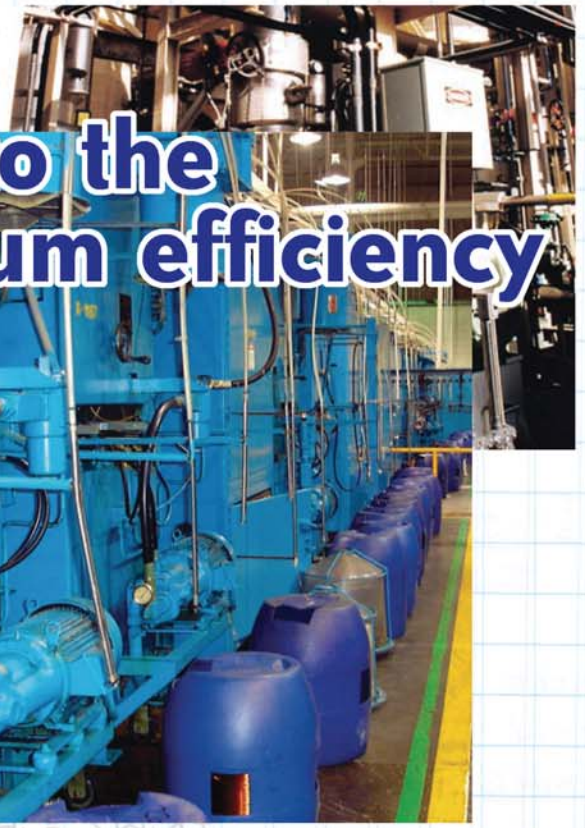
Your guide to practical products, technologies and applications

# Automation NOTEBOOK™

winter 2008 Issue 10



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## Match the motor to the load for maximum efficiency

## New Product Focus

**General Purpose Motors from 1/3 to 300 HP, Ethernet Drivers Added to C-more® Operator Interface Panels**

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# Automation NOTEBOOK

Your guide to practical products, technologies and applications


## Contributors


**Publisher** Tina Crowe

**Managing Editor** Joan Welty

**Senior Editor** TJ Johns

**Design Manager** Justin Stegall

**Contributing Writers**

Chip McDaniel
Jerry Reaves
Jack Smith
Doug Toman



**CONTACTS**
Automationdirect.com Inc.
3505 Hutchinson Road
Cumming, GA 30040

**Phone** ..... 1-800-633-0405
or 1-770-889-2858
**Fax** ..... 1-770-889-7876

Monday - Friday
9 a.m. to 6:00 p.m. EST

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For those who prefer to speak with us in person, please call 1-800-633-0405 x1845. Thanks for your interest, and we look forward to hearing from you.

## Publisher's Note

The New Year is underway and things at AutomationDirect are going full blast. As you will see in this issue, we introduced several products over the last few months, released our 2,016-page catalog, and we continue to expand our product offerings.

This issue of Automation NOTEBOOK is filled with articles about new products, and interesting advances in technology, such as a new adjustable speed motor concept from DynaMotors, Inc. We cover the burning issue of arc flash, and answer questions about AC motors and drives.

We're also pleased to include an article from guest writer Jack Smith, managing editor of Plant Engineering magazine.

But it doesn't stop there. You'll also enjoy an article about Tyler Law and his unique Eagle Scout project at Good Samaritan Healthcare in Cobb County, Georgia.

Our products are being used in literally thousands of applications. If you have information you would like to share with our readers, send it to us at **editor@automationnotebook.com**. We will review your submission and might use it in an upcoming issue of this magazine, or in a future enewsletter. Now, turn the page and enjoy…

TJ Johns
Senior Editor
**editor@automationnotebook.com**

*Cover, Cover Story Photos: Courtesy of Emerson Motor Co., Copyright Emerson Motor Co.*

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# New Product Focus

*what's new*

## General Purpose Motors from 1/3 to 300 HP

AutomationDirect's new IronHorse™ general purpose AC motor line includes rolled steel and cast iron styles in the most popular sizes. IronHorse motors are available in single and three-phase models and in one-third to 300 hp sizes; all motors have a base speed of 1800 RPM and are electrically reversible.

The MTR series 56C frame motors, in one-third to 2HP sizes, are housed in rolled steel, totally enclosed fan cooled (TEFC) enclosures and are equipped with removable bolt-on/bolt-off bases. MTR series motors feature large, easy-to-wire junction boxes, high tensile strength steel shafts, and cast aluminum end bells. The single-phase, 115/208-230 volt motors include large all-metal capacitor covers with rubber gaskets and oversized capacitors. Prices for single-phase motors start at $96. The three-phase, 208-230/460 volt motors are inverter capable and start at $97. IronHorse MTR series motors work well in applications using conveyors, fans, gear reducers, and pumps, and are CE and CSA certified.

The three-phase industrial duty MTC series motors are T-frame TEFC motors available in one to 300 HP sizes and feature ribbed cast iron frames to ensure maximum cooling. They are also equipped with solid full frame-length cast iron mounting feet, cast iron junction box with rubber gasket and rubber dust cover. Motor sizes 10 hp and lower are equipped with maintenance-free bearings. These high-efficiency motors are CSA, CE, ISO9001, and EPACT certified. IronHorse T-frame motors are ideal for applications such as pumps, material handling, metal and textile processing, and test stands. Prices for MTC series motors start at $120.

IronHorse AC motor accessories include Stable™ motor slide bases for accurate and easy motor positioning. Available in sizes from NEMA 56- NEMA 449T, these motor bases start at $10. Replacement capacitors and centrifugal switches are available for MTR single-phase motors for $12. C-flange kits, starting at $14, can be used for C-face mounting of the cast iron MTC series motors.

The new IronHorse general purpose motors are available for same-day shipping and are backed by a two-year warranty. See the full line of IronHorse motors at:
**www.automationdirect.com/ironhorse-motors**

## Ethernet Drivers Added to C-more® Operator Interface Panels


AutomationDirect's C-more touch panels now support several additional protocols for the Allen-Bradley® PLC brand. New Allen-Bradley Ethernet drivers allow simple connection of multiple panels and/or multiple Allen-Bradley PLCs. ControlLogix® Ethernet/IP Tag Messaging support simplifies tag database migration since no mapping or translation is required. RSLogix™ 5000 L5K files can be imported directly, or with a simple operation, the user can enter ControlLogix, CompactLogix® and FlexLogix™ tags from the PLC into the C-more panel. The new drivers also support MicroLogix™ 1100 Ethernet, SLC® 5/05 Ethernet™, and the ENI Adapter for the SLC series. To find out more, visit:
**www.automationdirect.com/c-more**

# Product Snapshots

*Press Releases*

## Industrial Ethernet Switches are IEEE 802.3 compliant

AutomationDirect has launched its new line of Stride™ industrial-grade unmanaged Ethernet switches and media converters. Built for industrial environments, the new Ethernet switches are designed specifically for PLC, HMI and drive users. Now available are 5-port and 8-port Ethernet switches, 4-port and 8-port Ethernet switches with one 100BaseF fiber port, and an Ethernet to Fiber Media Converter.

Once connected to the network, Stride Ethernet switches are true plug-and-play devices which start operating at power up. They automatically determine and remember devices connected to each port and only route messages through the appropriate ports, increasing speed and bandwidth. Even under heavy I/O and data exchange, Stride switches and the Ethernet control network maintain more consistent cycle times.

The Stride switches support 10BaseT (10 Mbps) and 100BaseT (100 Mbps) on RJ45 ports. Each port independently auto-senses speed and duplex, interfacing with legacy (10 Mbps) or fast (100 Mbps) Ethernet devices. All units feature redundant power inputs with industrial surge and spike protection.

The two-port Media Converter converts 10/100BaseTX Ethernet through an RJ45 connection to 100BaseFX Ethernet over an ST multi-mode fiber connection for links up to 4km. Fiber optic cabling greatly increases network distance and enhances reliability, saving time spent tracking communications problems caused by electrical interference.

Stride industrial Ethernet switches and media converters start at $99, are DIN-rail mountable and are UL, CSA, and CE certified, as well as rated Class 2, Div.2 for hazardous locations. Learn more about Stride Ethernet Switches and Media Converters at:
**www.automationdirect.com/ethernet**

## General purpose electrical wire now available

AutomationDirect announces the addition of building/hookup wire to its product offerings. Intended for general purpose applications, THHN building wire is 19-strand 600V uncoated copper wire available in 4-14 gauge sizes, making it ideal for new construction or rewiring 600V applications; THHN can be used in wet or dry locations.

MTW-type wire is available in 19 and 26-strand 600V bare, annealed copper in 10-16 gauge sizes. MTW-type wire is primarily used in control cabinets, machine tool applications, and appliance wiring applications.

Both THHN and MTW-type wire are UL, cUL, CSA, and NEMA rated. Available in 500-foot spools, prices start at $32 for MTW-type wire.

TFFN-type wire is available in 16 gauge, 26-strand, 600V, uncoated copper and is primarily used as fixture wire in dry locations. TFFN-type wire is UL approved and is $38 for a 500-foot spool.

To view the entire line of wire, visit: **www.automationdirect.com/wire**

## Fuse Holders now available in single packs

AutomationDirect now offers Edison fuse holders in single packs. The CHM and CHCC models feature multiple-pole configurations, finger-safe protection and optional "open-fuse" indication. Class CC fuse holders are UL listed, CSA certified and CE compliant, while the Midget models are UL recognized, CSA certified, CE compliant, and IEC approved. Prices for Edison fuse holders start at $6.75 for a single pack and $56.00 for a four pack. Learn more at:
**www.automationdirect.com/fuses**

## New generation of Industrial LCD Monitors

AutomationDirect's ATLAS™ industrial grade 15", 17", and 19" LCD color monitors are heavy duty TFT flat panel monitors offering superb quality with non-touch and analog resistive touch screen models. All models are equipped with 100-240 VAC input power supplies and NEMA 4/4X/12 panel-mountable front bezels. Less than 2.75" panel mounted depth, heavy-duty steel chassis and powder-coated machined aluminum bezels make ATLAS™ ideal for factory automation applications. The full line is UL and cUL listed, European CE and RoHS compliant, and backed by a two-year warranty. Prices start at $995. Learn more at:
**www.automationdirect.com/monitors**

## Expanded PLC protocol support for C-more® Micro-graphic panels


AutomationDirect's C-more Micro-Graphic panels now support five additional PLC protocols. In addition to supporting all *Direct*LOGIC™ PLCs and Allen-Bradley DF1 protocols, new communication drivers have been added to support GE Fanuc SNPX (90/30 and 90/70), Mitsubishi Melsec FX, Omron Host Link (C200 Adaptor; C500), Omron FINS Serial (CJ1/CS1) and Entivity's Think & Do Modbus (PLC tag name support). Updated software is available for download from:
**www.C-MoreMicro.com**

## Disconnect enclosures house many manufacturers' disconnects

AutomationDirect now offers steel and stainless steel flanged enclosures for mounting disconnects. These enclosures are designed to house disconnects from manufacturers including Allen-Bradley, ABB Controls, Cutler-Hammer/Westinghouse, General Electric, I-T-E and Square D, as well as the Ferraz-Shawmut line sold by AutomationDirect. The NEMA rated cabinets range in size from 20"x21"x8" wall-mountable to 84"x197"x18" heavy duty free-standing units. Visit:
**www.automationdirect.com/disconnectenclosure**

## New analog modules for DL05/06 PLCs

AutomationDirect has extended its line of *Direct*LOGIC option modules to include 16-bit high-resolution analog modules for the DL05 and DL06 PLCs. Eight-channel current or voltage input modules and four or eight-channel output modules are available. Prices start at $129. Learn more at:
**www.automationdirect.com/plcs**

## Flexible electrical tubing and connectors for panel and facility wiring

AutomationDirect now offers I-Flex flexible liquid-tight PVC tubing and connectors, manufactured by Iboco. The new tubing provides electrical wire protection outside the control cabinet and is suitable for indoor and outdoor applications.

I-Flex flexible liquid-tight PVC tubing and straight connectors are available in 3/8" to 2" ID sizes and 90-degree connectors are available up to 1-1/4" ID sizes. Prices for tubing starts at $25 (30-meter roll) and connectors start at $18 for a pack of 20. Visit:
**www.automationdirect.com/liquid-tight-tubing**

## New temperature controllers start at $99

AutomationDirect has added the SOLO™ process/temperature controller line to its list of products. With 22 models, 11 of which are priced under $100, these controllers are powerful process tools that offer flexibility and simplicity. Available in four standard DIN sizes (1/4, 1/8, 1/16, and 1/32), units are equipped with dual four-digit, seven-segment displays, useful for process variable and setpoint display. Each model offers dual output control, making it ideal for heating and cooling processes. Output configurations are available in various combinations of mechanical relays, pulse outputs and voltage or current outputs. The built-in auto-tune function with PID control feature allows for fast and easy startups. Flexible control modes include PID, Ramp/Soak, ON/OFF and Manual operation. Universal inputs are standard on all controllers, including thermocouple, RTD, milliamp (mA),

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# Cover Story

*Plant Efficiency*

## Match the motor to the load for maximum efficiency

**A half-loaded motor uses almost as much energy as one that's fully loaded. To save energy, optimize motor horsepower to the specific application.**

by Jack Smith,
Managing Editor, Plant Engineering
*Reprinted with permission from Plant Engineering*

When electricity was cheap, efficiency was not necessarily top of mind for many. However, current energy prices force manufacturers to further analyze where they use energy and how they spend their energy dollars.

According to NEMA, electric motor and generator driven systems account for nearly 70% of the electricity consumed in the U.S. industrial manufacturing sector.

Thanks to leading motor manufacturers and groups such as Motor Decisions Matter, manufacturers are beginning to replace motors with NEMA Premium motors, improve rewind practices and follow U.S. Department of Energy and Electrical Apparatus Service Association best practices.

However, some manufacturers are still using EPAct and pre-EPAct motors. Some manufacturers and OEMs are still applying larger motors than loads require, which is extremely inefficient. Some are still starting motors that could be used with soft starters or adjustable speed drives across the ac line.

### Too large for the load

Many of the motors in operation today in the U.S. are larger than they have to be. Many motors are loaded at less than 50%. However, they use almost as much electricity at lighter loads as they do fully loaded – an expensive mode of operation. Appropriately matching the motor and its load produces savings that add directly to the bottom line.

Tim Albers, director of marketing, Emerson Motor Co., St. Louis described a scenario where a facility wanted to upgrade to Premium Efficiency motors. According to Albers, many of their motors had been there 30 to 40 years. "More than half of their motors were 50% loaded or less. In many cases, the

**These 7.5 hp motors are driving hydraulic pumps on automated winders in an Emerson Motor Co. plant.**
Photo courtesy of: *Emerson Motor Co., reprint with permission from Plant Engineering*

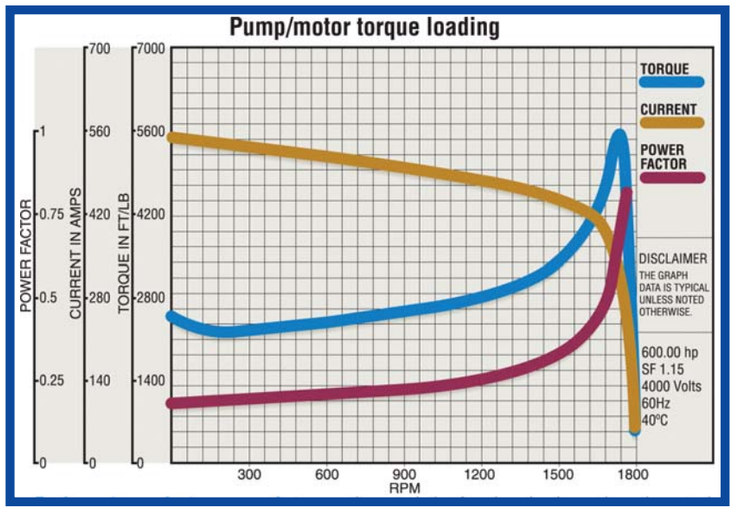
actual load on the belt was 15 hp – and they were using a 50 hp motor!" For this application, Albers explained a 20-hp motor provides a 25% safety factor; 25 hp provides a 40% safety factor. "Do they think they need more than 40%? No, they had a 150% safety factor on this motor!" Motors designed into original equipment are typically 'right sized' if the OEM is following best practices.

Albers said companies such as Ingersoll Rand, ITT Goulds and Flowserve have the tools in place to do an appropriate job. "When ITT Goulds or Flowserve is sizing a pump motor, or Ingersoll Rand is sizing a compressor motor, they understand that they're sizing motors between 75% or 80% to 105% of rated horsepower.

They know exactly what they're doing. They know whether they need the extra safety factor or not. They know the questions to ask to get a correctly sized product," Albers said.

"The biggest issue we run into is when people who are not experienced try to size a motor or choose a motor for an application," Albers continued.

"The biggest issue is either smaller manufacturers or end-user maintenance personnel who say 'I had a 40 hp, it failed, why don't I put a 50 hp on this time?' That 40 hp (motor) might have




**Equipment manufacturers supply torque characteristics for given loads, such as these typical pump curves. Motor manufacturers supply torque characteristics for the motors they manufacture. Appropriately matching motor and load requires this information.**

lasted 12 or 14 years, which is an appropriate life of the motor. Upsizing the motor may or may not be a good thing. For efficiency, it's probably a bad thing."

Not all end users fall into the inefficient category. "The same thing I said about the large OEMs is also true about the large end users," Albers said. "There are guys who have written papers about efficiency in their operation; they know exactly what's going on. They are sizing them – because they know that as long as they are at 70% loading or more, they are getting the full efficiency of the product – and they know exactly where they are going with it."

### Right-size the motor for the load

"Reduce system load," said John Malinowski, product manager, AC and DC motors, at Baldor Motors and Drives, speaking at the Plant Engineering Manufacturing Summit in Chicago. "In the U. S., we always think bigger is better. Well, it isn't. You need the right size. Motor downsizing is on the DOE list. I don't like calling it 'downsizing;' I like to call it 'right-sizing.'"

"Match the equipment to the load," continued Malinowski. "Something as simple as going to one of these notched V-belts, instead of a solid V-belt, can add 3% to system efficiency."

To optimize efficiency, determine whether the specific torque capabilities of a motor meet the torque requirements of the application's load. Although motors that operate with constant flux are said to have constant torque, the demand of the load determines the actual amount of torque produced. Compare the motor's speed-torque curve with the load's speed-torque requirements.

Motor manufacturers supply torque characteristics for the motors they manufacture. NEMA's publication MG 1 is another good source for this information. The most accurate way to obtain torque characteristics of a given load is to obtain them from the equipment manufacturer.

Malinowski said the sweet spot for an AC induction motor is between 75% and 100% efficiency. "If you size all the motors for the plant, (you should) size a motor for about 80% of the load. That's absolutely the efficiency peak on a typical AC induction motor. If you have a motor that runs at lighter loads, the efficiency drops off, but the power factor drops off really significantly, so that 75% to 100% is really the right-rated load point," he said.

**These motors are driving natural gas compressors used to compress gas from a pipeline prior to injection into a peak power gas turbine power station in Montreal.**
Photo courtesy of: *Emerson Motor Co., reprint with permission from Plant Engineering*

Malinowski recommends using current measurements as part of a Level 2 motor survey to determine if the correct motor is applied. He said using the right size motor for an application increases efficiency and power factor, as well as the purchase price. "While you're doing the survey, this is a point where you may also consider adding the adjustable speed drive," he said.

### Consider adjustable speed drives

Adjustable speed drives can greatly increase applied motor efficiency. ASDs enable induction motors to start up and operate using less current. Inrush current for typical pre-EPAct motors started across the line can be 5 to 6 times the running current of the motor. Inrush can be 6.5 to 7 times more for EPAct motors, and as much as 8 times for Premium Efficiency motors, which is one of their tradeoffs.

Using ASDs on variable torque loads such as pumps, fans and compressors produce enormous savings, said Malinowski, describing Level 3 plant surveys. "Now, you're really getting into some heavy engineering. You're going to look at the whole system. Look beyond the motor. Add adjustable speed drives on pumps and fans. The process control can also help you increase productivity," he said.

When selecting a motor for use with an ASD (also called variable-speed drive), consider the application, load characteristics, speed range, environment and drive requirements.

In an article published in the July 2002 issue of Plant Engineering titled "How to match AC motors and variable speed drives," the authors wrote:

*"Regarding torque characteristics, the majority of variable-speed AC drive applications fall into either variable torque or constant torque applications. Centrifugal pumps and fans are variable torque applications where most fixedspeed, energy efficient AC motors can be used without concern of overheating. The horsepower required to operate centrifugal pumps and fans decreases with the cube of the speed. That means if you reduce the speed of the AC motor to one-half of base speed, the horsepower required is only one-eighth of rated horsepower."*

Malinowski used a typical pump application to further describe this relationship. With a typical pump running with a bypass valve, if the amount of flow changes from 100% to 40%, the kilowatts needed to operate the motor in the pump system don't change. "If I put a throttle valve in there and vary the flow, it changes a little bit. But if I get rid of the valves – or the dampers in an HVAC system – and control the flow by changing the speed of the motor, between 100% flow and 40% flow, I've

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# Cover Story cont.

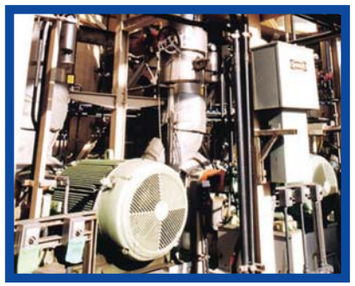
## Plant Efficiency

**Continued from, p. 9**

gone from 85 kW down to about 12 kW. The more we run at the lighter, lower flows, the more energy we're going to save."

**Don't forget maintenance**

When replacing a failed motor, upsizing horsepower is not among the maintenance best practices. However, taking good care of installed equipment is. "When you see something operating out of the normal trend, check it out," said Malinowski. "Find out what's binding it up, causing it to draw more current."



**These motors are driving blowers in a chlorine-free pulping process at a paper mill.**

Photo courtesy of: *Emerson Motor Co., reprint with permission from Plant Engineering*

Maintenance best practices also include establishing a Motor Management program. Motor Decisions Matter established guidelines that can streamline the process. According to Malinowski, MDM's Level 1 involves surveying the facility to take inventory of all the motors. "Tag each motor as to what to do when it fails," he said. "Undoubtedly, it's going to fail on the third shift or on a Sunday afternoon when one of the newer maintenance people is on duty. You don't want him deciding on his own what motor goes in there. He's just going to get the (equipment) up and running. It may be an oversized motor or an inefficient motor for what the job is. You're not going to change it because it's running, so you're stuck with it until it fails again. Tag the motors so that whoever is doing the maintenance knows what to do."

**See Jack Smith's bio on p.15>>**

# Product Snapshots cont.

## Press Releases Continued

**Continued from, p. 7**

millivolt (mV) and DC voltage. Select models are equipped with three available alarm groups.

All units offer RS-485 serial communications, allowing use of free software (downloadable from www.automationdirect.com) to configure and monitor up to eight SOLO controllers using Modbus RTU or ASCII protocols. SOLO process temperature controllers can also be configured manually with the user-friendly keypad on each unit. Visit: **www.automationdirect.com/processcontrollers**

### Dependable control transformers starting at $31

AutomationDirect has revamped and expanded its line of Hammond control transformers. The superior quality and design of the HPS Imperator series transformers make them ideal for high inrush applications requiring reliable output voltage stability. These transformers are 50/60 Hz, 600V class, machine tool rated with ratings from 50 VA up to 1000 VA. They are UL listed, CE marked and RoHS compliant. Finger safe terminal covers and primary side fuse kits are available.

HPS Imperator control transformers are priced from $31 to $141, and carry a limited lifetime warranty. To see the full line, visit: **www.automationdirect.com/powerandaccessories**

### New foot switches and LED pushbuttons

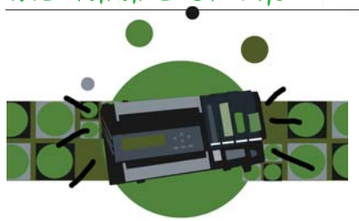
AutomationDirect has added foot switches to its line of product offerings. These switches, in single and double units, are designed for machines such as shearing and spinning machines, lathes, wrapping machines and riveting machines and presses. Foot switches are available in two operational formats: free movement and foot switch locked in neutral position. AutomationDirect has also extended its line of 22mm metal pushbuttons to include 24V and 120V LED illuminated pushbuttons, selector switches, and pilot lights. Replacement LED bulbs are also available in convenient two-packs. To see the selection of foot switches and pushbuttons, visit: **www.automationdirect.com/pushbuttons**

"I never lost a game. I just ran out of time."

– Bobby Lane, former Detroit Lions football player

# PLC Speaking

## The future of PAC



### What's in a name?

By Jeff Payne
AutomationDirect Product Manager

"What's in a name? That which we call a rose by any other name would smell as sweet."

PLC, DCS and PAC are a few acronyms used to describe what originally replaced the relays in the late 1960's. So, what are the differences and why do we need to call them by so many different names?


The Farlex Dictionary defines these as follows:

***Programmable Logic Controller***

A programmable microprocessor-based device that is used in discrete manufacturing to control assembly lines and machinery on the shop floor as well as many other types of mechanical, electrical and electronic equipment in a plant. Typically RISC based and programmed in an IEC 61131 programming language, a PLC is designed for realtime use in rugged, industrial environments. Connected to sensors and actuators, PLCs are categorized by the number and type of I/O ports they provide and by their I/O scan rate.

In the late 1960s, PLCs were first used to replace the hard-wired networks of relays and timers in automobile assembly lines, which were partially automated at that time. The programmability of the PLC enabled considerably faster changes.

***Distributed Control System***

A process control system that uses a network to interconnect sensors, controllers, operator terminals and actuators. Generally very large and costly systems, a DCS typically contains several computers for control and uses proprietary interconnections.

***Programmable Automation Controller***

A programmable microprocessor-based device that is used for discrete manufacturing, process control and remote monitoring applications. Designed for use in rugged, industrial environments, PACs combine the functions of a programmable logic controller (PLC) with the greater flexibility of a PC. They are also more easily configured for data collection and integration with the company's business applications than PLCs.

Although each PAC vendor uses their own development environment (IDE) and programming language, PAC networking is typically based on IP and Ethernet. Taking advantage of off-the-shelf microprocessors, PACs were developed in the 1990s to provide a single industrial controller that would provide the functions of a DCS (Distributed Control System) and PLC (Programmable Logic Controller).

These are fair assessments of three main types of control systems currently in use in today's controller markets … but why so many and do we really need them?

Today's PLCs have expanded well beyond their original design scope. They have continued to advance since their inception in the late 1960's. However, there has been an obvious spike in the technological influence in the control world within the past 5 to 10 years.

As we've discussed in the past, I believe flexibility is becoming a higher priority for those who are specifying automation systems. Today users need multi-functional control, simple connectivity and easy access of process data, all wrapped up in a nice neat package.

Today's PLCs have to be much more than the relay logic replacement which they were initially designed to be.

**Insert the world of PCs**

With PC technology becoming smaller, faster and less expensive, PLC manufacturers could not pass an opportunity to take advantage of these advancements in technology.

PACs are, for lack of a better term, today's "high-end PLCs". They still look like PLCs of the last decade, but introduce the intellectual properties of modern day electronics and computing into the industrial controllers we all know so well.

The advantage to the consumer is that you receive this technology in a platform you trust to perform in industrious environments while reaping the benefits of Commercial Off-The-Shelf (COTS) hardware.

Coincidentally, this new class of controller provides more memory capacity and processing power which allows for better data processing capabilities, and connectivity to enterprise business systems from the plant floor.

Additionally, we see the benefit of easy integration for multi-domain systems comprising Human Machine Interface (HMI), motion control and process control.

"So tell me again … what is a PAC?" It looks like a PLC with modular design for flexibility and reliability. It smells like a PLC, and programmability is basically very similar. (I can't say I tried the taste, but I would be willing to bet it tastes like a PLC.)

Will it replace the PLC? No, but it will complement today's control options to give you the best possible solution for your application.





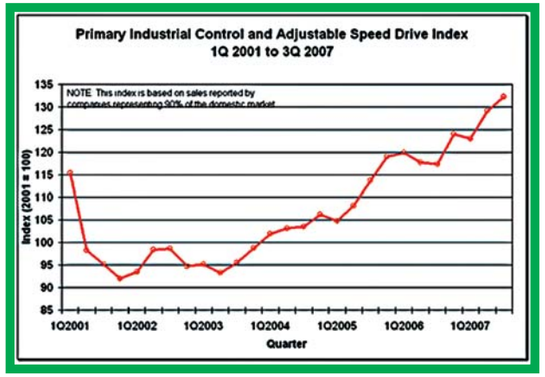
# Business Notes

## Goings-on in the Automation Industry

### The Ups and Downs of the Economy

By Joan Welty
Managing Editor

According to the National Electrical Manufacturers Association (NEMA), industrial control shipments continued to grow throughout 2007. Although measures of confidence among manufacturers slipped in the second half of the year, indicators of the industrial sector's performance remained in solid shape.




Courtesy of: *National Electrical Manufacturers Association.*
*Source: Demand for Industrial Controls Continues to Rise during Third Quarter of 2007, 09 Nov 2007.* **http://www.nema.org/media/pr/20071109a.cfm**


Looking ahead, reports from the Manufacturers Alliance (MAPI) indicate that the combination of the credit crunch, housing slowdown and high oil prices will slow GDP growth to just 1.3 percent in 2008. According to a survey by the National Association of Manufacturers (NAM), large manufacturers expect their capital expenditures to rise by just 0.3%, while small companies expect their investment spending to grow by a stronger 1.6%. For both large and small firms, this is a significant slowdown. These trends are consistent with a slow-down in overall business investment spending that has taken place over the past year. The third quarter survey suggests that investment spending by manufacturers will continue to grow over the next year, but at a slower pace than during the past few years.

Interestingly, exports appear to be a major factor in the 2008 economy, and could possibly comprise one-half of the U.S. gross domestic product increase next year. The weakening dollar coupled with continued global demand for U.S. industrial products, including high technology, military equipment and heavy machinery, will contribute to net export gains of over 8 percent in 2008.

**Water, water, everywhere…**

With 2007's extreme drought in the Southeast and other regions of the country, one seemingly sensible solution to the scarcity of water is to take the salt out of seawater. Desalination refers to any of several processes that remove excess salt and other minerals from water to make it suitable for animal consumption or irrigation, or, if almost all of the salt is removed, for human consumption. Obvious as desalinated water might sound, the energy costs have slowed its widespread adoption.

Depending on local energy prices, 1,000 gallons of desalinated seawater can cost around $3 or $4. Although that might not seem like much, it is still cheaper in many places to pump water out of the ground or import it from somewhere else.

Distillation is perhaps the one water treatment technology that most completely reduces the widest range of drinking water contaminants. However, the energy required for the distillation process makes it prohibitively expensive on a large scale. Much of the current market for "thermal desalination" has therefore been in oil-rich, water-poor countries in the Middle East.

Since the 1950s, researchers have been developing membranes that could filter out salt. This membrane technique, sometimes called "reverse osmosis," requires one-fourth of the energy and costs half the price of distilling saltwater. But even with membranes, large amounts of energy are needed to generate the high pressure that forces the water through the filter. Lowering the energy required and keeping membranes clean are two big challenges facing reverse-osmosis desalination. Recent research in the U.S. indicates that nanotube membranes may prove to be extremely effective for water filtration and may produce a viable water desalination process that would require substantially less energy than reverse osmosis.

Variations on desalination energy supplies include solar or wind-powered methods that could be useful in remote applications or in regions where those energy sources are consistent. In Perth, Australia, in 2007, a wind-powered desalination plant was opened that provides nearly 40 million gallons of clean water per day. As fresh water becomes scarcer in certain regions, even the current costs of desalination processes may well be worth the investment.

# User Solutions

## Color-coded Illuminated Indicator System

### Eagle Scout helps Good Samaritan

By TJ Johns
Senior Editor

If you were, or someone in your family was, ever part of the Boy Scouts of America, you are familiar with the Scout Oath. That oath begins, "On my honor I will do my best to do my duty to God and my country, and to obey the Scout Law; to help other people at all times…" More than 1.7 million Boy Scouts have fulfilled the oath since 1911 to obtain the ultimate rank of Eagle Scout. This elite group represents only about five percent of all Boy Scouts.

From left: Dr. Larry Hornsby, Tyler Law at the Good Samaritan Health Center in Cobb County, GA

One of the final stages in earning the rank of Eagle Scout is to plan, develop, and lead others in a service project that will be helpful to his c ommunity. Many candidates build swings for parks or construct nature trails; one candidate gave miniature American flags to our troops. In each case, the scout looks for an area of great need in the community.

Recently, Eagle Scout candidate Tyler Law saw a need at a local health care facility.

Good Samaritan Health Center of Cobb, in Marietta, Georgia, provides a comprehensive range of services for patients without health insurance or the means to afford care. The facility is comprised of eight exam rooms and one nurse's station. Outside each exam room, a color-coded flagging system is mounted to indicate the type procedure requested by the doctor for the patient. Due to the layout of the building, the nurse is unable to see each room from the nurse's station.

Seeing the need to improve the way nurses are notified, doctors began looking at different notification systems on the market. Since the health care center is nonprofit, an estimate of $22,000 for an automated system was out of the question. Tyler saw the need to replace the flagging system and had an idea for a color-coded illuminated indicator system for less money.

Dr. Larry Hornsby, Medical Director at Good Samaritan Health Center of Cobb states, "Showing God's love by providing quality care for our patients is a leading standard of excellence here at Good Samaritan. The lighting system project Tyler created [will help] fulfill this part of our mission statement by increasing the efficiency of appointments [for] our physicians, nurses and interpreters."

Tyler presented the idea behind his service project to AutomationDirect's Industrial Components product manager, Lenny Filipkowski. "During the meeting it was very evident that Tyler was a driven young man. He had put together a project that was out of his comfort zone but felt the benefits far outweighed the difficulties he would encounter along the way," Lenny commented.

With design help from his engineering mentor, Kirk Maassen, and installation help from fellow Scouts, and friends, Tyler designed and implemented the controls. The 24V system, powered by a RHINO power supply, consists of a series of four indicators, in a non-metallic enclosure, mounted outside each exam room. Each indicator is wired to a main indicator panel located in the nurse's station.

From left: Lenny Filipkowski, Tyler Law and Kirk Maassen discuss details of the project

With the new system in place, the doctor activates one of the color-coded indicators from the patient's examining room. A corresponding indicator will then activate at the nurse's station, informing her of which procedure is requested in which room. Upon completion of the procedure, the indicator is deactivated from the examining room.

On the main indicator panel, an additional enclosure is equipped with three indicators to alert the nurses of waiting patients. When a patient arrives, the receptionist activates the white indicator. Depending on which doctor the patient will see, either the red or blue indicator is then activated.

The nursing staff at Good Samaritan Health Center of Cobb now works more efficiently because of the installation of the new illuminated indicator system. Operations Manager Emily Jones exclaims, "The entire clinical staff is thrilled to have the new system in place. Our traffic flow is much smoother and we can provide an even better experience for our patients. It is especially helpful when we have our volunteer doctors in-house. This proficient system helps us train them more quickly and see even more patients. Tyler and his team were quick witted and kind-hearted as they spent many hours refining exactly what we needed to make it perfect for our center."

When asked how this project impacted Tyler, he replied, "From a leadership standpoint, this project taught me about the importance of giving a good example for those you are instructing and being what you want them to be. I also began to understand that leadership is more about giving to those who follow you than just being the guy who gives instructions. From a technical standpoint, I learned that it is very important to plan ahead, and measure twice and only cut once!"

To learn more about Good Samaritan Health Center of Cobb, visit: **www.goodsamcobb.org**





# Cover Story cont.

## Plant Efficiency

### Jack Smith's Bio

Jack Smith is Managing Editor of Plant Engineering magazine covering automation and electrical topics, and Editor of Applied Automation, a quarterly supplement of Plant Engineering. Smith joined Plant Engineering in 2000, and has written for several trade publications. Prior to writing and editing, Smith spent nearly 20 years in industry as an Engineering Technician. He worked in power generation, aerospace, and instrumentation and control in both process and discrete manufacturing industries. Smith also holds a B.S. in Journalism from Northern Illinois University.

"Loyalty is a really old-fashioned value. People don't talk about loyalty anymore. We've become more focused on the self, fulfilling our own personal needs. How your behavior affects the corporation has been chucked by the wayside in favor of personal actualization.

You really see a major shift in people's sense of whom they owe something to. They feel they're just as likely to be shafted by their companies, so if something better comes along, they're going to grab it."

– Susan Whitbourne, psychology professor at the University of Massachusetts in Amherst

"Actually, I'm an overnight success. But it took twenty years."

– Monty Hall

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- Industrial gauge steel motor frame and base

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### 56C Frame Rolled Steel Motors

| Part Number | hp | Phase | Price (US$) |
|---|---|---|---|
| MTR-P33-1AB18 | 0.33 | 1-ph | $96.00 |
| MTR-P50-1AB18 | 0.5 | 1-ph | $99.00 |
| MTR-P75-1AB18 | 0.75 | 1-ph | $110.00 |
| MTR-001-1AB18 | 1.0 | 1-ph | $123.00 |
| MTR-1P5-1AB18 | 1.5 | 1-ph | $152.00 |
| MTR-002-1AB18 | 2.0 | 1-ph | $185.00 |
| MTR-P33-3BD18 | 0.33 | 3-ph | $97.00 |
| MTR-P50-3BD18 | 0.5 | 3-ph | $99.00 |
| MTR-P75-3BD18 | 0.75 | 3-ph | $112.00 |
| MTR-001-3BD18 | 1.0 | 3-ph | $125.00 |
| MTR-1P5-3BD18 | 1.5 | 3-ph | $145.00 |
| MTR-002-3BD18 | 2.0 | 3-ph | $165.00 |

### T Frame Cast Iron Motors

| Part Number | hp | Phase | Price (US$) |
|---|---|---|---|
| MTC-001-3BD18 | 1.0 | 3-ph | $120.00 |
| MTC-1P5-3BD18 | 1.5 | 3-ph | $145.00 |
| MTC-002-3BD18 | 2.0 | 3-ph | $153.00 |
| MTC-003-3BD18 | 3.0 | 3-ph | $213.00 |
| MTC-005-3BD18 | 5.0 | 3-ph | $241.00 |
| MTC-7P5-3BD18 | 7.5 | 3-ph | $347.00 |
| MTC-010-3BD18 | 10 | 3-ph | $375.00 |
| MTC-015-3BD18 | 15 | 3-ph | $560.00 |
| MTC-020-3BD18 | 20 | 3-ph | $605.00 |
| MTC-025-3BD18 | 25 | 3-ph | $850.00 |
| MTC-030-3BD18 | 30 | 3-ph | $900.00 |
| MTC-040-3BD18 | 40 | 3-ph | $1,155.00 |
| MTC-050-3BD18 | 50 | 3-ph | $1,500.00 |
| MTC-060-3BD18 | 60 | 3-ph | $1,865.00 |
| MTC-075-3BD18 | 75 | 3-ph | $2,135.00 |
| MTC-100-3BD18 | 100 | 3-ph | $2,470.00 |
| MTC-125-3BD18 | 125 | 3-ph | $3,515.00 |
| MTC-150-3BD18 | 150 | 3-ph | $3,810.00 |
| MTC-200-3BD18 | 200 | 3-ph | $5,040.00 |
| MTC-250-3D18 | 250 | 3-ph | $6,240.00 |
| MTC-300-3D18 | 300 | 3-ph | $8,197.00 |

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# Feature Story

*Motor Technology*

## Future Adjustable Speed Motor Technology

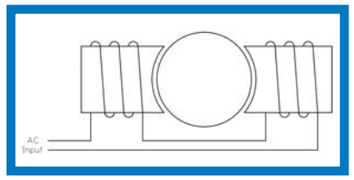
By Doug Toman
General Manager
DynaMotors, Inc.

High pole count motors have existed for years, and are in use today in some specialty industrial applications. They typically provide slower operation (without a drive), but the horsepower is reduced as the pole count increases. A new concept for high pole count motors has recently been patented by DynaMotors, Inc of Cleveland, OH.

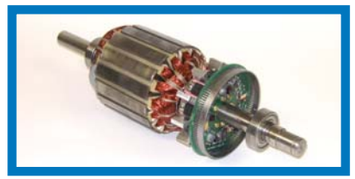
The DynaMotor™ is a brushless AC motor that runs at variable speeds by means of electronic switches embedded in the motor's wound rotor. These rotating switches regulate current flow in the rotor and thus the motor's torque and speed. The DynaMotor's characteristics include variable speed operation on single phase power, high torque at low speed, reduced RFI, completely integrated controls, and the ability to operate on GFCI protected circuits. Prototypes of the DynaMotor are being tested in various industrial applications, and the results are very promising. DynaMotors, Inc. is seeking additional manufacturing partners, and production motors may be on the market by the end of 2008.

**How it works**

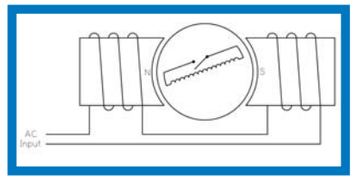
The DynaMotor looks like an ordinary AC or DC motor. It is the same shape and size, and is made from the same mechanical parts, laminations, windings, shaft, end-bells, bearings and housing. The difference is that the DynaMotor™ uses optically controlled solid-state switches embedded in its rotor windings. Opening and closing these switches controls the current, and thus the torque, right where it is being produced. The result is a self-contained variable-speed motor.



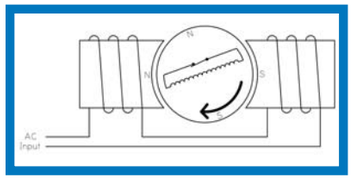

The DynaMotor™ is constructed like a DC motor, or universal motor with two or more opposed salient poles whose copper windings are connected directly to the AC line.



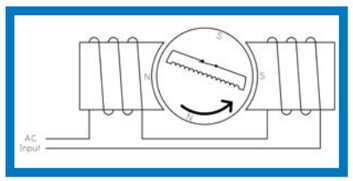
The rotor is similar to universal and DC motors, consisting of slotted steel laminations stacked on a shaft. Copper wire is wound in the rotor slots and the ends of each coil are connected by a solid-state switch, such as a transistor. In contrast, universal and DC motors have each coil connected to copper bars in a commutator that receives external power through carbon brushes.



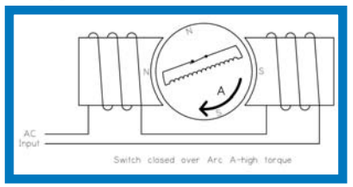

When the stator windings are connected to an AC line, a resultant magnetic field varies with the line current and magnetic poles are created. The stator flux passes through the rotor inducing a voltage in each rotor coil by transformer action. However, with the switch open, no rotor current can flow and no torque is produced.




When the solid-state switch is closed, current flows through the rotor coil. This produces flux and a magnetic pole. If the position of the rotor is such that its magnetic pole is not aligned with the magnetic pole in the stator, the non-aligned magnetic poles produce force. The tangential component of that force is torque and rotation occurs. The torque generated varies with the position of the rotor with respect to the stator.

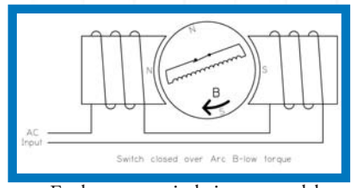



If the rotor's switch is closed when its coil is on the opposite side of the stator pole, then torque is produced in the opposite direction.

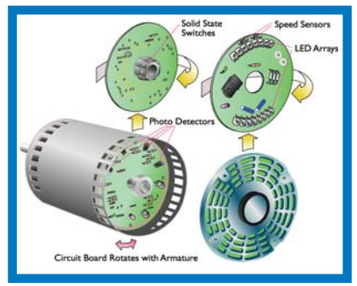



**Torque and Speed Adjustment**

The torque produced by the motor depends on the position of the rotor when the switch is closed, and the duration (over what rotational angle) the switch is closed. When the switch is open, current cannot flow and no torque or rotation is produced by the coil. Closing the switch for a long period produces high torque. Closing the switch for a shorter period produces less torque.




Each rotor switch is actuated by a dedicated photo-detector as it rotates past a stationary illuminated infrared light-emitting diode (LED). An array of LEDs mounted on the motor end-bell can be turned on for varying amounts of time to adjust the motor's torque and speed.



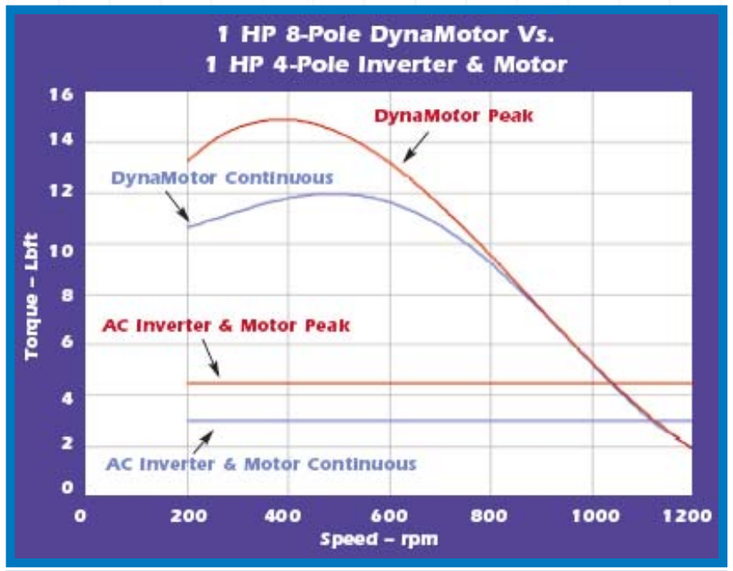

Since there are multiple coils on the rotor that can be energized simultaneously and controlled individually, continuous smooth torque can be produced.

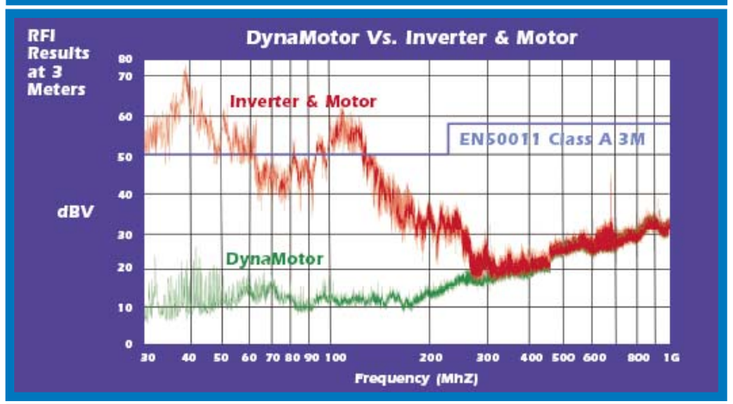
If operated open loop, the motor control's torque and speed may vary depending on the load. To precisely control and maintain speed, regardless of changes in load or other external factors such as temperature or input voltage, a simple internal optical speed sensor is used. This speed sensor compares the motor's actual speed with an external speed command signal and varies torque to produce the desired speed. The external speed signal can be a potentiometer, a variable voltage signal or a digital speed command. The microprocessor speed controller contains the functions usually provided by a variable speed drive, such as ramp rates and min/max speeds.

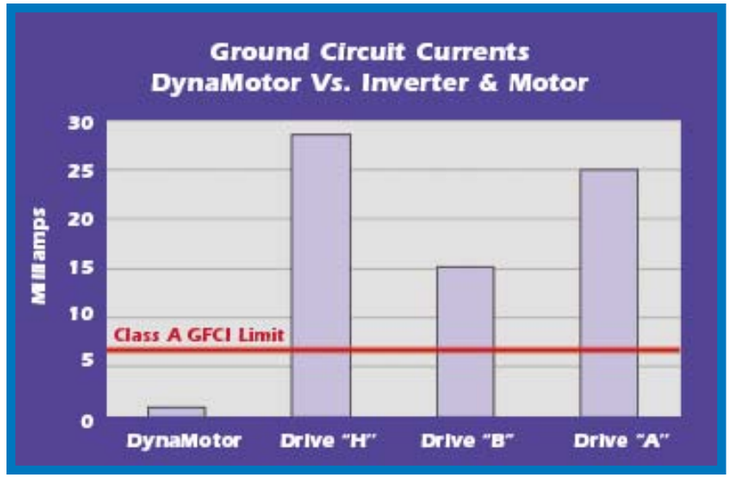
**DynaMotor Characteristics**

The DynaMotor's unique design leads to characteristics quite different

**Continued, p. 20 >>**



# Feature Story cont.

## Motor Technology

**Continued from, p. 19**

than conventional motors and drives:

***High Torque at low speed***

In an ordinary AC induction motor, increasing the number of stator poles decreases the motor's base speed by the same ratio. However, the torque does not change and the horsepower the motor can produce decreases. In the DynaMotor, adding stator poles decreases the speed but the motors torque increases proportionately so constant horsepower is maintained. As shown below, at speeds of 200 to 800 rpm, a NEMA 56 frame DynaMotor can produce over three times the torque of a comparably sized 4-pole AC induction motor and drive.

This characteristic enables the DynaMotor to run equipment in the low speed range directly without mechanical speed reducers such as gear boxes, and reduces the number of reduction stages even if lower speeds are required. This eliminates the size, weight, cost, maintenance, and losses inherent in gear boxes or other mechanical speed reducers.

***No High Frequency PWM Switching***

In conventional AC induction motor/drives, the incoming AC power is converted to DC, and then inverted back to variable voltage/frequency AC; this is usually done by high frequency pulse width modulation (PWM). PWM switching can generate significant amounts of audible whine, Radio Frequency Interference (RFI), poor motor insulation life, and ground currents. RFI can interfere with the operation of other controllers, computers, sensors, and communication devices. In contrast, the DynaMotor's stator connects directly to the AC line. Switching occurs on the rotor at about 300 Hz producing essentially no RFI (shown below). The filtering, shielding or extraordinary grounding techniques necessary with AC drives are not required with the DynaMotor.

In addition to radiated noise, conventional AC drives can create power line noise. The stator of the DynaMotor acts as a filter, reducing noise injected back onto the power line, and also protects the DynaMotor's electronics from power line noise generated by other equipment.

PWM switching in conventional motor/drives creates ground currents due to capacitive coupling to ground, which shortens bearing life and prevents operation on GFCI protected circuits. The DynaMotor produces no measurable ground current.

***Integrated Electronics***

Conventional AC or DC controllers are typically mounted remotely from the motor. The DynaMotor has the control electronics integrated into the motor, eliminating the separate controller and its enclosure as well as the wiring from the controller to the motor. In many cases the DynaMotor is simply plugged into a receptacle, which eliminates the possibility of wiring errors or loose connections.

***56/60 Hz Operation***

The speed of AC induction motors depend on the frequency of their input power. The speed of the DynaMotor is independent of line frequency; therefore it can operate equally well on 50 or 60 Hz power.

The speed is also not affected by fluctuations in input voltage.

***Reliability***

The DynaMotor is unique in that it has rotating electronics. Simple, inexpensive, and effective techniques have been developed to ensure the integrity of the rotating printed circuit board. These techniques have been verified by extensive accelerated life testing, including over-speed operation. This is especially effective as the forces on the electronics increase by the square of the speed. Over-speed tests have been successfully conducted at 15,000 rpm on boards designed to operate at 3000 rpm, which subjects the electronics components to forces 25 times what they experience in normal operation.

***Applications***

As a result of its unique characteristics, the DynaMotor has demonstrated the ability to power a wide range of applications such as mixers, pumps, fans, material handling systems, lathes, saws, and many other machines.

For more info visit:
**www.dynamotors.com**

Or contact:

Doug Toman
General Manager
DynaMotors Inc.
4945 B Pointe Parkway
Warrensville Heights, OH 44128
Ph: 216-292-7278
Fax: 216-292-7288
**dtoman@dynamotors.com**

"Imagine a world in which a Boeing 737-500 has come down in price from $35 million to $3,500. You can get one at any Wal-Mart and take it home. But it's no less complicated to fly, no less complicated to maintain. If something goes wrong, there are not mechanics standing by to help you. You are expected to fix the problem yourself, after calling tech support.

That's just about what has happened in the computer industry. You come home with a 166-million-instruction-per-second monster, controlled by an operating system with 3 million lines of code, and if something doesn't work you are expected to fix it yourself."

– *Forbes*, 13 March 1995

# Technology Brief

*Electrical Safety*

## Arc Flash: What's the big deal?

By Jerry Reaves
AutomationDirect
Product Manager,
Power Distribution Components

The subject of arc flash has become a major concern in electrical safety. What exactly is arc flash and how can it be prevented? Arc flash is high temperature conductive plasma formed when a short circuit fault occurs between at least two energized conductors. It occurs when a phase-to-phase fault or phase-to-ground fault causes energized conductors to go beyond their rated voltage and current limits. If the protective device allows this condition to happen, conductors will explode or "arc flash," producing a flash of light, loud noise, and temperatures exceeding 5000° F. When this happens, hot gases are released and molten metal is projected outward from the fault area. An arc flash can happen in as little as 1/1000 of a second, creating a shock wave that can hurl loose items from the area outward. The shock wave produced from the instantaneous heating of air could be great enough to knock someone completely off their feet. Personnel standing in the area could be seriously injured with loss of sight, loss of hearing and severe burns; injuries can be severe enough to cause death.

Even though arc flashing has existed for as long as electricity, why does this topic seem to be at the top of everyone's list today? With the high demands on electrical energy in the industrial environment, arc flash accidents are increasing. Some reports indicate as many as 10 to 15 serious arc flash incidents happen each day in the United States. This is causing concern about personal safety in the event of an arc flash. Authorities have begun to rigorously investigate what an arc flash is and what causes it. The results provide a better understanding of arc flash, quantify its potential hazards, and encourage the adoption of safer work practices.

The Occupational Safety and Health Administration (OSHA) has been able to enforce safer workplace practices with their standards. When an accident has occurred due to an arc flash, OSHA is likely to cite the employer with non-compliance of 29CFR 1910.335(a)(1)(i) and 29CFR 1910.132(d)(1) which requires proper protective equipment usage and requires the employer to perform an assessment of workplace hazards. In 1976 the National Fire Protection Association (NFPA) formed a committee to write and publish their first workplace safety standard concerning electrical safety. In 2004 the NFPA 70E, "Standard for Electrical Safety in the Workplace", was approved and adopted for use. Even though OSHA has not incorporated the NFPA 70E in the Code of Federal Regulations, they still use it as a "how to comply" manual. An employer is not mandated to comply with the NFPA 70E, but OSHA has been able to show that conforming to the standard helps maintain compliance with mandated OSHA regulations. OSHA contends that compliance with NFPA 70E can prevent or lessen the risk of injury and has been able to use this as a baseline to prove if an employer has acted reasonably.

One method to minimize the magnitude of an arc flash and decrease the damages incurred involves the use of current limiting fuses. Current limiting fuses reduce the amount of thermal energy (I2t) produced during a fault.

In a current limiting fuse, the fusible link's typical design has many places where the cross-sectional area has been reduced in size, and the link is usually encapsulated in quartz sand. When a short circuit fault occurs, the reduced cross-sectional areas on the fusible link will heat up quickly and melt, thus opening the fusible link. As the fusible link opens, clearing the fault, an arc will form across the opening. The quartz sand helps quench the arc, reducing the amount of time it takes to clear the fault. The sand also helps dissipate the heat generated during the fault condition. The link, which had a very low resistance before the fault, becomes a link with very high resistance. This significantly reduces the current in the short circuit.

Looking at the thermal energy let-through formula, I2t, "I" is the effective let-through current, squared, multiplied by "t", which is the time it takes for the fuse to clear the fault. It is easy to see that the thermal energy will be greatly reduced if less current is available during the fault.

Are current limiting fuses the best solution for arc flash hazards? Current limiting fuses can reduce the amount of thermal energy generated during a fault, but they do not eliminate it completely. An arc flash hazard is still present; it is just greatly reduced in magnitude. In many cases, even with reduced thermal energy, the arc flash can still cause serious injuries and damage.

NFPA 70E 110.8(B)(1)(b) states that a flash hazard analysis should be performed in order to protect personnel from the possibility of being injured by an arc flash. A flash hazard analysis will determine the required personal protective equipment (PPE), the boundaries and the approach limits. Article 130.3(A) defines the Flash protection boundary or approach limits, and Article 130(B) defines how to determine the proper personal protective equipment needed.

Most people who work around energized equipment are familiar with arc flashes; some have even seen it. However, an "it can't happen to me" mentality often exists. An arc flash incident is a very serious situation and one that everyone working with live circuits must consider. While current limiting fuses can reduce the risk of an arc flash, they are not a substitute for a complete arc flash analysis. Working on energized equipment can be done as safely as possible, but ensuring safety includes knowing personnel are properly prepared for arc flash hazards and are aware of how to reduce this risk.

*References*

1) NFPA 70E, "Standard for electrical Safety in the Workplace," 2004 edition
2) Occupational Safety and Health Standards 29CFR1910.335 "Safeguards for personal protection"
3) Occupational Safety and Health Standards 29CFR1910.132 "General Requirements"

### Staged Arc Flash Event

Worker nearing an open electrical panel

Bright, intense flash from the arc engulfs the worker

Non-FR work clothing burns after arc exposure

*Photos courtesy of Schneider/Square D Corp. Used with permission.*

Courtesy of: *Schneider Electric/Square D Corp.*
*Source: Arc Flash Awareness: Information and Discussion Topics for Electrical Workers, January 2007*
**Department of Health and Human Services**
**Centers for Disease Control and Prvention**
**National Institue for Occupational Safety and Health**
**Pittsburgh Research Laboratory**
**Pittsburgh, PA**

"We know nothing about motivation. All we can do is write books about it."

– Peter Drucker, business guru

# Tech Thread

*operator interface*

## Understanding the Advanced Recipe Function of the C-more® Touch Panel

By Keri Schieber
AutomationDirect

Recipes are used in a multitude of control applications including batch processing for the food, beverage, chemical and pharmaceutical industries, as well as complex applications such as robotics fusion. Recipes, when used with an HMI, provide a simple and effective way to change the data in a large number of tags with the push of a single button.

The C-more touch panel, offered by AutomationDirect, has an advanced recipe function that allows operators to easily view and select from a list of multiple recipes. The operator simply touches a Call Recipe button on the screen, a Recipe Sheet pops up with a list of recipes, and the operator chooses which recipe to run. If configured, the operator can even change values in a recipe.

The C-more multiple recipe function consists of a call recipe button which accesses a recipe sheet located in the recipe database. Both are configured using the C-more programming software.

**Recipe Database**

The Recipe Database, found under the Database dropdown menu or Function tab, can store up to 99 user defined recipe sheets, with each recipe sheet configurable with up to 1,000 recipes. A single recipe can have up to 256 tags or values.

**Creating a Recipe Sheet**

We will create a recipe sheet called "Cookie Recipes" (Figure 1, item A).

When creating a recipe sheet, a spreadsheet style window is used (figure 2). The first column in the sheet

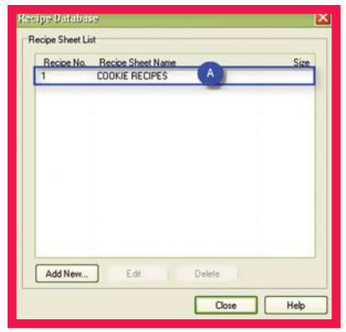



**Figure 1**

contains the recipe name destination tag (Figure 2, item A) and the names of the recipes.

In this example we are setting up

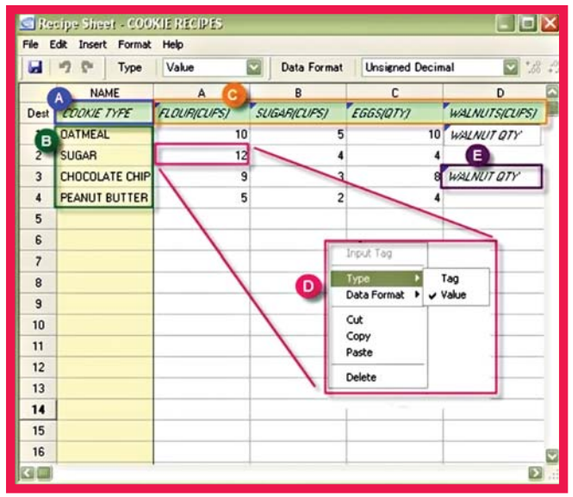



**Figure 2**

cookie recipes, so we created a tag called COOKIE TYPE for our recipe tag name destination. The destination can be an internal C-more tag or a PLC tag using an ASCII String data type. We used a PLC tag so the PLC can track which cookie recipe is being used.

Below the COOKIE TYPE tag we listed our various cookies: Oatmeal, Sugar, Chocolate Chip and Peanut Butter. (Figure 2, item B) These names are static text and are not associated with any tags. When an operator selects and loads one of the cookie recipes (item B), the cookie name is loaded into the COOKIE TYPE tag (item A), which can be displayed on the C-more panel, or used for control or logging data in the PLC or panel.

Next we added the ingredient tags: Flour(Cups), Sugar(Cups), Eggs(Qty), Walnuts(Cups), etc. (Figure 2, item C). The ingredients are the destination tags where the values from the recipes are loaded. These are entered in the green cells at the top of each column. They can be Tag Names that were previously created in the Tag name Database, or a new Tag Name can be created by simply entering the desired Tag Name in a cell and a dialog box will open for configuration.

Since different cookie recipes typically call for different quantities of ingredients, we needed to list how many units of each ingredient are used for each cookie type. By right-clicking on a cell in one of the ingredient columns we can select the cell type as a value or a tag (Figure 2, item D). If selecting a value type cell, we enter a number that is within the range of the data format, such as BCD, decimal, etc. If a sugar cookie uses 12 cups of flour, we enter 12 in the flour cell for the sugar cookie recipe. The values will be written to the ingredient destination tags when an operator selects a cookie type and presses the LOAD button.

If using a tag type cell, we assign a tag name, such as WALNUT QTY (Figure 2, item E), and assign a PLC address. This way the PLC knows the amount of walnuts used for a specific cookie, such as Chocolate Chip cookies.

Some other facts to know about the recipe sheet are:

- A blue triangle in the upper right corner of a cell denotes the cell is a tag type, no triangle is a value type
- If incorrect data is entered in a cell it will be displayed in red
- The recipe sheet can be edited using drag and copy/autofill features similar to an ExcelTM spreadsheet
- The recipe sheet can be exported to and imported from Excel as an XLS or CSV file for easy editing, using care to maintain the syntax and format, or a CSV file may be accessed through the C-more panel FTP server feature

**Creating the Call Recipe Button Object**


**Figure 3**

The Call Recipe button is used to display a specific recipe sheet on the panel (Figure 3). The button can be placed on one or more screens of a C-more panel. When an operator selects the button, the recipe sheet is displayed on the panel screen.

To configure the Call Recipe button, select it from the objects list. Enter the text to be displayed on the button (Figure 4, item A). We called ours "Select Cookie Recipe". Next, select Cookie Recipes from the drop down list of Recipe Sheets (Figure 4, item B). To view and edit a recipe sheet, select the "Recipe Sheet" button (Figure 4, item C).

When configuring the Call Recipe button object, there are three types of sheets to choose: Display Only, Display and Download, and Display, Download and Edit (Figure 4, item D). 1) Display Only will not allow any action from the operator. 2) Display and Download will allow the operator to select a recipe and load it into the destination tags. 3) The third type will allow the operator to edit the value in a cell that is to be written to a destination tag. Since we want to allow

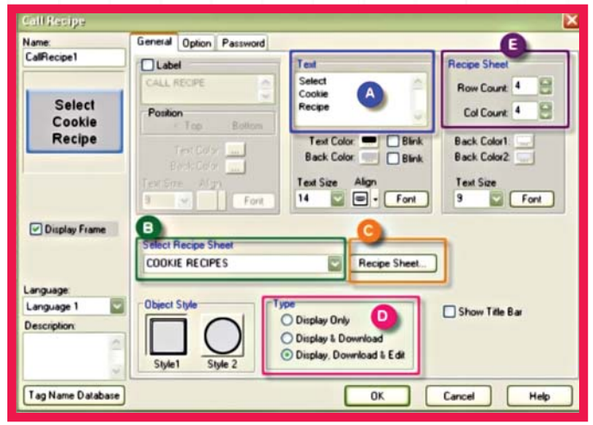



**Figure 4**

the operator to change the amount of ingredients in the recipes, we selected the third type.

The Call Recipe button object also allows predetermination of how many recipe sheet columns and rows will be displayed on the panel screen (Figure 4, item E). Use the Simulate feature to test the project for the optimum display. In this case some of the ingredient names are rather long, therefore we will set the number of columns to four in order to view the entire name. We have four types of cookies, so we will select to display four rows.

Other features of the Call Recipe button include adjusting text size and changing fonts for the button text and for the recipe sheet text.

If preferred, a "Recipe Button" object can be used to load a single recipe from any recipe sheet.

**Using the Recipe Function on the C-more Panel**

Once the project is loaded into the panel, simply touch the "Select Cookie Recipe" button to display the recipe screen.

In order for the operator to access the recipe functions, they will need to open the toolbox by touching the button in the lower right corner of the screen (Figure 5, item A). The toolbox (Figure 6) will allow the operator to scroll through the recipe list, edit tags, and load the selected recipe into the destination tags.

To scroll through the recipes use the arrow buttons located on the toolbox (Figure 6, item A). To change the value in a recipe, select Edit, then select the cell to be edited and enter a value using the pop up keypad. To load the recipe, select the recipe name, such as Oatmeal, and press the Load button.


**Figure 5**


**Figure 6**

For further information on the Call Recipe object, reference the Help files included with the C-more programming software or download the latest Help file from:
**http://support.automationdirect.com/downloads.html**

"Real courage is when you know you're licked before you begin, but you begin anyway and see it through no matter what."

– Harper Lee

# Technical Review

*Transportation Innovation*

## Urban Challenge 2007

By Chip McDaniel
AutomationDirect

AutomationDirect was pleased to help support two vehicles hoping to compete in the 2007 DARPA Urban Challenge. Team Mojavaton, with their "White Knight" (a modified Nissan Xterra), and Insight Racing (fielding a Lotus Elise dubbed the "Lone Wolf") were both invited to the National Qualification Event held in Victorville, CA, at the end of October 2007. The teams were competing with 33 others for 3.5 million dollars in prize money.

The Urban Challenge was the third such event that DARPA has held since 2004 in an effort to further the technology of autonomous vehicles. Congress has charged the U.S. military with a mandate that one third of all military vehicles be driven autonomously by 2015. DARPA, the Defense Department's R&D arm, is using the series of challenges to help spur the innovations needed to accomplish this goal. The first two "Grand Challenges" were held in a desert environment, and the vehicles were tasked with plotting a course and driving more than 130 miles across rugged terrain, but with only static obstacles. While none of the teams completed the course in 2004, several vehicles completed that task in 2005, and a team from Stanford University collected the two million dollar first place prize. The 2007 Urban Challenge upped the complexity, and the stakes. The vehicles had to be able to drive on roadways, and obey all standard traffic laws. Not only did they contend with other moving vehicles but they also plotted a course while driving through sixty miles of urban obstacles. The first prize was again $2 million dollars, with $1 million for second and $500,000 for third.

DARPA also changed the format of the challenge by splitting the teams into two separate "tracks" for the Urban Challenge. Eleven different Track A teams, all from major universities in the US, were identified early in 2006 and were awarded $1 million in "seed money" to help defray the costs of the project. The remaining 78 (Track B) teams were encouraged to participate, but were not offered any "up-front" money. Both Mojavaton and Insight racing were Track B teams.


The Lone Wolf, Insight Technologies

Team Mojavaton competed previously in the 2005 Grand Challenge where the White Knight performed flawlessly, passing ten other cars (in the staggered-start format) before a broken throttle linkage stranded the Xterra on the course at the 23-mile mark. As soon as the Urban Challenge was announced, Team Mojavaton jumped at the chance to further their technology, and immediately began upgrading the onboard systems and software for the new Challenge.

Insight Racing also earned a spot in the finals of the 2005 Grand Challenge, but they didn't attempt that course with the Lotus. They employed a more off-road capable Chevy Suburban in 2005, and they also made it 20+ miles before becoming disabled.

All the teams in the Challenge used a combination of sensors, GPS receivers, powerful computers and custom software to achieve their autonomous goal. Both Mojavaton and Insight used an AutomationDirect PLC to actuate the steering, throttle, and brakes. The PLC was also used to actuate the turn signals, and the warning claxon that all the cars are required to sound whenever they are under autonomous control.

Both teams had to prepare their vehicles for the unique challenges of the urban setting. The vehicles had to obey all traffic laws, while constantly scanning for other vehicles, stopping at stop signs and obeying the rules of precedence at intersections. They were required to pass other stationary and slow moving cars (without crossing double yellow center lines), back up, park, make U-turns and plan a new course when the main road is blocked, and even take evasive action if a collision with another vehicle is imminent. "It sort of makes a 132 mile drive on a closed course in the desert seem like a walk in the park," commented Jim Crittenden, team leader for Team Mojavaton.

After DARPA announced the details of the Urban Challenge in May of 2006, they received applications from 86 teams wishing to participate.


The White Knight, Team Mojavaton

DARPA narrowed the field in 2007 by requiring the submission of demonstration videos in April; technical papers were due in June, and site visits by DARPA officials were conducted in July. Thirty-five teams (including both Mojavaton and Insight) were invited to the National Qualification Event (NQE) in October, where they were competing for the opportunity to participate in the Urban Challenge Final Event held on November 3.

The NQE and the finals were held at the former George Air Force Base in Victorville, CA. At the NQE the vehicles were tested in three separate test areas: Area A - left turn and merge, Area B – obstacle avoidance, and Area C - precedence at intersections. DARPA provided a number of professional racecar drivers and cars to simulate traffic on the various courses. "We have developed a lot of respect for these professional SCORE drivers. Their precision and their driving skills are remarkable. We've wondered what kind of waiver they each had to sign to get the job of traffic driver. It must have said something like: 'You will be driving a little Ford Taurus in close proximity to other cars that are at least twice as big as your car (or in the case of team TerraMax, 5 times as big) and those cars won't have anyone in them. We hope they will drive well, but we just don't know what they're going to do. While we will ask you to honk your horn to signal an infraction, don't expect that to do any good,'" said Crittenden.

DARPA had originally announced that 20 teams would be selected to go to the finals, but after three days of qualifications only 11 teams were selected to move on. Both Mojavaton and Insight were among the disappointed teams who were not selected. Of those eleven, seven were Track A teams, and of the 25 Track B teams in the semifinals (who received no funding from DARPA) only 4 were accepted for the finals.

In the finals, the vehicles simulated military "supply" missions by navigating a 60-mile obstacle course. The vehicles were graded on how well they could flow with traffic, heed stop signs, maneuver traffic circles and avoid accidents. The first three robots to complete the mission in less than six hours were declared the winners. University teams swept the top three spots in the finals, with Carnegie Mellon in first (two million dollars), Stanford in second (one million), and Virginia Tech in third ($500,000). Congratulations to Mojavaton, Insight, and all the teams that participated! The technology that they have developed will help the military develop the autonomous vehicles that will save lives on the battlefield and behind the front-line – and will most likely enable safe, autonomous vehicles for our roads and highways some day.

For more about the teams visit:
**http://www.mojavaton.com**
or
**http://www.insightracing.org**

For more information about the Challenge visit:
**http://www.darpa.gov/grandchallenge**
or
**http://blog.wired.com/defense/urban_challenge**

"The best measure of a man's honesty isn't his income tax return. It's the zero adjust on his bathroom scale. "

– Arthur C. Clarke (1917 - )

# FYI
## AC Motors and Drives

## Motor Questions Answered

**Can IronHorse™ motors be used with a drive?**

IronHorse™ motors can be used with drives, but there are some limitations. Depending on your application, there may be good reasons to step up to an inverter-duty motor in your application.

**What's the difference between a General Purpose motor and an Inverter Duty motor?**

General purpose motors have been around for many years. They are the workhorse of almost every industry. The inverter-duty motor is a much newer concept that became necessary with the advent of variable frequency drives or VFDs (sometimes called inverters or AC drives). An inverter duty motor can withstand the higher voltage spikes produced by all VFDs (amplified at longer cable lengths) and can run at very slow speeds without overheating. This performance comes at a cost: inverter-duty motors can be much more expensive than general purpose motors.

**When should I choose a general purpose motor?**

If your application is an "across the line" motor installation, IronHorse general purpose motors are a perfect fit and a great value. But IronHorse will also work with a drive in many situations. Guidelines for choosing an IronHorse general purpose motor are given in Figure 1. If your application falls within these guidelines, there is no need to apply an inverter-duty motor.

***NOTE: Inverter-duty motors have limitations as well. Please see the Marathon section of our catalog for details.***

**What does "across the line" mean?**

"Across the line" refers to connecting a motor directly to the power source, without a drive or a soft-start circuit. Pay close attention to the ratings of contactors when specifying contactors for full-voltage starting - most contactors have a separate AC-3 rating for motor loads. Resistive loads (use AC-1 ratings) are much easier on contactors compared to heavy inductive loads (like motors). Of course, proper fusing, disconnects, and E-stop contactors should always be used for electrical and personnel safety.

**Why should I spend more money for an inverter-duty motor?**

If you need to operate the motor at very low speeds (with a drive), or if you need full rated torque across the speed range, you might want to take a look at our inverter duty motors. Extended cable lengths between the drive and motor can also require use of an inverter duty motor.

**Heat considerations**

| | IronHorse speed ratio | For an 1800 RPM motor, minimum IronHorse speed is: |
|---|---|---|
| Variable Torque applications (fans, centrifugal pumps, etc.) | 5:1 | 1800/5 = 360RPM |
| Constant Torque Applications (conveyors, extruders, etc.) | 2:1 | 1800/2 = 900RPM |

**Voltage Spike considerations**

| | Max cable distance from drive to IronHorse motor | Max cable distance with a 3% line reactor between drive and IronHorse motor |
|---|---|---|
| For use with 230V and 460V VFDs* | 125' | 250' |

** Up to 6kHz carrier frequency*

Figure 1

**When should I use a drive?**

A drive allows the speed of a motor to be varied while running and it lessens the inrush current required when the motor is started. A vector drive can also tightly control the speed and/or torque output of the motor.

Without a drive, AC motors are operated "across-the-line" with contactors and motor starters. The electricity sent to the motor is a very clean sine wave at a fixed voltage and frequency (60Hz in the US). Noise and voltage peaks are relatively small, and reflected waves are generally not a concern. However, there are drawbacks: the motors can only run (electrically) at one speed. Speed reduction, if required, must be handled with gearboxes or other mechanical means, and there is a large inrush of electrical current (when the motor is started) that is often 5 to 6 times the normal current that the motor consumes. The speed reduction apparatus can be expensive and bulky, and inrush can wreak havoc with power systems and loading (imagine an air conditioning system in an older home: when the compressor starts, the lights dim; imagine the same circumstances with a motor the size of a small car).

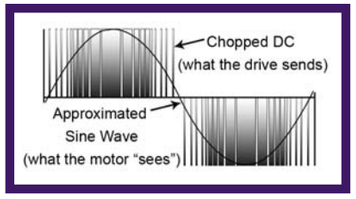



Figure 2

**How does a drive control a motor?**

A drive rectifies the incoming 60 Hz AC power to a DC voltage. Every drive has a DC bus that is roughly 1.4 (sqrt of 2) times the voltage level of the incoming AC line. The inverter section of the drive then "chops" this DC voltage with power transistors (IGBTs) at very high frequencies to simulate a sine wave [see Figure 2]. This "chopping" is called pulse width modulation (PWM). By converting the incoming power to DC and then performing pulse width modulation to mimic AC, the drive can vary the amplitude (volts) and frequency (Hz) of the simulated wave, which in turn varies the speed of the motor.

**Will a VFD cause my motor to overheat?**

A VFD-driven general purpose motor can overheat if it operates at too slow a speed. Since most general purpose motors cool themselves with shaft-mounted fans, slow speeds mean less cooling. If the motor overheats, bearing and insulation life will be reduced. Therefore there are minimum speed requirements for all motors.

**Why do long cable lengths cause voltage spikes?**

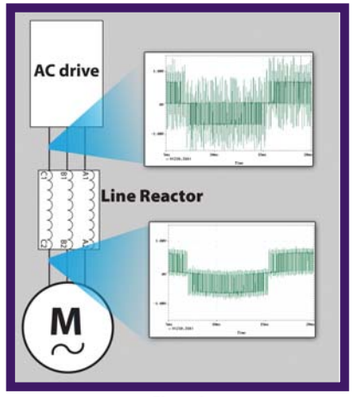



Figure 3

Voltage spikes occur as a result of the "pulse width modulated" output of the drive and are associated with the "rise time" of the IGBT transistors in the inverter section of the drive. IGBT transistors are used in modern drives due to their high speed switching capability. The IGBT transistor allows for higher carrier frequencies in the drive and quieter operation of the motor as a result. As carrier frequencies rise, harmonics and the phenomena known as "reflective waves" become a concern.

Reflective waves occur due to impedance mismatches between the motor leads and the motor winding. Mismatches are most prevalent with long motor leads and the lower impedance of smaller horsepower motors.

Reflected waves can effectively double the voltage on the motor leads and can lead to premature failure of the motor insulation.

Line reactors help by reducing the amplitude of voltage spikes from the drive and are used in situations where the motor is located at longer distances from the drive[Figure 3].

**What is a line reactor, and why is it so important?**

Line reactors are single stage transformers that provide isolation without any change in voltage. Line reactors are used with AC drives both on the input side of the drive and also between the drive and the motor.

On the input side, line reactors help protect the drive from voltage spikes/transients and they help prevent the drive itself from inducing transients back on the power lines where they may disrupt other equipment in a factory.

On the output side (between the motor and the drive), line reactors protect the motor insulation against IGBT reflective wave damage. Output reactors also smooth the current waveform into the motor, allowing the motor to run cooler. IronHorse motors require a line reactor when used with a VFD if the cable distance between the drive and motor is more than 125 feet. You should not exceed 250 feet in cable length between an IronHorse motor and a drive.

**Isn't there more than one type of drive?**

Yes, the term "drive" typically refers to either a Variable Frequency Drive (VFD), also called an inverter, or a vector drive. Drives typically operate in either "scalar" (volts/hertz mode) or "vector" mode. Volts/Hz drives are the most commonly applied drives. Vector drives are more expensive but offer tighter control.

**What is scalar or Volts/Hertz control?**

In scalar control, a VFD simply commands the motor to run at a certain speed by modulating the output frequency and RMS voltage. With no feedback mechanism, the VFD has no idea if the motor is responding correctly to that command; it just keeps humming along, blissfully ignorant even if changes in the load cause the motor to slow down or if the line voltage drops. However, in many applications these factors do not warrant the cost of a more sophisticated drive.

AutomationDirect's GS1 and GS2 series of AC drives offer excellent Volts/Hertz capabilities at a great price. For more info about the GS1 and GS2 drives please visit:

**http://www.automationdirect.com/drives**

**What is "vector" control?**

Vector control is all about adjusting for changes in the load and system. A vector drive uses feedback from what is happening at the motor (measuring) to make changes in the output of the drive in order to affect the desired outcome with the motor, i.e. speed or torque accuracy.

**What is a flux vector drive?**

In a flux vector drive, a sensor is used (an encoder mounted on the motor shaft) which provides near-absolute rotor position feedback to the microprocessors in the drive so that the exact vector algorithm of voltage and frequency can be attained. This means that no matter where the rotor is at any given moment, the VFD can adjust the output vector algorithm to produce whatever speed or torque the motor is capable of. The true test of a vector drive

**Continued, p. 30 >>**

# FYI cont.

## AC Motors and Drives

**Continued from, p. 29**

is holding a precise amount of torque at zero speed, i.e. supporting a hoist load when you release a holding brake. You can even use the encoder feedback to attain a rudimentary form of motion control from a flux vector VFD.

AutomationDirect's Hitachi SJ300 line of AC drives can be configured for vector control with encoder feedback.

**What is sensorless vector control?**

"Sensorless" or "open loop" vector is really a misnomer because with vector technology there is always a closed loop, and there are always sensors. The difference is in the location and capabilities of the sensors. In the so-called sensorless versions, the measurements are done by looking at minute effects on the output current created by what is happening in the motor to determine what to do. These effects are caused by the motor's rotor bars passing through the magnetic fields in the stator windings and can be "seen" by very high speed digital signal processors (DSPs) in the drive. So the sensors are the Hall Effect current transducers within the VFD itself, instead of external sensors such as the encoders. The microprocessor makes the vector calculations based on a mathematical model of the motor that it creates when you first set up (tune) the system. This method can be just as accurate as using encoder feedback in 99% of applications. The one thing unattainable with a sensorless drive is that holy grail of 100% torque at zero speed, because the motor is not providing those minute current distortions when the rotor isn't turning!

AutomationDirect's DURApulse line of AC drives offer sensorless vector capability at a great price. For more info about DURApulse drives please visit: **http://www.automationdirect.com/durapulse_drives** or **http://www.durapulse.com**

**Why do I need to tune a sensorless vector drive system?**

The biggest mistake people make with a sensorless vector drive is to allow it to run on the default motor model instead of taking the time to tune the drive to the specific motor that is being used. Many VFDs now come with auto-tune features, but surprisingly few people take advantage of them. The result is performance that is barely better than a scalar drive at a higher cost.

**What about all those new NEC regulations? They confuse me, but I still want a safe and legal motor installation?**

For a brief run-down of branch circuit and motor circuit protection please see the Circuit Protection section of our catalog or download: **http://motors.automationdirect.com/images/circuit_protection.pdf**

**Can I run a three-phase motor on single-phase power?**

No, not "across the line", but we do offer our GS1 Drive in several single-phase models. They can control three phase motors up to ½ hp with 110VAC single phase input power, and up to 1 hp with 200-240VAC single phase input power. For more info about the GS1 drives please visit: **http://www.automationdirect.com/drives**







# The Break Room

## Humorous Stories and Brainteasers

### Thanks for the advertising, but…

By Tina Crowe, Publisher


My dad is always looking for ways to help out with my mother's business – a day spa in my small hometown. He's also always on the lookout for ways to save money. A few years ago, he purchased a new van and decided to put advertising graphics for her spa on the side, call it a business vehicle, and thereby take a tax deduction for the vehicle. With quite a bit of hesitation, she agreed.

My dad purchased the graphics and began tooling around town, running errands for Mom, but mostly doing his own "thing."

After only two weeks, my mother began fielding phone calls complaining about her "rude company driver." People reported observing her company van not stopping at stop signs, failing to use turn signals, driving too slowly, and cutting people off.

Fearing irreparable damage to her business' reputation, and innumerable phone calls, she made him remove the graphics and told him, "no thanks" for the free advertising.

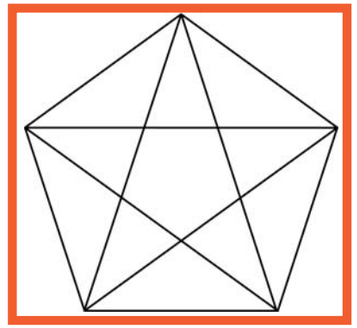
## Brainteasers

**1. Widget Fidget:**

A factory owner took a certain number of widgets to a county fair and sold some of them. He took the unsold widgets back to his factory that night and - while he slept - his fully automated factory doubled the number of widgets on hand. He took these to the fair the next day and sold the same number as on the first day. That night his factory tripled his remaining widgets. Again he went to the fair and the same number was sold. On the third night his remaining widgets were quadrupled, and on the following day he sold the same number yet again. On the fourth night the factory quintupled his remaining stock of widgets. The next day he took those to the fair and sold the exact number as on each of the previous days, and thus depleted his entire stock.

*What is the minimum number of widgets he could have taken to the fair on the first day? And on which night was his factory the most productive?*

**2. Triangle Wrangle:**



*How many triangles can you count in this figure?*

**3. Fuse Ruse:**

*Can you transform the shape below, formed by these six Edison fuses, into two diamonds, by moving only two and adding one fuse?*


Please visit **www.automationnotebook.com** for answers to brainteasers.

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