ARC WHITE PAPER

By ARC Advisory Group

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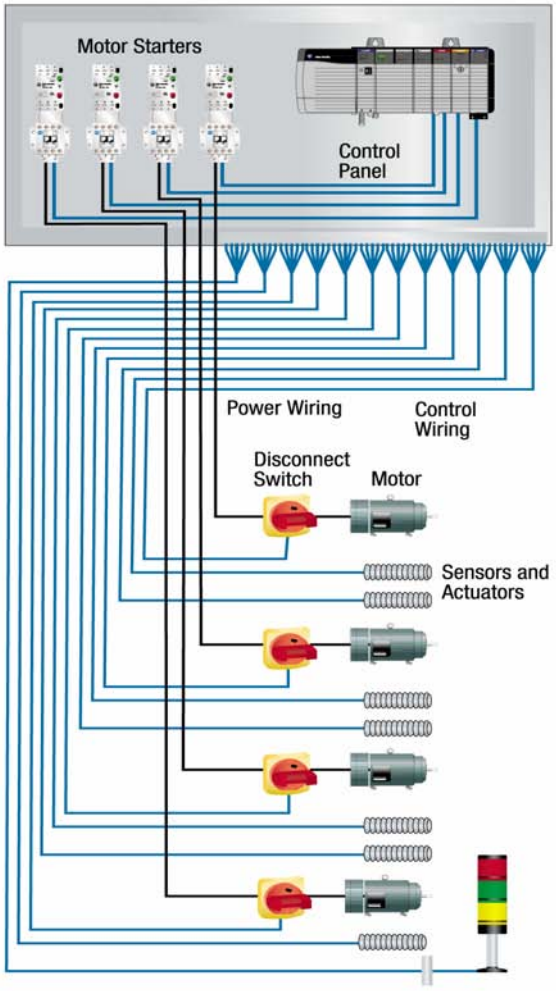
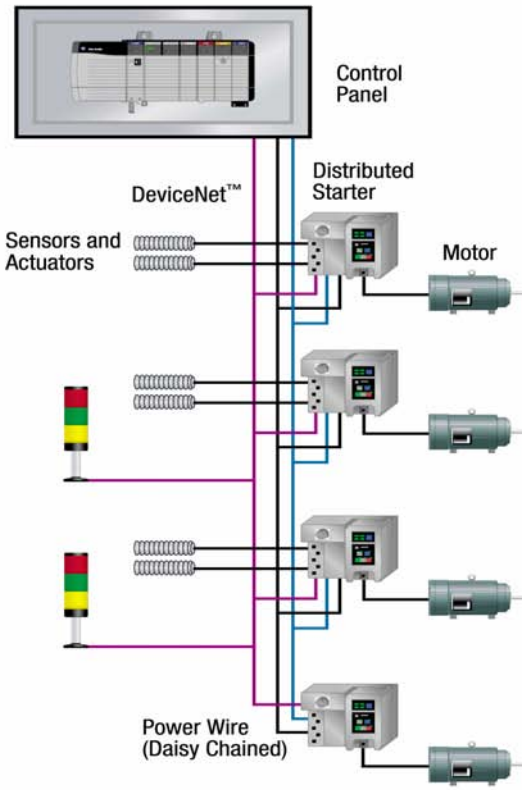
Rockwell Automation Applies Collaborative Power Control as a Science

Distributed, "on-machine" architecture simplifies integration and maintenance





Traditional Wiring Method

- Traditional, centralized panel architecture requires complex, costly wiring and significant space requirements
- Dependent on hard-wired control circuits, the system requires substantial design & engineering time
- The resulting solution can be difficult to troubleshoot and may not accommodate future upgrades easily

On-Machine Distributed Wiring Solution

- Distributed Motor Control decreases design & installation time by 20% with use of standardized connectors
- Cuts cabling costs by 30% with daisy-chain power wiring
- Built-in intelligence and communications capabilities of distributed, plant-floor devices alerts operators to faults before downtime occurs
- Minimizes space requirements

Executive Overview

In all industries, shareholders and financial analysts are driving manufacturers to improve bottom-line performance by operating more efficiently. One area that affects all aspects of manufacturing, regardless of industry, is power control. To remain successful, manufacturers must invest in power optimization tools and expertise to manage these costs, which can be unpredictable and unstable. Most importantly, there needs to be an assurance of a quick return on the power control investment.

Many manufacturers view power control as simply turning motors off and on or monitoring powered components. However, those who properly apply the science of power control discover immediate increases in uptime, decreases in energy costs and improvements in product quality.

Trends Driving Integrating Power Control Assemblies

- A reduction in the numbers of facility engineers.
- A move from centralized to distributed motor control.
- An increased pressure to meet varying global and regional standards.

Properly integrated power control assemblies provide substantial opportunities for collaborative manufacturing and operational efficiencies. That is why manufacturers seek the advice of power control automation experts who approach power control as a science to meet individual application needs and process challenges. They must understand, however, that these needs and challenges are unique by industry, process, geography, installed base and user experience.

This white paper defines the science of collaborative power control and describes how it is helping manufacturers maximize uptime, increase energy efficiency, and optimize processes for improved product quality and throughput.

Trends Driving Integrating Power Control Assemblies

Properly integrated power control assemblies contribute to operational efficiencies. This increased need for interaction among power products, coupled with trends indicating a reduction in the numbers of facility engineers, a move from centralized to distributed motor control, and an increased pres-

sure to meet varying global and regional standards, mean manufacturers must partner with power control automation experts to be successful.

A Reduction in the Numbers of Facility Engineers

Across the globe, manufacturers are using fewer in-house facility engineers and maintenance people in an effort to cut costs. With limited in-house expertise, manufacturers are increasingly requesting turnkey power control packages, where products are optimized to work together. From basic motor starter selection to specifying, configuring and commissioning power control into integrated architectures, manufacturers should take advantage of these turnkey power control packages.

Turnkey power control packages require mastery of heat, harmonics, and control system integration. When packaging drives, manufacturers need to utilize power control automation experts who have the expertise to effectively address the heat and harmonic issues that help to ensure system performance. This is why collaborative power control is considered a science. The scope of power control collaboration includes incorporating products such as electrical and electromechanical soft starters; standard, medium-voltage and servo drives; packaged components, panels, combination starters, motor control centers, and predictive maintenance and configuration software into a unified turnkey power control packages. These packages are supported by power control suppliers who can provide advanced drive system application engineering knowledge and power engineering services, applying their expertise in collaborative power control to maximize the manufacturers' machinery lifecycles and operating efficiencies.

When packaging drives, manufacturers need to utilize power automation control experts who have the expertise to effectively address the heat and harmonic issues that help to ensure system performance. This is why collaborative power control is considered a science.

Manufacturers should look to source these turnkey power control packages from power control suppliers with broad portfolio of products that range from open gearing to power and energy management systems, with a 'bearing to boardroom' power control offering. These suppliers must also have software configuration tools to help manufacturers select the best power control packages for better management and utilization, such as electronically configuring assemblies that minimize non-compatible selection and data entry errors, offering time saving benefits and providing plug-and-play assurances on the plant floor. Together, this will ensure that manufacturers

can leverage a single point of accountability in their quest to maximize operational uptime as a result of the reduction in the numbers of facility engineers.

A Move from Centralized to Distributed Motor Control

Increased distribution of motor control gives manufacturers more installation options. In stand-alone applications in the industrial manufacturing market, manufacturers are deploying many small motors that share circuit protection. This puts added pressure on power control suppliers to help customers select the best power control method.

Today, manufacturers have more power control choices than ever, but power control needs present themselves across facilities and plants in different ways. That is why manufacturers need to deploy power control automation experts to help seamlessly integrate the best power control solution, which could range from a single soft starter or an AC drive to a centralized motor control center or part of a distributed, 'On-Machine' control application.

On-Machine control is the placement of motor control components directly on a machine rather than housing them in a remote, central cabinet. Some control components have always been located on the machine, but what's changing is the number of components moving from the control panel closer to the point of application. On-Machine components can include everything from programmable logic controllers (PLCs), motor starters, drives, sensors, contactors, network hardware, distribution boxes and inputs/outputs (I/O), as well as human-machine interface (HMI) devices.

Typical 'On Machine' Components

- PLCs and I/O
- Motor Starters and Drives
- Contactors and Distribution Boxes
- HMI devices
- Network Hardware
- Sensors

On-Machine solutions can significantly reduce system set up and startup and minimize wiring errors. Due to the modularity and simplified connectivity of components, On-Machine designs allow OEMs to more cost-efficiently build a machine at their site, pre-test it and then disassemble it for transport to an end user's plant.

An Increased Pressure to Meet Varying Global and Regional Standards

Meeting global standards requires advanced application knowledge. In light of more numerous and stricter global standards – such as CUL, CSA, C-Tick,

CCC, UL and IEC, selecting power controls is more difficult for end users and OEMs than in the past. Power control suppliers and manufacturers need to understand both global and regional standards. For example, IEC-rated products still need to meet UL capabilities. In addition, regional standards, such as Canada's CUL and CSA standards and the unique voltage requirements of certain countries must be taken into consideration.

Typical 'Global' Standards

- UL and IEC
- CUL and CSA
- C-Tick and CCC

It is imperative that manufacturers choose power control suppliers that offer products designed to meet global standards. The power control purchase decision is becoming more difficult and manufacturers are increasingly relying on power control suppliers to have the application knowledge and regional and global standard understanding to optimize their applications.

Smarter Power Control Devices Driving Higher Uptime

Access to information is critical for operational uptime, and the manufacturers' rapid adoption of smarter, networked, electronic power control components fuels that access. 25 years ago, less than one percent of AC induction motors incorporated some sort of electronic or solid-state control device, with the balance using mechanical starters. Today, AC drives and electronic soft starters account for nearly 15 percent of the total worldwide motor control market.

Electronic soft starters are beginning to replace some the more complex electromechanical assemblies. Similarly, electronic motor control products, such as overload relays and drives, are increasingly being employed to monitor and share critical motor status information to alert the manufacturer when threats to uptime are imminent.

Moving from mechanical to electronic power control requires an in-depth understanding of power component interaction, such as harmonics and effects on motors and cabling. Proper power control installation requires intimate knowledge of various application issues, and consequently, end users and OEMs are looking to power control automation experts to effectively package power components to address space, heat and harmonics issues.

Prediction Tools Helping Maintain Uptime

Smarter products are driving predictive capabilities to virtually all applications. In the past, only the higher-end applications with crippling downtime costs could justify investment in the predictive maintenance tools. Now, predictive power control devices are monitoring motors on the front lines of a broad range of applications and alerting operators to potential unplanned downtimes, which save time and money.

Advanced motor starters with built-in microprocessors are now commonly housed in networked motor control centers, permitting manufacturers to apply these devices to all loads throughout the plant, not just critical ones. Their electronics provide features, such as communication, programmable alarm and trip values, and ground-fault sensing to help avoid downtime.

Early motor starters were designed to only protect against electrical overloads. Traditionally, these devices tripped when the motor current got too high. They had no ability to read ground-fault current, current imbalance, or whether the motor was close to tripping. Later models added an adjustable trip setting and offered quicker phase-loss protection, as well as other features such as jam, stall, ground fault, and phase imbalance. Today, manufacturers can purchase overload relays that not only identify the causes of a trip but also communicate current information, allowing themselves to see how much thermal capacity is utilized.

Manufacturers in all industries are seeking solutions that integrate software, hardware and communication technologies to deliver plant-floor benefits, such as downtime avoidance, improved process control, and diagnostics to pinpoint problems.

This device-level integration through digital communication is the key to unlocking the full potential of the electronic controls being installed in today's industrial plants. Manufacturers in all industries are seeking solutions that integrate software, hardware and communication technologies to deliver plant-floor benefits, such as downtime avoidance, improved process control, and diagnostics to pinpoint problems.

Device-level communication and sensing capabilities, along with dedicated software, enable intelligent power control architectures to provide energy savings, abundant real-time process information, and predictive failure information to further improve productivity.

Predictive Maintenance Intelligence with Condition-Based Monitoring

A more sophisticated example of predictive technology is predictive maintenance, which involves monitoring the motor and downstream components such as sensors and pumps. In the quest to increase productivity and boost equipment performance, many facilities have turned to reliability-centered asset management practices and predictive maintenance programs to enhance the bottom line.

Predictive maintenance can reduce repair and operation costs by 10 to 30 percent, substantially increasing the return on net assets.

Unexpected downtime can often slash profits, throwing budgets out of balance. Downtime can incur costs of thousands of dollars an hour. For example, a failed heater or pump motor in a plastic resin application could bring the application down for weeks and potentially destroy manufacturing assets. Motor failures on high-speed production lines churning out thousands of products per minute have serious productivity consequences. Even in less extreme situations, predictive maintenance can reduce repair and operation costs by 10 to 30 percent, substantially increasing the return on net assets.

Until recently, monitoring systems only protected equipment against catastrophic failure, and plants often needed to shut down power periodically for maintenance technicians to check machinery closer for developing problems. Today, more companies recognize that to be proactive and prepare for virtually any type of potential failure, they need to put into place a sound program of asset optimization. That means smarter power control monitoring and protection that doesn't sacrifice valuable operating hours and productivity.

Manufacturers should look to their power control suppliers to provide monitoring and protection systems to continuously monitor and protect their plant-floor machinery and equipment. Information collected by these monitoring and protection systems enables maintenance personnel to identify and correct pending machine failures before they stop production or compromise safety.

Power Control Science Gets Return on Energy Solution Investment

In additions to using power control devices for process improvements and downtime avoidance, manufacturers are increasingly looking at power consumption as a more prominent part of the bill of materials in the production of individual products. Manufacturers rarely looked at power as part of the bill of materials. They tracked labor and material, but not power. Rising manufacturing costs are forcing companies to rethink power use. Smarter devices in the power flow, especially at the point where that power is converted to mechanical energy, gives the manufacturer better data, and, in turn, results in better power management.

Like the need to tightly integrate machine and information systems throughout facilities to increase return on investment, maintaining a reliable electric power source and enabling the factory to efficiently manage energy use is equally integral to efficient manufacturing. Today, all plant assets must contribute to revenues. Power optimization tools, such as variable frequency AC drives, add performance and help motors operate more energy efficiently. These devices have an immediate, measurable impact on a company's bottom line. With the right information, these investments can be made with the assurance of a quick return.

Today, all plant assets must contribute to revenues.

Many current energy optimization goals for manufacturers are only geared toward energy conservation, or simply using less energy without regard to what the energy is used for. Instead, manufacturers need to focus on energy efficiency, or using less energy to do equal or more useful work. Factory-floor automation advancements, from drives to intelligent motor control centers, enable relevant, timely decisions that create uptime and optimize energy consumption by essentially adding capacity without adding costly assets. By approaching manufacturers with a system solution, power control automation experts can be deployed to help keep systems fully operational, increase capacity, reduce costs and eliminate the need for additional assets. In short, these system solutions can provide a quick return on energy investment.

Optimizing Motor System Efficiency

According to the Department of Energy, motor systems consume nearly 63 percent of industrial energy, which means auditing them is the most logical

starting point to find ways to conserve energy and reduce costs. That is why manufacturers are requesting power and energy management solutions from their power control suppliers to gather detailed information on power consumption in different areas of their plants, on specific machines, or on individual product lines.

In addition to usage data, plant managers also have access to power quality information that can improve productivity and lengthen equipment life, further enhancing the manufacturers' ability to maximize production, reduce power costs, increase profits and get the best value for their energy expenses by monitoring and tracking power usage.

There are two major questions that are asked by manufacturers as to how energy savings potential can be determined. The first is how efficiently is energy delivered to the motor while starting. The second is how efficiently is the load or machine connected to the motor.

How Efficiently is Energy Delivered to the Motor While Starting

Using electronic motor control products, such as drives and smart motor controllers with 'soft' starts and stops, reduces mechanical stress on systems and lengthens their productive lives, which helps reduce the overall cost of equipment ownership. Additional energy-saving features of drives and smart motor controllers minimize energy consumption on unloaded or lightly loaded motors.

Energy Savings Potential Can Be Determined By:

- How efficiently is energy delivered to the motor while starting
- How efficiently is the load or machine connected to the motor

When applications require less than 100 percent of the designed speed, manufacturers should rely on power control automation experts to help select and integrate variable frequency drives for both low and medium voltage applications. Variable frequency drives help eliminate valves, increase pump seal life, decrease power surge during start-up, and contribute to more flexible operation.

How Efficiently is the Load or Machine Connected to the Motor

Many motor applications, such as conveyors and mixers, require gear reduction to multiply torque and reduce speed. Gearing is a common method of speed reduction and torque multiplication. A gear motor effectively con-

sumes a certain percentage of power when driving a given load. As losses due to friction from gear contact are reduced, efficiency improves. Choices of gearing types, from worm to helical, can offer cost and efficiency alternatives.

Picking the right gear type allows cost-efficient, higher-speed reductions. Applications that require long, near-continuous periods of operation and/or those with high energy costs are very good candidates for analysis. Proper installation of equipment and alignment of mechanical transmission equipment will reduce energy losses and extend equipment life.

Additional energy savings are possible by closely matching and optimizing the motor controller, motor and mechanical power transmission components as a system. Thorough evaluations by power control automation experts help manufacturers find these opportunities.

Conclusion: The Future, Collaborative Power Control is a Science

Manufacturers should rely on the advice of power control automation experts, such as Rockwell Automation, who approach power control as a science to meet individual application needs and process challenges. Rockwell Automation applies its collaborative power control science expertise, which includes a portfolio of electrical and electromechanical power products, predictive maintenance and configuration software, and power engineering services, to meet manufacturing's unique application demands and challenges.

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Through cost-sharing partnerships with the U.S. government, Rockwell Automation is helping apply advanced technologies to reduce energy consumption in motors. Rockwell Automation engineers have developed a 1,600-Hp synchronous motor that uses high-temperature superconducting (HTS) field windings. The new motor uses more than 20 kilometers of this wire and a 4 Tesla DC magnetic field in the motor. The motor also features air-core construction, so that the air-gap field can be increased without core loss and saturation problems common to motors with laminated iron stator and rotor cores. It gives industry a glimpse of the lighter, smaller, and more-efficient motors of the future. This

research will contribute to the commercial success of superconductivity as a viable energy-saving solution.

The Rockwell Scientific Company also is creating power control innovations in the materials sciences and power switching areas. These advancements will continue to be integrated into commercialized products that minimize space, increase energy efficiencies, and improve performance.

By offering a broad portfolio of products that range from open gearing to power and energy management systems, Rockwell Automation is in a unique position to offer manufacturers a "bearing to boardroom" power control offering. This single point of accountability should be leveraged by manufacturers in their quest to maximize operational uptime.

Case Study: Medium-Voltage Drives Cut Costs at ChevronTexaco

Manufacturer: ChevonTexaco, Richmond, CA
Challenge: Reduce or Maximize Energy Use
Performance Impact of: Medium Voltage Drives
Result: Saved $220,000 per year on energy costs

With more than $25 million a year spent on electricity costs, ChevronTexaco's Richmond, CA refinery was looking for ways to reduce or maximize energy use. With capital spending limited, any upgrades had to show a proven return on investment.

Two pumps in the refinery's diesel hydro treater were operating at 40 percent below best-efficiency points, resulting in low hydraulic efficiency and excessive vibration. ChevronTexaco installed medium voltage drives on the 2,250-Hp primary feed pump and 700-Hp product pump to reduce vibration and energy consumption. The drives allowed ChevronTexaco to maximize its return on investment by using its existing standard motors, as opposed to replacing the standard motors with inverter-duty motors. The result is annual energy cost savings of $220,000.

Case Study: Digital DC Drives Minimize Waste at LA Times

Manufacturer: LA Times Newspaper
Challenge: Lower Daily Start-Up Printing Waste
Performance Impact of: Digital DC Drives
Result: Saved over 800 copies of Newspapers Daily

The LA Times newspaper needed to lower its startup waste of over 2,000 copies each day generated by its system of presses. One remedy was to replace its outdated drives with a new PC-based control system. Rockwell Automation Drive Systems engineers partnered with the LA Times to replace its existing DC analog drives on all 16 presses with Allen-Bradley 1395 digital DC drives.

The high-performance digital drives can react to web stresses much quicker than the previous drives, which helps minimize the risk of web breaks, paper waste and downtime. This new system is meeting the waste goal of fewer than 1,200 copies each day with ease. They integrated the drives with a new press control to provide diagnostics, including drive status, overload conditions, out-of-tolerance, and other failure alerts.

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