening lifetime. It increases line losses and voltage drop. It can also cause transformer heating and lead to wasted capacity in transformers/cables.

Correcting the problem starts with identifying it. Power meters generally offer power factor functionality (see Figure 2).



Figure 2: In addition to basics like current and voltage monitoring, the Trumeter ADM100W-HPS graphical power meter includes advanced functions like power factor, THD, and energy monitoring. Modbus connectivity provides expanded reading of data values, like phase angle or alarm(s).

What you see: Low power factor reading due to inductive loads (motors, welding processes, HVAC)

Corrective actions:

- Install capacitor banks or active harmonic filters.
- Add synchronous condensers (synchronous motors whose shafts are not connected to a load) to cancel out lagging PF.
- Use VFDs with active front ends or 12-pulse or 18-pulse rectifiers.

Voltage transients – sags/dips, surges, and swells

The term voltage transient refers to variations of voltage levels supplied to a load as a result of the startup, shutdown, or operation of another load on the distribution system. Voltage sags, or dips, are defined as a drop of 10% to 90% from steady-state voltage. Voltage swells and surges are voltage increases classified by duration: Voltage surges involve brief (microseconds to milliseconds) spikes, while voltage swells can last for as long as a minute. >>

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● POWER MONITORING

Voltage transients can have a variety of negative outcomes ranging from nuisance trips to premature failure of equipment. The damage from voltage spikes, in particular, can be both immediate and also cumulative, degrading and damaging equipment over time. They can also reduce product quality and throughput, impacting Overall Equipment Effectiveness.

What you see: Dips when large motors start, or spikes when equipment shuts off

Corrective action:

- Add motor soft starters or VFD ramping.
- Use uninterruptible power supplies (UPS) for critical loads.
- Install surge protection devices (SPD) on main panels.
- Upsize transformers or drives to reduce current draw.
- Stage startups of problem equipment or diversify feeder circuits for critical or problematic loads.

Harmonics and total harmonic distortion (THD)

Total harmonic distortion (THD) refers to the degradation of a perfect sinusoidal voltage or current waveform as a result of higher-order harmonics. THD is effectively a measure of how distorted or "dirty" the power is with respect to the reference sinusoidal wave. Common sources of harmonics include nonlinear loads such as VFDs, switching power supplies, and LED or fluorescent lighting. This isn't just a problem for factories. Data centers are filled with nonlinear loads, including servers, UPS, and the VFD-driven AC induction motors that power the HVAC units.

High THD can lead to overheating and premature failure of assets, as well as strange behavior and premature failure of sensitive equipment like PLCs. It can also decrease power factor and introduce voltage transients. For more information on THD levels and their impact on distribution systems and equipment, see IEEE 519.

What you see: High harmonic distortion from drives, servers, UPSs, LED lighting, welders, etc.

Corrective actions:

- Install harmonic filters (passive or active).

- Use 12-pulse or 18-pulse drives where possible.
- To protect loads sensitive to high THD, use K-rated or harmonic-mitigation transformers on dedicated circuits.
- Balance loads by putting nonlinear loads and other troublesome assets onto different circuits.

Voltage imbalance/unbalance

Voltage imbalance refers to the differences between the phase voltages in multi-phase electrical systems or networks compared to the average voltage. On motors, a voltage imbalance of 2% or more can cause overheated windings, premature failure, and performance degradation such as counter torque. On transformers, unbalanced loading can lead to hot spots and overheat windings, which may cause premature failure. In addition, voltage imbalance can lead to current imbalance, a problem in its own right.

What you see: Unequal line-to-line voltages (typically >2% imbalance)

Corrective actions:

- Redistribute loads between phases.
- Inspect supply transformers for tap settings or winding issues.
- Fix loose or corroded connections.

Current imbalance/overloaded circuits

Current imbalance refers to differences in the phase currents for each phase of a three-phase system compared to the average. In three-phase motors, current imbalance can cause overheating, torque variations, and premature failure. But it's a bigger problem than that. In the three-phase power system running the facility, even modest current imbalances can raise neutral currents. It can create problems across the entire facility, for example overheating panels and transformers, particularly if the system already has high THD.

IEEE 141 recommends current imbalances of <5% for small industrial facilities and <4% for large facilities, noting that for some sensitive equipment, even 2% is too much.

Current imbalance has a variety of causes ranging from unbalanced loads in the distribution system to loose or corroded contacts.

What you see: One phase of a three-circuit carries much higher current

Corrective actions:

- Rebalance load distribution across phases.
- Identify failing motors or drives pulling uneven current.
- Upgrade wiring or breakers if they are consistently overloaded.
- Fix loose or corroded contacts.

Conclusion

It's easy to assume that power issues are caused by the utility and there's nothing to be done about it. In reality, many power quality issues, and the headaches they create, originate within the facility and can be corrected – once they're identified. Power monitoring makes the invisible visible through

granular data that reveals exactly what's going on. The insights it delivers can slash energy costs through eliminating waste peak demand and power factor penalties. Power monitoring can help identify troubled assets and prevent productivity-killing repeat failures and the costly downtime they cause. Most fixes are straightforward, such as load balancing, filtering, improving controls, or making equipment upgrades like switching to VFDs. From factories to process industries to the AI data centers springing up around the world, power monitoring can improve efficiency, reliability, and profitability. Find out more at wtwh.me/powerquality. ▼

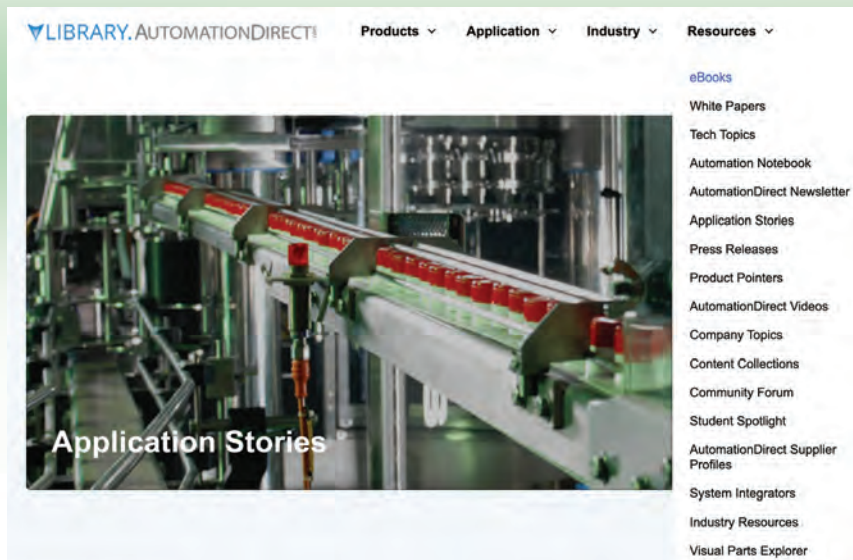
Brent Purdy is product manager, and **David Saenz** is product engineer, for Power & Circuit Protection at AutomationDirect.

TIPS FOR GETTING STARTED

1. Design power monitoring systems into expansions and new builds – it's easier to include in the budget upfront.
2. For retrofits, look for an internal champion to help drive the initiative.
3. Emphasize that data from meters will reduce unscheduled downtime and speed troubleshooting in the event of failures. This can be used to justify the expense of installing the monitors and fixing the system.
4. Don't try to instrument the entire floor all at once – look for low-hanging fruit where you can get short-term wins. Examples include assets that fail frequently, and equipment subject to nuisance trips.
5. Conversely, you do need enough granularity to obtain actionable insights – one power meter at the main might be able to show a general problem but won't help with troubleshooting.
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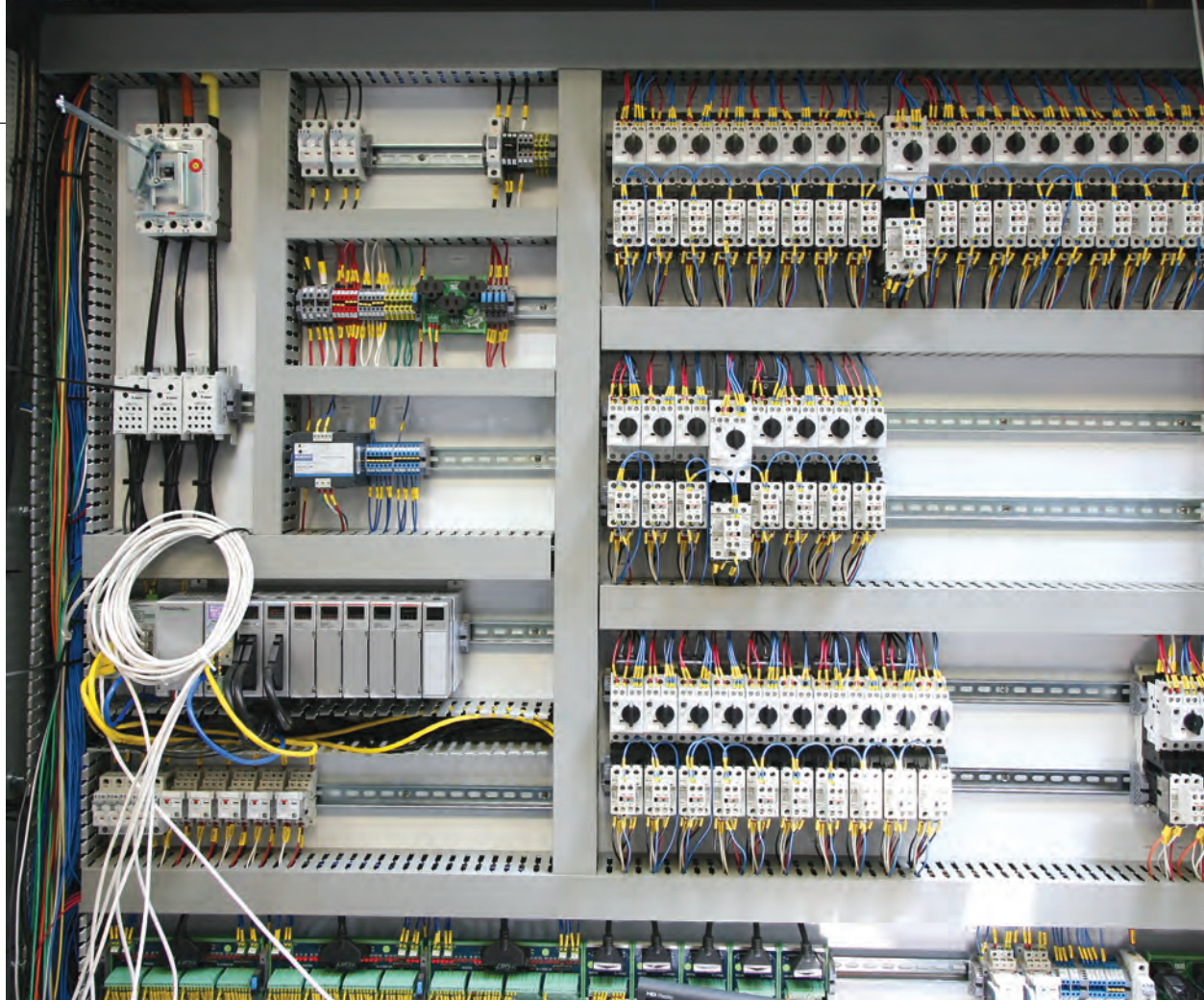
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Electrical Circuit Protection Essentials

A wide range of products support reliable and safe electrical circuit designs for any application.

**BY BILLY SONNENTHAL,
AUTOMATIONDIRECT**

Nearly every electrical or control panel — whether destined for a home, office, or busy factory — features an incoming power circuit, internal power distribution, and connections to/from field devices. Careful hardware selection and compliance with electrical codes and standards are essential to safeguard every circuit.

Panels may house digital controllers, hardwired relays, voltage transformers, motor starters, variable frequency drives (VFDs), and other electrical devices, but they all share one non-negotiable requirement: robust circuit protection engineered to prevent costly failures and dangerous hazards (Figure 1). The path to safe and reliable panel designs is paved by designers and engineers who immerse themselves in the relevant codes, standards, and best practices, and specify effective electrical circuit protection products.

What can go wrong?

Electrical problems can lead to downtime, damage, and dangerous conditions. While

improper designs are more likely to result in electrical issues, a correct design will properly handle trouble. Common failure modes which must be addressed include:

- **Overload:** When an unacceptably high electrical current flows, such as due to a too-heavily-loaded motor, or too many items connected to a circuit.
- **Short circuit fault:** When energized conductors are inadvertently connected to each other or to neutral.
- **Ground fault:** When energized conductors are inadvertently connected to ground.

These and other failures can cause varying degrees of overheating, thermal damage, fire, or arc flash explosions. Short circuit and ground faults — which occur when conductors directly or indirectly connect due to mechanical damage, degraded insulation, or the introduction of a conducting medium like water — are a particular problem due to the resulting fault current, representing an extreme spike compared to typical overload

Figure 1: Electrical and control panels used throughout commercial, industrial, and other applications all require appropriately applied electrical circuit protection engineered to prevent and handle hazards.

conditions. This can cause an arc fault, which occurs through the air, and is especially dangerous because of the light, heat, and rapidly expanding shockwave produced.

Creating safe electrical designs

Due to the many possible hazards associated with electrical circuits, codes and standards have been developed to define how to avoid and handle faults. Depending on the application, installation location, industry, and other criteria, there can be several applicable codes and standards, but some of the most well-known are:

- National Fire Protection Association (NFPA) 70 "National Electrical Code" (NEC)
- UL Solutions 508A "Standard for Industrial Control Panels"
- International Electrotechnical Commission (IEC) 61439 "Low-voltage switchgear and controlgear assemblies"

In accordance with the codes and standards, designers must calculate the electrical loads and evaluate the available fault current (AFC) — as well as the short circuit current rating (SCCR) of each device — to ensure proper coordination.

A key component for guarding against electrical circuit problems is an overcurrent circuit protection device (OCPD), which is designed to reliably open an electrical circuit even while withstanding potentially high fault currents.

Electrical and control panel designers typically follow these steps:

- Define devices: Select hardware — including components like relays, controllers, and motors, as well as the power supplies to operate them — to accomplish the needed functionality.
- Size OCPD components to carry the normal electrical loads they will supply while protecting supplied elements.
- Size the conductors, including the terminal/distribution blocks, to connect them.
- Verify the SCCR for all devices are appropriate.
- Provide physical protection: Components are commonly located within an enclosure to protect them from mechanical damage, moisture, and temperature extremes.
- Repeat this design cycle as needed until all conditions are satisfied.

Electrical circuit protection components

There are several types of OCPDs, and there are many other associated electrical circuit components. Following is a summary of the main categories. >>

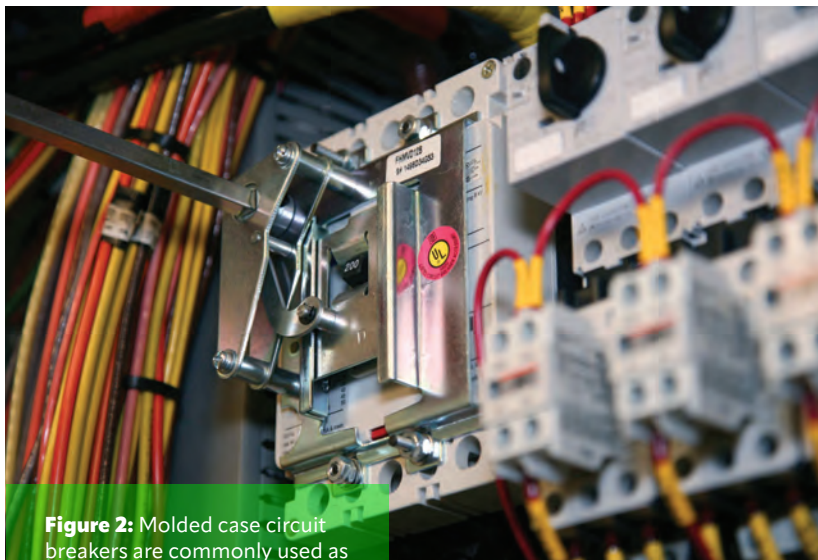
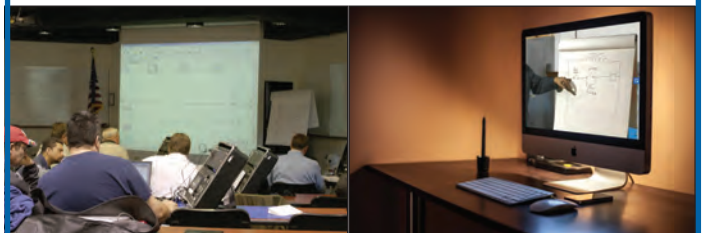


Figure 2: Molded case circuit breakers are commonly used as the incoming line overcurrent circuit protection device, and can also be configured as the lockout/tagout means, for larger electrical and control panels.

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Disconnects

Disconnects basically work as electrical open/close switches, although versions are also available with fuses. There are many form factors, and a circuit breaker can act as a disconnect. Electrically powered equipment usually requires a disconnecting means, with lockout/tagout (LOTO) provisions, to help users clearly and easily isolate electrical energy from components.

Distribution

Electrical distribution is handled by conductors — typically wires and cables, but also busbars — connected to terminal blocks, distribution blocks, and associated connectors.

Fuses

Fuses are a traditional overcurrent protection method that come in a wide range of current/voltage ratings and fuse holder form factors, providing a relatively low-cost option with a high short circuit current interrupting rating (such as 10kA, 100kA, or even larger). They are thermal devices, with internal portions that melt to open the circuit if the current is too high, so they are single-use and must be replaced after operating.

Molded Case Circuit Breakers (MCCBs)

MCCBs are automatic electrical devices, used to protect against overload and fault currents in power circuits (Figure 2). They open or “trip” automatically upon fault connections, and can be reset and then closed when the problem is removed. MCCBs have a higher initial cost than fused installations, but provide a long operating life. They are designed to comply with the UL 489 standard, and are available in sizes from 15A up to many hundreds of amps. However, their short circuit current interrupting rating is lower than that of fuses, ranging from 22kA to 65kA.

Miniature Circuit Breakers (MCBs) and Supplementary Protectors

MCBs are smaller size circuit breakers, also designed to comply with the UL 489 standard, and available in sizes starting at 0.5A with short circuit current interrupting ratings of 14kA or less (Figure 3). Supplementary protectors are like MCBs, but they are designed to comply with UL 1077 and provide additional, although limited, protection in conjunction with an upstream MCB.

Creating safe electrical circuit solutions

There are many more possibilities when it comes to electrical circuit protection. Motor power circuit protection is a specific category, and there are other products such as electronic circuit breakers (ECBs), ground fault protection, and power quality protection, to provide even more advanced safeguarding. The AutomationDirect website provides a complete portfolio of electrical circuit protection products, related components, and information resources to help designers create reliable and safe solutions. ▼



Bill Sonnenthal is a technical marketing engineer at AutomationDirect. He has worked at AutomationDirect since 2009 in technical and marketing roles, and he holds a BSEE degree from the Georgia Institute of Technology. Before joining the company, Sonnenthal spent 15 years designing, programming, and commissioning control systems in the newspaper and printing industry.



Figure 3: Miniature circuit breakers and supplementary protectors are used to accomplish power distribution and protection of individual circuits within a panel.

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Surge Suppression Requirements are Expanding

Surge suppression provisions are now mandated for many applications, and users are recognizing the value of protecting increasingly digital and connected systems from electrical disruptions.

BY DAVID SAENZ, AUTOMATIONDIRECT

For many years, surge suppression protective devices may have seemed like an optional and supplementary choice, perhaps something consumers plugged their sensitive computers and TV equipment into for peace of mind. However, in an increasingly digital world, there are now greater regulatory requirements around providing surge protection in a variety of residential, commercial, and industrial applications. The proliferation of intelligent devices, EV charging stations, data centers, and countless other applications all require surge suppression for top performance.

Power surges can originate in many ways, and the apparent and hidden costs associated with these disruptions increase exponentially based on the degree of electronics and automation involved. For industrial operations, surge protection is about more than preventing electronics damage. New products and regulations are available to help designers create surge-resistant systems that maintain uptime, protect valuable data, and provide other safeguards.

Surge sources and hidden costs

Electrical surges can originate externally to or internally at a site, although some estimates indicate that the majority (perhaps 80%) are attributable to internal sources. Some common causes are:

- External: Lightning strikes, utility and generator grid switching, or nearby faults.
- Internal: Motor starts/stops and variable frequency drive (VFD) inverter operation.

- Restoration: Surges instigated when a utility restores power after an outage, or a site engages backup power.

Surges take many forms in terms of how the voltage and current vary, and they frequently cause electronics and hardware damage. But there are also other hidden costs. Any disruptions leading to downtime stop production, and may waste product. Outages also create labor waste, both in terms of workers waiting for systems to come back online, and for technicians to troubleshoot and then restore service. In the worst case, a domino effect causes all these issues.

Expanding surge suppression requirements and technologies

In recognition of the growing importance for addressing surge suppression, industry standards and product technologies are both evolving. Some key standards include:

- UL 1449 "Standard for Surge Protective Devices (SPDs)", now at edition 5 as of 2021.
- IEC/EN 61643 series, addressing SPDs for a variety of applications.
- IEEE C62 series, addressing many surge protection topics.
- NFPA 70, the National Electrical Code (NEC), now has many sections related to surge protection.

The surge protection bar continues to rise. Some original requirements called for surge protection on "industrial machinery with safety interlock circuits" (which included a large number of



Figure 1: A variety of industrial-grade SPDs make it convenient to build protection into new power and signaling designs, or retrofit it into existing systems.

installations), and today the requirements have extended to various types of dwellings. Surge protection techniques are applicable for main power distribution, and even for low-voltage signaling circuits, which may be susceptible to surges.

Industrial-grade SPDs are designed to detect and divert harmful overvoltage conditions, shunting the surge to ground before it can reach sensitive downstream electronics (Figure 1). Metal oxide varistors (MOVs) and gas discharge tubes (GDTs) are two fast-reacting technologies commonly used for handling and clamping excess voltages, and there are other hybrid designs as well. Some OEM equipment includes built-in SPD provisions, but power distribution systems of all types can require surge protection.

Unfortunately, SPD technologies tend to be sacrificial. Therefore, there are increasing requirements to provide indication and even signaling to prove that protection is active, and to let personnel know if a replacement is needed.

Implementing surge protection

SPDs are parameterized by characteristics such as the single surge current rating, nominal discharge current, short circuit current rating (SCCR), response time, nominal operating voltage, maximum continuous operating voltage (MCOV), and voltage protection level (let-through voltage). SPDs are usually available as parallel-connected devices, but they can also be connected in series. They may or may not require overcurrent protection, or compliance with the tap rule, depending on the installation.

UL has defined several SPD categories (Figure 2):

- Type 1: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service equipment overcurrent device, as well as the load side.

- Type 2: Permanently connected SPDs intended for installation on the load side of the service equipment overcurrent device.
- Type 3: Point of utilization SPDs, installed at least 10 meters from the service panel, usually at the point of use.
- Type 4 Component assemblies (CAs): Assembly of discrete components intended to be integrated into end-use products or larger SPD assemblies
- Type 5: Discrete components such as MOVs.

While surge suppression may be mandated for new installations, it is also prudent to retrofit SPDs into existing systems. A variety of SPD form factors exist to support any type of installation (Figure 3):

- Open types, for panel or DIN rail mounting, with one or more circuits. Some types have plug-in protection modules for fast hot-swap replacements.
- Enclosed types, for external mounting near the connection point.
- Terminal block types, for high-density DIN rail mount, especially useful for data- and signal-level surge protection.

Figure 3: Several SPD categories and form factors are available to protect systems at the electrical service entrance, throughout the distribution at a site, and at field locations.



- Conduit-compatible types, made of stainless steel for installation right near a field device.
- Specialty configurations, designed for direct installation to the busbars of compatible panelboards.

Surge protection is fundamental

In the age of increasingly connected digital systems, and industrial internet of things (IIoT) deployments, surge protection is no longer just a “nice to have,” but a fundamental need or regulatory requirement. Industrial surge protection is more than an insurance policy — it is a performance strategy for safeguarding assets, uptime, and valuable data. Visit the AutomationDirect website to discover surge protection products for a wide range of applications. ▼



David Saenz is a product engineer at AutomationDirect. He joined AutomationDirect in 2024, and holds a BSEE degree from the Georgia Institute of Technology. Before joining the company, David Saenz spent 10 years supporting a medical device manufacturing facility as a controls and electrical engineer. He previously worked as an I&C engineer supporting civilian nuclear power generation engineering projects.

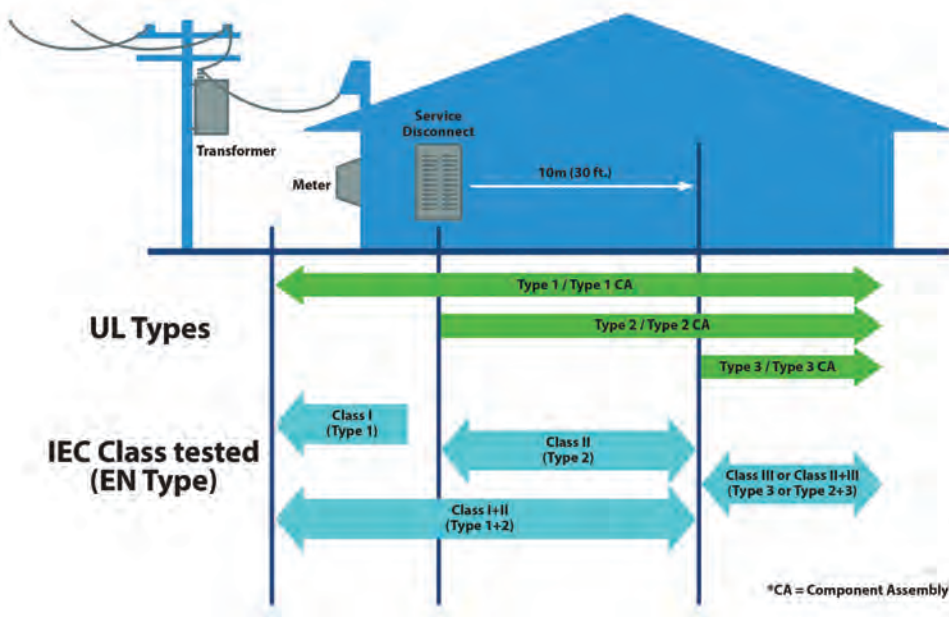


Figure 2: Several categories of surge protection devices are defined for use at various locations of the electrical distribution system within a facility.

Figure 1: Historically, the M.A. Patout & Son sugar processing operation has used steam-driven boiler feed pumps, but they are moving to introduce VFD-controlled motors to provide a lower-maintenance option with greater flexibility. All figures courtesy of M.A. Patout & Son

Louisiana Sugar Mill Depends on Trusted Automation Products During the Short Harvest Season

BY JOSH CAMEL, M.A. PATOUT & SON SUGAR MILL



Because the sugar mill operates in overdrive production for just four months out of the year, and recovers for the other eight months, reliable products are essential for maximizing uptime during the busy season.

At most manufacturing plants, the production year is near-constant, with occasionally scheduled times for preventive maintenance and other shutdown operations. During these rare periods, a team of engineers, technicians, and operators — temporarily converted into maintenance personnel — race to prepare the factory to run like new mere days later.

For sugar cane processor M.A. Patout & Son, the production/maintenance cycle is turned on its head because the annual harvest occurs over a few short months, demanding an intensive effort to process a massive amount of sugar cane before it spoils.

Once the harvest starts, processing it is all-hands-on-deck for four months of intense production, with engineers and technicians making sure the plant

operates as expected — or at least holding things together as best they can — until the work is done. The plant is then shut down until the next run eight months later. During this time, plant personnel rebuild equipment and make improvements. One might compare this process to how a professional sports team performs on game day, but puts in a massive amount of work throughout the year to prepare.

To ensure peak performance during the production sprint, and to enable useful upgrades during the maintenance period, the company needs reliable and readily available automation components.

A sugar-processing sprint

The unique challenge for sugar cane processors — including M.A. Patout & Son, which has been in the Louisiana sugar

industry since 1825 — is that during the four months of processing, the plant must run (Figure 1). If something breaks, quick access to replacement parts, support, and documentation is absolutely critical.

Downtime is bad in any industry, but the time-sensitive nature of processing sugar cane means that interruptions simply cannot be made up with extra working hours or by pushing back the delivery date. Furthermore, because the overall process demands significant effort to properly startup and shutdown, any unscheduled outages can have an oversized effect on downtime.

Component reliability is important for any application, and a sugar mill tests equipment and components in an extremely harsh environment with extremes of temperature, vibration, debris, and more. In most cases, it is not a

matter of if a part will fail, but when. Some components are considered sacrificial to an extent, and will only last one season.

With a long history of learning what approaches result in reliable production, M.A. Patout & Son effectively rebuilds their entire processing operation every year — to the point where it nearly becomes a new facility. This renovation includes servicing

programming software makes it easy to quickly set up the panels. This free software paradigm extends to their PLCs, drives, field IO, and more. The site also has also had plenty of positive experience using ProSense pressure, temperature, and vibration sensors and transmitters from AutomationDirect, as they provide plenty of accuracy and have proven durable in service.

“Component reliability is important for any application, and a sugar mill tests equipment and components in an extremely harsh environment with extremes of temperature, vibration, debris, and more.”

everything from mechanical equipment to electrical and control systems, and provides the opportunity to improve the process engineering where it makes sense. Almost all of this work is performed in-house, including servicing control panels, running conduit, and rebuilding valves.

Since many of the operators need a job in the eight-month offseason, it is a natural transition for them to perform many of the maintenance operations. As an added benefit, when the plant is running, they know how to fix or replace everything in the facility. Even though new parts are typically specified and installed in the comparatively calm offseason, the mindset of plant engineers has to be that replacement parts must be available at a moment's notice. Lead time and supplier reliability are therefore paramount to the operation, and when it is cost-effective they strive to keep critical component spares on-hand for instant access.

Reliability and availability keep the plant running

The primary boiler automation system consists of specialized legacy controllers that have proved reliable. However, for many other subsystems, the site takes advantage of AutomationDirect's extensive product offerings.

Productivity and CLICK programmable logic controller (PLC) lines are implemented to handle a wide range of automation duties. For human-machine interface (HMI) tasks, C-more graphical touchscreen HMIs are localized near individual equipment to provide easily-deployed operator access (Figure 2). Once the new hardware is in-house, AutomationDirect's free

that a new device will be procured on time. Or, if a substitute needs to be considered, AutomationDirect's online documentation and personal phone support are there to help.

Boiler feed pump project

When the plant goes down each year for service, engineers do not just replace and rebuild existing components, but they also take this opportunity to implement new ideas.

Currently, after sugar juice is extracted, the remaining fibrous pulp, known as bagasse, is burned in seven biomass boilers. This generates steam that is in turn used to operate turbine pumps supplying boiler feed water at up to 1.2 million pounds of water per hour. While this biomass-based system effectively burns waste and makes the plant largely self-sufficient from an energy standpoint, there are several downsides. Biomass tends to have a widely varying energy content depending on moisture. Steam systems are challenging to startup/shutdown and keep in good operating balance, and they are notoriously high maintenance. >>



Figure 2: The site has had countless positive experiences deploying capable and cost-effective AutomationDirect devices, such as C-more touchscreens, throughout the plant to provide convenient and operator-friendly functionality in even the most challenging locations.



Figure 3: Based on many positive experiences with AutomationDirect PLCs, HMIs, instruments, and other products, the plant has specified a DuraPulse 250-horsepower VFD as a first step in transitioning from steam-driven equipment toward a more flexible cogen-based electrically operated system.

The seasonal usage pattern — fully loaded for a few months, idle for the rest of the year — also negatively impacts the lifespans and performance of the steam-based equipment.

To improve flexibility, performance, and overall efficiency, the site is exploring the move to cogeneration (often shortened as “cogen”) to produce electricity in an environmentally friendly manner in the future. Steam would still be produced, but it would be used to make electricity to power site equipment (rather than spinning turbines that mechanically operate equipment). As a first step in this direction, it was decided to add a new 250-horsepower variable frequency drive (VFD) controlled boiler feed pump to operate in parallel with the existing steam-driven units (Figure 3).

The facility has already successfully used AutomationDirect variable frequency drives (VFDs) in a variety of smaller applications. The fact that many of the smaller VFD versions are washdown-capable

is very convenient for this environment.

While some other brands have been used before, in recent years the team has found AutomationDirect to provide much better — and more reliable — delivery lead times, which has become an important factor. High product quality, solid technical performance, and pricing are important attributes, but in the rigorous world of sugar processing, other considerations such as short lead times, supplier reliability, and great support play key roles when specifying automation components.

With all this in mind, the team is confident that the new VFD-driven pump will work well as a next step in improving process performance. Of course, the facility will always require some steam-driven pumps in operation, as they produce low-pressure steam used for heating. But once a degree of cogeneration is available, the site will have options for balancing the overall electrical load in relation to what the utility can supply, especially when production overlaps with hot Louisiana

summer months where air conditioning loads are a considerable demand.

Sweetening the sugar cane production system

Faced with relentless environmental challenges and unforgiving production schedules, designers and engineers in the sugar cane industry must rise to the occasion with ingenuity and resilience. Each approaching harvest season brings a whirlwind of activity — systems rebuilt, processes refined, and improvements forged under pressure. Partnering with reliable suppliers for PLCs, HMIs, electrical equipment, and other automation products empowers end users, integrators, and original equipment manufacturers to keep the gears of production turning. In this demanding landscape, only those who adapt and innovate truly thrive. ▼

Josh Camel is a Louisiana native and chemical engineer who works at the M.A. Patout & Son sugar mill in Lafayette, Louisiana.

Relays you can rely on



NEW! DOLD **Phase Monitoring Relays**

Starting at \$121.00 (RN9877-1203P4W525V)

Dold VARIMETER phase monitoring relays quickly detect fault conditions, such as overvoltage, undervoltage, exceeding voltage range, phase unbalance, phase reversal, and missing or broken neutrals in single- or three-phase AC systems. Easy-to-use single-turn switches simplify setup, eliminating the need for complex menus.

- Up to 575 VAC 50/60 Hz measuring range
- Single- or three-phase AC voltage monitoring
- 5A SPDT output contacts
- Adjustable voltage, hysteresis, and time delay
- Fast fault detection
- DIN rail mounting

NEW! DOLD **Voltage Monitoring Relays**

Starting at \$121.00 (RL9854AC45-135V)

Dold VARIMETER series voltage monitoring relays protect equipment from damage caused by abnormal voltage fluctuations. These relays continuously monitor voltage levels and trigger a fault when they exceed or fall below a predetermined threshold. Four single-turn switches allow quick setup for a broad range of applications.

- Up to 250 VDC or 300 VAC measuring ranges
- For use in single-phase AC or DC systems
- Overvoltage, undervoltage, or voltage band monitoring
- 5A SPDT output contacts
- Adjustable voltage, hysteresis, time delay, and monitoring function
- Fast fault detection
- DIN rail mounting

GEFRAN **Solid State Relays**

Starting at \$24.00 (GQ-15-24-D-1-3)

Gefran GQ and GRSH series solid state relays are available in DIN rail or panel mounting styles and offer a variety of overload and thermal protection options. Both series provide zero-crossing technology, 100kA SCCR ratings, and IP20 finger-safe protection ratings.

- Gefran GQ series “hockey puck” style relays feature contact ratings from 15 to 90A and include thermal mounting pads and overload and thermal protection
- Gefran GRSH series relays offer contact ratings from 15 to 120A, support for up to 600VAC, and include built-in overtemperature and overvoltage protection

Electro-Mechanical Relays

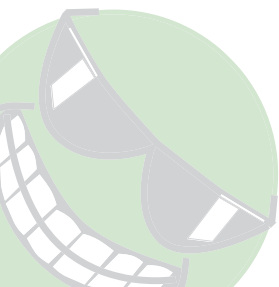
Components starting at \$5.00 (781-1C-24D)

Electro-mechanical relays receive an electrical input that magnetizes an internal coil, causing the relay's contacts to open or close. Although typically less expensive than solid state versions, they have a shorter lifespan due to the mechanical components.

- Force guided relays
- Square relays/cube relays
- Octal relays
- Power relays
- Hazardous location sealed relays
- Slim/card relays
- Slim interface relays

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Ardent Multimeters & Accessories

AutomationDirect has added Ardent digital multimeters, testers, and testing accessories which are ideal tools for diagnosing and maintaining electrical systems. Digital and clamp-on multimeters measure voltage, current, resistance, and continuity with high accuracy, helping identify faults and verify system performance.

Ardent's auto or manual ranging digital multimeters feature an Automatic terminal Blocking System (ABS), to secure proper lead connection, and their clamp-on multimeters have rotary clamp jaws that allow the user to align the clamp in the orientation of busbar/conductor while keeping the display and keys facing the user. A specialized insulation tester, also equipped with an ABS, provides quick, targeted checks to ensure equipment safety and functionality. Accessories such as test leads, clips, temperature adapters, and more enhance measurement precision, safety, and accessibility in tight spaces.

Learn more by visiting: <https://www.automationdirect.com/electrical-test-equipment>



More BRX PLC DC I/O and Pluggable Option Modules

AutomationDirect has added new DC I/O and pluggable option modules that expand BRX PLC communication capabilities, support higher-voltage systems, and provide diagnostics.

Added DC I/O expansion modules include a 16-point, 12–24 VDC discrete output module and a 16-point, 12–24 VDC discrete output module with individually configurable outputs that detect fault conditions such as open load (broken wire), over-temperature, and overcurrent (short circuit). For 48 VDC control applications, such as those in data centers and telecom environments, new options include a 16-point discrete input module, a 16-point discrete output module, and an 8-point input/8-point output discrete combo module.

New Ethernet pluggable option modules (POMs) offer protocol-specific support for either Sparkplug B or OPC UA, providing dedicated connectivity for IIoT and data-centric systems. A new USB-C pluggable option module provides additional flexibility for programming and communication. These swappable POMs allow custom communication configurations and easily slide into the open slot on BRX CPUs.

Learn more by visiting: <https://www.automationdirect.com/brx-plc>



Define Instruments Twin Link Series Point-to-Point Wireless I/O

AutomationDirect has added Define Instruments Twin Link series point-to-point wireless I/O devices, which provide a cost-effective solution for applications where wiring is difficult or impractical, such as long distances, physical obstacles, or moving equipment. They create a dedicated, bidirectional radio link between a pre-paired set to reliably transmit analog or digital signals with minimal setup. The signals can be transmitted up to 0.9 miles line-of-sight or 500 feet through walls, and up to 15 repeaters can be used to improve the signal path or extend the range.

The sender/receiver pair accepts thermocouple, RTD, mA, or frequency inputs and provides two isolated 4–20 mA outputs for seamless integration with control or monitoring systems. Discrete I/O is also included to support advanced control, alarms, or transparent signal pass-through. The free Define ToolBox software simplifies configuration and includes advanced features such as signal simulation, configuration export, and PDF documentation.

The Twin Link point-to-point wireless I/O sender/receiver pair is priced at \$614.00 (DEFINE-TWIN-LINK) and repeaters are priced at \$236.00 (DEFINE-REPEATER).

Learn more by visiting: <https://www.automationdirect.com/wireless-io>



Endress+Hauser iTHERM and iTEMP Series Temperature Transmitters

AutomationDirect has added Endress+Hauser iTHERM and iTEMP series temperature transmitters that offer precise and reliable temperature measurements with easy integration, a rugged design, flexible configurations, and IO-Link or HART communication options.

Endress+Hauser's TM311 iTHERM CompactLine integrates an RTD and transmitter in a stainless steel housing, featuring an adjustable temperature range within 32 to 302°F (0 to 150°C) and probe insertion lengths of 30–150mm. They are available with 4–20 mA or IO-Link outputs, 1/4" or 1/2" NPT process connections, as well as 3-A approved sanitary tri-clamp fittings, and an IP69 rating with suitable cables.

TMT36 iTEMP series head-mounted temperature transmitters support Pt100 and Pt1000 RTD inputs with a single-channel IO-Link output for easy configuration and diagnostics. They are available with screw or push-in terminals and can be used with the optional TID10 series digital display.

TMT72 iTEMP series programmable, HART-compatible temperature transmitters accept RTD, thermocouple, resistance, or voltage inputs and are available with connection head or DIN rail mounting options. They feature configurable measuring ranges, linearized 4–20 mA outputs, Bluetooth setup via the free SmartBlue app, and adjustable filtering. They also support the optional TID10 series digital display.

The rugged TMT142B iTEMP transmitter supports multiple input types and offers configurable ranges, HART communication, adjustable filtering, and a built-in digital display.



Eltwin Reversing and Non-Reversing Solid State Contactors

AutomationDirect has added Eltwin solid state contactors which provide load switching control with the advantage of no moving parts, considerably extending service life and reducing maintenance costs. In addition, solid state components make switching incredibly fast and allow for a much smaller contactor. Since these contactors are UL/cUL rated as motor controllers, they can be used for motors, heaters, transformers, and more.

Reversing solid state contactors seamlessly reverse AC motors with precision control, unmatched durability, and enhanced efficiency for demanding applications. Non-reversing solid state contactors control AC motor operation in one direction and are also available in "direct-on-line" (DOL) versions that provide peak performance for demanding 3-phase motor applications with frequent starts, stops, and jogs. The added overload protection switch accessory for use with Eltwin SCx, SMCx-DOL, and SRC solid state contactors provides protection from over-temperature conditions.

Learn more by visiting: <https://www.automationdirect.com/solid-state-contactors>

Its IP67-rated die-cast aluminum housing is suited for harsh environments, and Bluetooth via the SmartBlue app enables remote configuration.

The iTEMP series temperature transmitters start at \$210.00 (TMT36-13A9/101), the iTHERM series start at \$234.00 (TM311-TLU6/0), and the head-mount digital display (for TMT36 & 72 series) is priced at \$121.00 (TID10-1009/0).

Learn more by visiting: <https://www.automationdirect.com/temperature-transmitters>

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NEW PRODUCTS



More Murrelektronik Connection Cables and Connectors

AutomationDirect has added A-coded M8 and M12 sensor and signal cables to facilitate accurate data transmission between sensors and control systems. New D-coded M12 Cat5e and X-coded M12 Cat6a Ethernet connection data cables support the high-speed Ethernet communication essential for network reliability and performance.

Additional Murrelektronik A-coded 3-pin M8 and 5-pin M12 field wireable connectors are now available to carry out quick, tool-free cable terminations in the field. New T- and Y-couplers enable efficient signal or power branching, simplifying cable routing and system expansion, and the new industrial Cat6a Ethernet bulkhead connectors maintain the integrity of network performance (supporting speeds up to 10 Gbps) while allowing network cables to pass through protective barriers.

Learn more by visiting: <https://www.automationdirect.com/circular-connection-cables>



Viking Drill Bits and Taps

AutomationDirect has added Viking drill bits, including double-ended, jobber-length, mechanic-length, screw-machine-length, and split point step bits, which are available individually or in sets and come in titanium nitride (TiN), gold oxide, or black oxide finishes.

Viking split point drill bits are self-centering and come with 118° or 135° point angles to deliver enhanced penetration and cleaner, more accurate holes. New combination drill bit and machine taps drill and thread in a single operation, streamlining production and reducing setup time. These dual-function tools are offered in either a 1/4-inch hex shank or a 3-flat shank for compatibility with standard drivers.

Viking hand taps, machine taps, and taper pipe taps are incredibly versatile and ideal for applications across manual or CNC machining tasks and designed for use on stainless steel or iron. Ratcheting T-handle tap wrenches feature a three-position gear box, allowing forward, reverse, and locked operation for efficient ratcheting control.

Learn more by visiting: <https://www.automationdirect.com/hole-cutting-tools>



WAGO Signal Conditioners

AutomationDirect has added WAGO JUMPFLEX® 857 series signal conditioners and temperature transmitters which deliver reliable signal conversion in a compact 6 mm-wide housing, ideal for high-density DIN rail installations. With configurable input and output ranges, these modules adapt easily to a wide range of industrial applications.

WAGO conditioners and transmitters easily convert voltage, current, RTD, and thermocouple signals (depending on model chosen), and are available in single- or dual-channel, and splitter versions. Temperature models include built-in diagnostics to streamline troubleshooting and reduce downtime. Push-in connections and jumper slots at every terminal simplify wiring, reduce errors, and shorten maintenance time.

Learn more by visiting: <https://www.automationdirect.com/signal-conditioners>

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Metal Work ISO 6432 pneumatic air cylinders offer an ideal solution for metric applications where an inexpensive actuator is desired. They feature a magnetic piston for position sensor compatibility.

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- Stroke lengths from 50mm to 300mm
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- Chamfered 304 stainless steel barrel
- 145 psi maximum operating pressure

NEW! Metal Work Dual Guide Rod Cylinders

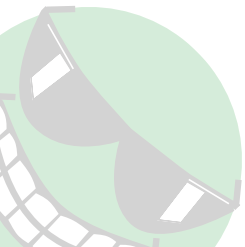
starting at \$135.00 (W143016A010N)

Metal Work heavy-duty metric dual guide rod cylinders are ideal for applications requiring precision mounting and tolerance to a sideload. These cylinders feature magnetic pistons, bronze bushings, anodized extruded aluminum alloy housing, and switch mounting tracks.

- Interchangeable with other common brands of metric guide rod cylinders
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- Stroke lengths from 10mm to 400mm
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- Maximum operating pressure of 145 psi
- Maximum sideload of 10N to 250N

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