Your guide to practical products, technologies and applications

Automation NOTEBOOK™

Spring 2005 Issue 4

Cover Story

AC Drives Focused on Energy Conservation

New Product Focus

Molded case circuit breakers for electrical protection

Technology Brief

Improving Business Tools for Greater Customer Service

Feature Story

Motion Control System Choices

Automation NOTEBOOK

Your guide to practical products, technologies and applications

Contributors

Publisher Tina Crowe

Managing Editor Keri Schieber

Senior Editor Joan Welty

Design Manager Justin Stegall

Contributing Writers

Russ Sanders
Jeff Payne
Chip McDaniel
Dave Hartig
Robert Thornton
Tom Elavsky

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

www.automationdirect.com

Editor's Note

Another National Manufacturing week has come and gone. We had a great time talking to everyone that stopped by our booth and want to thank all of you that visited us. If you didn't get a chance to pick up our catalog on CD or a product brochure, you can go to our Web site to make a request and we'll send it right out.

We're working on our next catalog, expected to be released by early summer, offering more new automation products at great prices. Watch for your copy of our new volume, and if you aren't currently receiving our catalog, go to our Web site and sign up.

Something else we're still working on, as I mentioned in our last issue, is our expansion into an adjacent building. It's not going as quickly as planned, but we should be all settled in by our next issue of Automation Notebook. We'll keep you informed, as we hope to have some interesting stories to tell about our move-in experience.

Keri Schieber
Managing Editor
editor@automationnotebook.com

Table of Contents

New Product Focus

what's New

Molded case circuit breakers for electrical protection

AutomationDirect now carries a line of Molded Case Circuit Breakers (MCCBs) that offers UL489 listed performance for branch circuit overcurrent protection and disconnecting means. The circuit breakers' small size saves panel space, compared to standard breakers or comparable fusible devices. The breakers are manufactured under license from Eaton Electrical, Inc., the manufacturer of Cutler-Hammer products.

The MCCBs use patented contact conductor designs featuring high-speed "blow-open" action that results in superior performance when high level fault currents produce extraordinary electromechanical forces. They also feature advanced arc extinguishing technology, and a toggle handle that provides three positions (on/off/tripped) along with visual indicators.

Units available in the MCCB line include the 100A G-Frame, 225A F-Frame, 400A K-Frame and 600A L- Frame. The G-Frame and F-Frame size units are suitable for reverse feed, and the K-Frame and L-Frame breakers include a 3-pole adjustable magnetic trip. All breakers include base mounting hardware for panel mount applications.

A line of accessories is also available for the MCCBs. Flex and standard shaft handles are available to make installing and operating the enclosure mounted MCCBs easy. Also available are multi-wire lug kits to save valuable panel space and wiring time by eliminating terminal blocks. Standard accessories, such as auxiliary contacts, shunt trips, and under-voltage releases are offered on all frame sizes. The line is manufactured in ISO9000 certified facilities. Prices for the MCCBs start at $139.

Molded Case Circuit Breakers Technical Specifications

Circuit Breaker Type	Ampere Rating at 40°C	No. Poles	Volts		Type of Trip*	Federal Specification W-C-375B	UL Listed Interrupting Ratings (rms Symmetrical Amperes)			
							AC (kA)			DC (kA)
			AC	DC			240	480	600	250
G-Frame	15 -100	3	480	250	N.I.T.U	13b	65	22	–	10
F-Frame	100 - 225	3	600	250	N.I.T.U	22a	65	35	18	10
K-Frame	250 - 400	3	600	250	I.T.U	23a	65	35	25	10
L-Frame	400 - 600	3	600	250	I.T.U	23a	65	35	25	22

The quest for certainty blocks the search for meaning. Uncertainty is the very condition to impel man to unfold his powers."

– Mandy Aftel

Product Snapshots

Press Releases

Non-fused disconnects

Cumming, GA --- April 15, 2005 --- AutomationDirect has introduced a line of non-fused switch disconnects for breaking and disconnecting on equipment loads. The SD1 series non-fused disconnects allow breaking and disconnecting on equipment loads of up to 600 VAC, at a nominal current range from 16 A to 40 A. SD2 series non-fused disconnects allow breaking and disconnecting on equipment loads of up to 600 VAC, at a nominal current range from 63 A to 125 A.

Both models are DIN rail or panel-mountable and feature high breaking capacity (AC 22 A to AC 23 A), double break contacts, high electrical and mechanical endurance, and are resistant to damp heat. The non-fused disconnects have an IP20 degree of protection and are HACR rated.

Prices for the non-fused disconnects start at $19. A complete line of standard accessories is also available, including an optional auxiliary contact module (one N.O. and one N.C. contact).

New 22 mm and 30 mm pilot devices available

Cumming, GA---April 15, 2005

---AutomationDirect has extended their 22 mm and 30 mm pushbutton product offering to include several new non-illuminated and illuminated models. New 22 mm models are available in plastic or metal designs. Plastic models include several choices of push-on / push-off configurations. Metal pushbutton models with LED indicating lights are available in either extended operator or mushroom operator designs, rated for 24 VDC/VAC or 120 VDC/VAC voltages. Also available for the 22 mm metal line are potentiometers and audible buzzers with LED indication. New Cutler-Hammer 30 mm models feature NEMA-rated metal housing designs and include flush momentary operators and mushroom push-pull operator configurations. Several of the 30 mm pushbuttons include a guarded housing for protection from accidental activation or obstruction. A line of accessories rounds out the offering.

115 VAC GS2 drives added to line

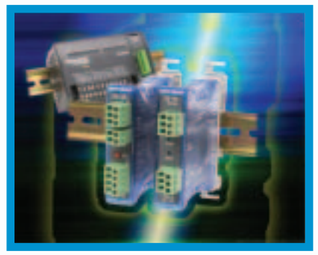
Cumming, GA---April 15, 2005

---AutomationDirect has added three new models to the GS2 series of AC drives. The 0.25 hp, 0.5 hp and 1.0 hp drives have a 115V single phase input and a 230V three phase output. These 115V drives can easily be used in environments where a 230V supply is not available and in such applications as fans, pumps, and general motor control. These new drives have all the same features as the 200V and 400V class of GS2 drives and start at $179. Features include integral PID control, removable keypad with potentiometer, onboard RS232/485 MODBUS communications and an Ethernet interface option. Accompanying line reactors, EMI filters, braking resistors, fuse kits and fuses are also available.

UPDATE–ECT promis•e draw packages Version 5.06 now available

Cumming, GA---April 15, 2005

---ECT promis•e® draw and draw + power pack software generates control system schematics, panel layouts, bills of material, wire lists, terminal plans and more to automate the control system design process. The products are available in two versions: draw, the standard package, which includes features such as an electrical symbol library, project-based organization, and the ability to search for symbols by name, thumbnail icon or description; and draw + power pack, which includes all the features of draw and adds automated functions for schematics and page manipulation. Both versions are available as an add-on package for those customers who have AutoCAD®, or a stand-alone package that incorporates the AutoCAD OEM engine, requiring no additional CAD software for operation. All promis•e AutoCAD add-on packages, such as PC-DRAW-STD and PC-DPLUS-STD, now support AutoCAD and AutoCAD LT® 2000i/2002 (version 5.05) and 2004/2005 (version 5.06). The packages start at $995.



RECAP - Signal conditioners interface directly to PLC

Signal conditioners are widely used to convert process, temperature and other electrical signals into voltage or current signals for transmission or input to a PLC or other electronic control system. The devices also protect expensive electronic equipment against electrical noise. AutomationDirect's FC series of signal conditioners are currently available in four models. The FC-11 is a loop-powered signal conditioner and isolator for 4-20 mA signals. The FC-33 is a DC-powered selectable signal conditioner and isolator for voltage/current signals with pushbutton programmable ranges and LED indicators for power and performance. The FC-T1 offers conditioning, isolation and cold-junction compensation for thermocouple/mV input signals such as Type J, K, E, R, S, T, B, N, and C. The FC-R1 is a loop-powered signal conditioner for RTD signals with selectable inputs for Pt100, Pt1000, and Cu100. All models offer three-way isolation up to 1500V, are DIN-rail mountable and come with removable terminal blocks for easier installation and maintenance. Prices for the FC series start at $89.

New Product Request

AutomationDirect is actively adding new products so it can become your one-stop shop for industrial automation components. We welcome your input; we recently introduced wire duct and non-metal enclosures largely in response to customer requests.

If you have suggestions, please feel free to jot down the info requested below and fax to 770-844-4212. Or, use the “Suggest a Product” link online at the bottom of our “Contact Us” page at www.automationdirect.com (If you need to review our current product offering, the best way to do it is to visit www.automationdirect.com and click on the Site Map link at the bottom of the home page.)

Product Request

Name _____

Company _____

Type of Business: End user OEM Integrator Other

Product Suggestions:

_____

_____

_____

_____

_____

_____

Cover Story

AC Drives

AC Drives Focused on Energy Conservation

by Russ Sanders,
Guest Writer

Today, energy conservation and cost-cutting solutions have become a major focus in the manufacturing sector. Fossil fuel costs continue to increase and the extreme growth in China is contributing to rising costs in other areas of goods, including steel and coal. Managers of manufacturing facilities are faced with many questions regarding energy conservation and efficiency. They are evaluating what is viable for their facility. Periodic reviews of soaring costs are necessary to stay competitive as implementation of new processes can be expensive. That's where today's more energy efficient AC drives can help.

Historically, manufacturers of drives have been able to differentiate their product offerings from those of their fellow competitors on a combination of price, performance, quality, and service. As the market has matured, drive prices have continued to decrease, the performance gap has narrowed, and the level of quality has increased. AC drives have almost become commodities; however, there are still areas where drive manufacturers can add value for their customers and differentiate their products from their competitors. In addition to energy efficiency and cost, other notable areas are: power quality, ease of use, size, and integrated functionality.

AC drives, sometimes called variable frequency drives, are primarily installed for either improvement in energy efficiency or for better control of industrial processes. In each type of installation, users must decide which manufacturer's model offers the desired mix of characteristics for cost, performance, precision, environmental impact, ease of use, communications, interface, installation and size.

Typical industrial applications for AC drives include extruders, centrifuges, presses, pumps, conveyors, material handling, and cranes. The AC drive's ability to reliably control speed and/or torque is critical. Not only must the drive provide precise control of its load, it must also operate for extended periods of time, with many applications requiring 24 hour operation. The primary evaluation criteria for AC drives in industrial applications have typically centered on reliability and performance. Initial cost is usually a secondary consideration, limited to the AC drives that have met the initial performance requirements.

Energy Savings

As energy costs continue to rise, the savings from the use of drives becomes even more significant. Electric motors consume approximately half of all the electricity used in the United States. Motors controlled by AC drives are among the most efficient of all types of motors in use. Therefore, widespread use of AC drives in industrial, HVAC and similar applications can help reduce current levels of energy consumption.

In applications designed with energy efficiency in mind, AC drives are used to control the speed of devices such as blowers, fans, pumps and chillers. The primary objective in these applications is the reduction of energy usage, measured over a pre-defined period of payback. Typical payback periods as short as 18 months or even one year are used to justify the purchase of an AC drive system. In some cases, the energy cost savings can pay for the AC drive and installation in even less time. Of course, payback periods and the amount of savings will vary with the application. Typically, all motors must be sized for the worst case scenario, often the starting of the device. Once running, the motor no longer requires the same amount of current to keep running, but without an AC drive in the system, most motors will continue to draw unnecessarily high current levels. With an AC drive operating the motor, the drive adjusts the current levels automatically to meet the demands of the application. Additional savings are also possible during lower demand cycles, as the motor speed can be reduced, which in turn reduces the energy used during those periods.

One promising mainstream application in this category is the use of sub-micro drives on residential HVAC units. As the cost of drives continues to fall and the potential energy savings continue to increase, this application should become more common. The compressor pump motor and the condenser fan motor on a residential air conditioner each require high start-up current. Once up to speed, the efficiency of both motors can be improved if they are controlled by drives. Under drive control, these motors can also operate very efficiently at slower speeds on certain days, based on the temperature differential between the indoor and outdoor environments.

Though the immediate and primary impact from applying an AC drive is the reduction in energy costs, the introduction of the AC drive into the installation must not affect reliability. For this reason, redundant systems, as well as bypass options and mechanical flow control, are often installed.

Power Quality

There are many compelling reasons to implement AC drives. However, due to their consumption of non-sinusoidal currents, power quality problems can arise. Without proper protection and power input considerations, the installation of AC drives can cause power quality and interference problems that may affect nearby electrical equipment.

Most of today's AC drives use diode-rectifier circuits on the power input side (front end) of the drives. When these drives are installed without line reactors, EMF filters, and RF filters on their power inputs, they can negatively impact the power quality for an entire factory or facility. The Insulated Gate Bipolar Transistors (IGBTs) that are already used extensively on the motor control side (back end) of most AC drives are now being used to replace the diode-rectifiers on the front end of the drive. IGBT-based rectifiers offer several advantages. Lower order current harmonics can be eliminated, while maintaining a near-unity displacement power factor across the entire load/speed range. These drives will not require the extensive filtering of the more common diode-rectified drives, and "power factor" is crucial to cost savings for large electrical users. A side benefit of IGBTs on the input side of the drive is a highly reliable 'soft-start' function, with no contactors or resistors to fail. Another benefit of IGBT-based rectifiers is their ability to regenerate electrical energy back into the AC lines during braking operations, saving energy and eliminating the need for dynamic braking transistors and resistors. While the higher costs associated with IGBT front-end drives have limited their widespread use, middle to high horsepower applications that demand regeneration will be the obvious early adopters. As the cost of AC drive technology continues to fall, more manufacturers will begin to offer IGBT front-end drives for smaller horsepower applications.

Ease of Use

Due to increased reliability and lower cost, it is not uncommon today for AC drives to be considered commodities. This concept is strengthened by the fact that only minor differences exist between the various hardware platforms used for AC drives. Thus it becomes increasingly difficult for manufacturers to differentiate their products from their competitors. Offering products that reduce training time is an extremely effective competitive advantage. This can be accomplished through:

- Keypad designs with increased functionality: - larger display size, greater number of keys, graphical displays, and user-defined keys.
- Hierarchical parameter structures with advanced / complex functions hidden from the average user.
- More intuitive parameter descriptions and error messages that allow customers to interact with the drive in plain English

Shrinking cost and size

AC drives will continue to become smaller and cheaper. Three major factors will be responsible for the continuation of this trend:

- The reliability, performance, and cost of electronic power components continue to improve.
- Successive generations of microprocessors continue to offer higher levels of performance and reduced cost.
- The manufacture of these drives continues to migrate to offshore countries (such as China), which have the capability to produce high quality, complex products at substantially lower costs.

Integrated functionality

In addition to connecting to the AC power system and the motor, an AC drive must also interface with external devices, such as PLCs, limit switches, push buttons, potentiometers, etc. In order to connect to these auxiliary devices, an AC drive typically provides a number of both digital and analog I/O connections. Because of the flexibility inherent in microprocessor-based design, these inputs and outputs can usually be configured to perform many different functions. This flexibility allows an off-the-shelf product to be custom tailored to each individual application. In many instances, the need for specialized function cards is eliminated due to the additional functionality present in the AC drive. The following are areas in which manufacturers will continue to add integrated functionality to their products:

- Manufacturers will continue to add programmable functionality, perhaps even offering the functional equivalent of an embedded PLC.
- With more emphasis placed on ease of use, the user interface will be a primary focus. Manufacturers have already begun replacing simple alphanumeric keypads with "real-language" LCD-based models. Remote mounting of the keypad is also now possible with some models. This trend is expected to continue with additional features, such as graphics, being offered.
- With the adoption of flux vector technology, the line between AC and servo drives continues to blur. Manufacturers will continue to add enhanced motion control algorithms to their AC drives, making the distinction between AC and servo drives even more difficult to define.

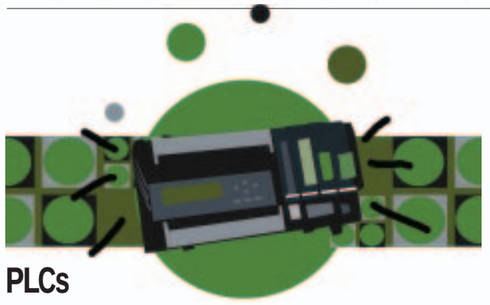
In closing

It seems ironic that the global pressures that have increased the "commoditization" of AC drives now provide an opportunity for manufacturers to create product differentiation. As the global AC drive market matures, downward cost pressures have forced many manufacturers to develop global designs for their AC drive product lines. Manufacturers can leverage these universal hardware platforms and develop differentiated products through firmware/software customization for the different markets of the world. Manufacturers can focus on the unique needs of each market and develop products that incorporate the "ease of use" and integrated functionality that each market requires. What more could a customer want: an AC drive that possesses the characteristics of high quality and low cost derived from a global platform coupled with a feature set specific to his needs.

Russ Sanders is based in Atlanta, Georgia. A former design engineer of industrial products and systems, Russ is now completing his PhD in marketing strategy at Georgia Tech. When not teaching marketing classes at Georgia Tech, he provides product development, training, and consulting for industrial automation companies.

PLC Speaking

Let's talk PLCs



PLCs Evolving Toward Motion Control

by Jeff Payne,
AutomationDirect Product Manager
PLC, I/O and PC-Controls Group

In our fast paced and economically stressed industrial world, flexibility is becoming a higher priority for those who are specifying automation systems. Users need multi-functional control, simple connectivity and easy access to process data, all wrapped up in a nice neat package.

Today's Programmable Logic Controllers (PLCs) have to be much more than the relay logic replacement they were designed to be in the late 1960's.

As the PLC has evolved, we have seen its intelligence grow too. In the early 1970's, the PLC became capable of communicating to other devices. The introduction of MODBUS communications protocol by Modicon was the beginning of many new responsibilities for the PLC because MODBUS allowed communications among PLCs over standard cabling. This allowed the PLC to be placed in closer proximity to the real world devices and communicate back to the system controls in the main panel.

The communications craze has spread far and wide. In the past 30 years we have seen literally hundreds of proprietary and standard protocols developed, each with their own unique advantages. It is fast becoming the responsibility of the PLC to be the information superstar of the process communications conglomeration.

Today's PLCs have to be data compilers and information gateways. They must interface to bar code scanners, printers, temperature and analog sensors, and more. They need multiple protocol support to be able to connect with other devices in the process. Furthermore, they need all of these capabilities while remaining simple to program, easy to edit and allowing you to remain within your budget.

By expanding the controls beyond discrete I/O, we have opened the door for the PLC to perform much more than the basic sequencing functions of earlier models. With high resolution analog modules, most PLCs are capable of computing complex PID algorithms, including Auto-Tune capabilities. The PLC is now well equipped to replace stand-alone process controllers in many applications.

Whether it is reading a temperature, pulsing a heater element with a time-proportioning control output, or reading a 4-20mA pressure transducer for modulating a control value to adjust the hydraulic pressure in a system, today's PLCs are up to the task.

One of the most recent responsibilities the PLC has been tasked with is simple motion control. There are many process applications that require accurate control at a fast pace, without expecting exact precision and blazing speed. These are applications where the PLC works well. Many nano and micro PLCs are now available with high speed counting capabilities and high frequency pulse outputs built into the controller, making them a viable solution for open-loop control.

Despite being a relatively simple, less than ideal form of control, open-loop control alternatives are still a growing part of industrial applications. What makes this different from other types of motion control is that the controller does not know the position of the output device during the control sequence. So why even consider this as an option when designing your process application? Simple – cost.

This type of control is no stranger to the process world, but in the past has required an expensive option module, and at times has been restricted to the more sophisticated control platforms in order to achieve system requirements.

Positioning applications are probably the most common open-loop processes because a stepper is a position-based no-feedback device (it will drive at full force to get to commanded position or fail trying) vs. a servo that closes its position loop, and will vary its output torque to get into/stay at commanded position.

Consider the following applications –

- cut-to-length
- indexing tables or conveyors
- x/y tables (plotter/cutter)

These are only a few examples of what you can easily accomplish with a low cost PLC and stepper system.

So how is the PLC accomplishing these new market requirements? The modern PLC has incorporated many types of Commercial off the Shelf (COTS) technology in its CPU. Taking advantage of the latest technology gives the PLC a faster, more powerful processor and more available memory at less cost.

These advances in technology have allowed the PLC to expand its portfolio and take on new tasks without sacrificing the rugged nature of its design. It is better equipped to handle communications, data manipulation and high speed motion, without giving up the rugged and reliable performance we expect from our industrial control equipment.

Business Notes

Goings On in the Automation Industry

AutomationDirect assists Team Buffalo in 2005 DARPA Challenge

Team Buffalo, a small group of highly talented individuals skilled in bringing abstract technical visions from conception to reality, has committed to participating in a Defense Department research and development initiative aimed at advancing robotics technologies for future military use. The initiative, known as the DARPA Grand Challenge, is a field test of fully autonomous ground vehicles to be conducted in the Mojave Desert on October 8, 2005. The Defense Advanced Research Projects Agency (DARPA) is offering a $2 million prize to the vehicle that completes the course the fastest within a 10-hour period. The 2005 event will be the second DARPA Grand Challenge. So far, 136 teams have successfully completed the application process to compete in the 2005 event.

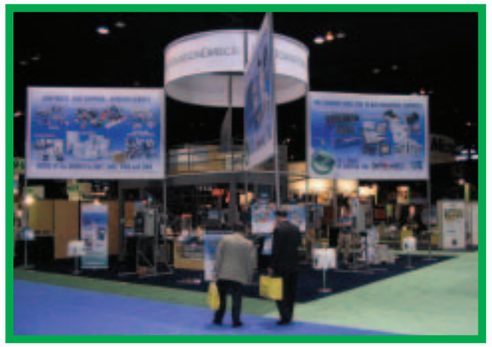
AutomationDirect is providing Team Buffalo with all the necessary PLC equipment, other electrical controls and most of the sensors for their entry in the DARPA Grand Challenge. The equipment will be installed on the A.N.T (Autonomous Non-manned Transport), which started life as a 2005 four-wheel ATV (all terrain vehicle).

Team Buffalo had been in discussions with several other PLC manufacturers, however AutomationDirect was the only one that was willing to make a firm commitment to Team Buffalo with a concrete ship date. Team Buffalo received their first shipment of PLC equipment from AutomationDirect in mid-February. Team Leader Mark Schwartz said "This is great, we couldn't be happier with the service and dedication provided by AutomationDirect. It's no wonder they were voted #1 in customer service. Everything was shipped right on schedule. No unpleasant surprises, no missed ship dates and no hassles!"

For more information on the Grand Challenge, visit http://www.darpa.mil/grandchallenge/index.html.

Watch for a full-length article on Team Buffalo's progress in the next issue of Automation Notebook, or visit www.teambuffalo.org for up-to-the-minute developments.

AutomationDirect exhibits at National Manufacturing Week in Chicago



AutomationDirect exhibited in the Industrial Automation show at National Manufacturing Week for the second year in a row March 7-10. The 2,000 square foot booth consisted of displays featuring industrial control products and an "Automation I.Q. Challenge". The Challenge consisted of three interactive equipment stations designed to test basic knowledge of PLCs, HMI and AC drives. The panels were built and programmed by BizWareDirect, whose DataLynx data collection software extracted the test data via wireless modem, and then compiled and displayed the scores. Almost 200 attendees participated, with the high scorer each day winning a Laser Tool Kit. Also, AutomationDirect's upcoming products were displayed upstairs on the second floor.

Editor's Choice Award for the H2-EBC/ECOM100 Ethernet modules

AutomationDirect received a 2004 Control Engineering Editors' Choice Award for the H2-EBC and ECOM 100 Ethernet modules, presented at an awards ceremony during National Manufacturing Week in Chicago. This award represents the opinions of the editors that the products are among the most significant innovations featured in Control Engineering magazine during the past year. These modules bring high-speed 100Mbit Ethernet-based data exchange for I/O control or peer networking among DL205 PLCs.

User Spotlight

New Control Technology

Holographic Technology Replaces Conventional Operator Input Devices

In April 2002, HoloTouch®, Inc., a Delaware corporation with offices in Darien, Connecticut, announced that its founder and President, R. Douglas McPheters, had been granted a U.S. Patent for his "holographic control arrangements." This innovative technology allows operators to actuate and control a wide variety of electronic devices by simply passing fingers through colorful, three-dimensional holographic images floating in the air at a location convenient to the user. Utilizing well-developed wave source technologies, an infra-red detector or laser scans the plane of the holographic images, detects the intrusion of a finger into the defined area of the images, identifies which number or symbol has been selected and transmits the selection to the equipment's internal software, much the same way pressing a button on any ordinary keypad would (see

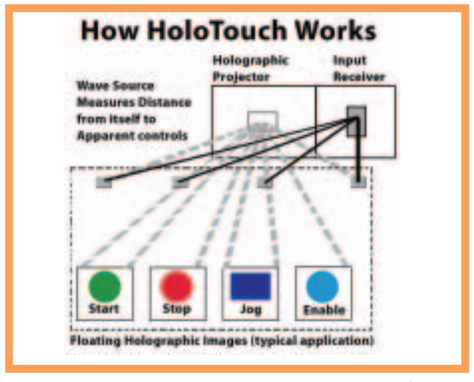


Figure 1

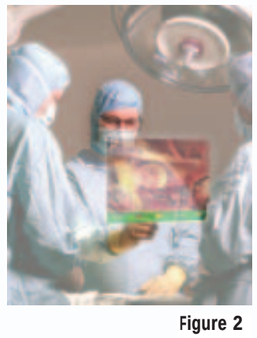


Figure 2

Figure 1). Interestingly, this basic technology was envisioned by McPheters while writing a thriller (as yet unpublished) about a Manhattan lawyer who starts a loan sharking operation in what's left of the Soviet Union.

HoloTouch solves many problems inherent in conventional tactile keypads and keyboards, particularly those regularly subject to contaminants, dirt, moisture, temperature fluctuations and shock. The easy-to-use interfaces can provide reliable operation of equipment where conventional tactile interface sizes have shrunk below normal finger size. There is no wear with repeated operation because HoloTouch interfaces have no moving parts to fail under normal or even heavy use. Because there's nothing to physically touch when using HoloTouch, healthcare personnel can gain direct, reliable control of operating room equipment where actuation and control must be indirect because computer keyboards cannot be effectively sterilized (see Figure 2). Further, contrary to many new technologies, HoloTouch interfaces are cost-effective, both initially and over time.

One of the first products using HoloTouch technology has been created by Atlantex Corporation. The two companies recently announced that their fully functional touchless holographic interface, BeamOne (www.holodemo.com), won a 2004 Control Engineering Editors' Choice Award as "among the most significant innovations featured in Control Engineering during the past year." BeamOne (see Figure 3), is seen by PCs as a keypad and allows operators to control equipment by simply passing a finger through holographic images of "keys" floating in the air. The 1-inch square holographic "keys" are projected several inches in front of the hardware. Power and communications are provided by the PC's USB port and sensors in BeamOne detect an operator's interaction with the holographic images operating as a simple 4-button keypad. The BeamOne product has already been purchased by several large automakers to evaluate for use in their products and production facilities.

Figure 3

About our user:

Incorporated in Delaware in 2002 by entrepreneur and inventor R. Douglas McPheters, HoloTouch, Inc. is licensing its interactive holographic technology to manufacturers for specific applications that provide value. McPheters received a B.A. from Yale and a J.D. from the University of Pennsylvania Law School. He also served in the US Atlantic Submarine Force as a commissioned officer. McPheters practiced law in New York City, principally mergers, acquisitions and securities for foreign companies and financial institutions. Building on business experience McPheters obtained while serving as the Chief Operating Officer of two high-tech start-ups, HoloTouch, Inc. was started after issuance of the U.S. patent in 2002. HoloTouch used sensors from AutomationDirect during the product development process and in earlier demo units of the interfaces. (www.holotouch.com)

Feature Story

Motion Control

Motion Control System Choices

by Chip McDaniel
AutomationDirect

Motion control is generally understood to mean the use of servo and/or stepper systems as the "muscle" to move a given load. Motor and drive systems, such as variable frequency drives (VFDs) with AC motors, can be controlled by a PLC. These systems are typically used for providing speed control, while motion control systems are capable of extremely precise position control as well as velocity and torque control. Applications which require positioning of product, synchronization of separate elements, or rapid start/stop motion are all perfect candidates for the use of motion control. PLCs are very capable of providing the signals required to command these servo and stepper systems in a cost-effective and digital (noise-free) manner.

In a typical motion control system there are three basic components: the controller, the drive (sometimes referred to as an amplifier), and the motor. The path planning or trajectory calculations are performed in the controller, which sends low-voltage command signals to the drive, which in turn applies the necessary voltage and current to the motor, resulting in the desired motion. Sometimes feedback devices on the motor or the load are used to notify the drive or the controller with specific details about the actual movement of the motor shaft or the load. This feedback data is used to increase the accuracy of the motion, and can be used to compensate for dynamic changes that may occur at the load, such as changes in mass, friction, or other disturbances. Servo systems operate in a closed-loop fashion while most stepper systems provide open-loop control of position. The choice of open-loop versus closed-loop control depends on many factors and both are useful methods for controlling motion. PLC-based controllers can be used for either type of system.

Types of Industrial Motion Controllers

Historically, there have been three basic types of controllers used for motion systems; standalone controllers, PC-based controllers, and PLCs.

Standalone motion controllers are usually dedicated devices or option cards that are purpose-built for motion applications. They are typically very good at controlling motion, but most are expensive, sometimes difficult to integrate into the overall machine control system, and may use analog or proprietary signals for communication with the drives. Programming languages are often proprietary and may require high-level engineering assistance for basic troubleshooting and programming changes. Standalone controllers are usually sold based on an axis count with 2, 4, 8 and even 16 axes of control being common. Tight coordination between multiple axes of motion is possible with these controllers.

PC-based motion controllers are a more recent option. These controllers have evolved from the standalone controllers, and have both advantages and disadvantages. PC-based controllers can handle high axis count applications with requirements for tight coordination between axes and usually benefit from the extensive communication options available on a PC platform. PC-based motion can also be integrated with PC-based logic control and HMI software, often running on the same hardware platform for integrated "single box" control for a machine. But PC-based motion is also expensive and suffers from ease-of-use and maintenance issues, with motion control code often written in proprietary or complex programming languages. Some PC-based controllers are nothing more than standalone controllers that happen to fit inside the PC. These motion control "cards" use the PC bus for communication and power, but they are still proprietary controllers with motion specific circuitry, which do not utilize the processing power of the PC.

The third type, PLC-based control, is often considered to be the simplest way to control motion. The classic 'pulse and direction' signals that are widely used with PLCs provide an inexpensive, noise-free (digital) method for precision motion control. Extensions or function blocks within the PLC ladder logic are typically used for programming and are easy for factory personnel to understand and maintain. While typically limited to a few axes of control and where coordination between axes is limited, PLC controllers with pulse and direction capability are an excellent fit for many motion applications. Often, low-cost PLCs are already being used for logic control on the machinery and can also handle the motion tasks with the addition of a pulse output card and some additional programming. This can eliminate the need to integrate the logic controller with a separate motion controller. Machine builders can also save considerable time when implementing PLC-based systems, especially if they are already familiar with the PLC and its programming software.

In a typical PLC-based motion control system, high-speed pulse output cards are used in the PLC to generate a 'pulse train' for each servo or stepper drive. The drive receives the pulses and indexes the motor shaft by a pre-set amount for each pulse. Typical stepper systems might index 1/200 of a revolution per pulse, while micro-stepping or servo systems might be configured for as little as 1/10,000 of a revolution for each incoming pulse. The amount of motion dictated by a single pulse can be adjusted in the drive to accommodate the maximum pulse output frequency from the PLC. A separate signal is used to determine the direction of travel. A similar but functionally equivalent method, clockwise/counterclockwise, uses a separate pulse train for each direction of travel. This method is somewhat less popular, but has advantages in some applications. Electronic gearing can usually be enabled in the drive to allow high-resolution moves at low speeds, as well as a high speed mode for faster moves with lower resolution. >>

Feature Story
Motion Control Continued

Encoder feedback, when used, is normally handled at the drive level. Two simple hardwired signals from the drive back to the PLC, drive fault and in-position, are often used to notify the PLC of exceptions and/or completion of each move.

Early methods of motion control

Electric motion control systems originated as alternatives to hydraulic motion systems. With most electric systems ranging in size from a few watts into the kilowatt range, electric motion control has become prevalent at these smaller sizes, while hydraulic systems continue to dominate the larger applications approximately 5 kW and above, where electric power is impractical or unavailable and where the environment is harsh or extreme. The electric systems are more factory-friendly, less obtrusive, and are easier to install than the plumbing required by hydraulics. Early electric servo systems were usually operated in velocity or torque mode, accepted analog command signals, and were quite successful despite problems with electrical noise and drift. Early PLC-based controllers used analog output cards to provide the velocity or torque command signals.

Motion control systems have allowed machine builders to move away from line shaft driven machines, where all motion was geared back to a single large motor or line shaft. Gears, chains, cams, and pushrods were employed to create all of the desired motions at each point on the machine. While these machines were functional, they weren't very flexible, and often required changing parts for different sizes and types of products. Spare gears with different numbers of teeth and various mechanical cams with different shapes were required to perform a change-over for different sizes of product or machine configurations. The time required to complete the change-over was also an issue, with lengthy downtime required for maintenance personnel to complete the changes. Once the mechanical change-over was completed, the machines could require a lengthy adjustment period until the new set-up was optimized.

More recent motion control technology enables the concept of software-based change-over. With each motion on a machine controlled by a separate motor, new motion control parameters can be quickly implemented, converting the machine to a saved configuration without having to replace mechanical components.

Modern motion control technology

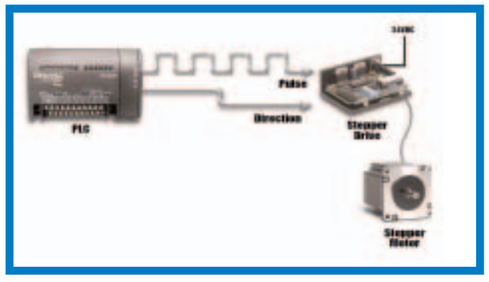
One beneficial technology for modern motion control is the permanent-magnet brushless motor. The old brush-type motors were less efficient, and required brush replacements at regular intervals. Advancements in magnet technology have enabled the design of compact, powerful motors, whose rotors require no electrical connections (or brushes). Virtually all modern motion control systems, both servo and stepper-based, now employ brushless motor technology.

While analog control signals are still used on some systems, most modern motion systems have migrated to some form of digital control. The advent of the digital servo drive, with the ability to close the position loop, was another major step forward. New types of signals between the controller and drive are now required to send position commands to these digital servo drives.

The three most common control signals used by today's PLC-based motion controllers are the pulse and direction signals detailed earlier, discrete signals to an intelligent or indexing drive, and fieldbus communications.

The pulse and direction interface that was originally developed for stepper systems has now become a standard feature on most servo products as well. A PLC with a high-speed output is unquestionably the most cost effective method for controlling motion today. No intelligence is required in the drive and all programming is performed in the PLC. All of the PLCs available from AutomationDirect offer some form of high-speed pulse output. Even the DL05, AutomationDirect's $99 PLC, includes a single 7kHz high-speed output which can be used for limited motion control applications. The DL05 will also accept an optional H0-CTRIO module which provides an additional high-speed output channel at up to 25kHz. The AutomationDirect SureStep stepping motor, drive, and required DC power supply start at $267 for a single axis of motion, and can easily be controlled by the DL05. In addition to the benefit of a low price, all motion and logic instructions are programmed in the DirectSOFT programming software for significant time savings.

Indexing drives offer another two options for PLC-based



control. Indexing drives are a combination of a standalone controller built in to the servo or stepper drive. These single-axis devices have I/O capability, and can execute motion profiles based on a single PLC or real world input. This type of drive often includes a fieldbus connection and can perform moves based on commands and parameters received across such a connection.

The new SureServo line of servo products from AutomationDirect (available summer 2005) are indexing drives. The SureServo drives can be pre-programmed with parameters for up to 8 separate motion profiles, which can then be initiated via discrete inputs from a PLC or signals from other devices, even pushbuttons. These moves can consist of precise, user defined accelerations (ramps) to preset speeds, with accurate decelerations carefully timed to end at predefined positions. Dynamic velocities (with controlled ramps) and precise application of torque are also possible. Parameters for vibration suppression (notch filters), load inertia range, proportional and integral gain, and many others can also be customized for specific applications in the SureServo drive. The SureServo offers two adaptive auto-tuning modes, which continue to tune the system while it operates.

The SureServo products also have a built-in MODBUS interface. MODBUS enabled controllers, including PLCs, can initiate moves and download parameters to the SureServo drive across the MODBUS link. The MODBUS link can also supply information back to the controller about the performance and status of the servo motor and drive system. Multiple SureServo systems can be controlled via a single MODBUS port on the PLC. The SureServo's ability to download custom motion profiles from a PLC on the fly, and execute these moves on command, allows the ultimate in flexibility and control with a PLC based motion controller.

The future of PLC-based motion control

While it is difficult to predict the future, AutomationDirect is always interested in the enhancements and features that our customers are requesting. Features that are frequently requested are higher speed output cards for our PLCs, easier to use configuration software, and high level function blocks in the ladder programming environment.

The current high-speed CTRIO modules offered by AutomationDirect have a maximum output frequency of 25kHz. While this is sufficient to command motion at high speed (4500 RPM at roughly 330 pulses per revolution), or high resolution (8000 pulses per revolution, up to 375 RPM), users are asking for outputs that would allow both high speed and high resolution without any trade-off.

Software is playing a bigger role in the evolution of PLC specialty modules for both discrete and hybrid control applications. Advancements in small footprint microprocessors and the acceptance of flash ROM memory, combined with software that provides intuitive graphical configuration, are eliminating the need for large amounts of setup ladder logic often needed in the beginning of the PLC user program. These new breeds of specialty modules, such as high-speed output cards or motion control modules, are being designed as low-cost "mini-coprocessors", capable of executing logic asynchronous to the PLC scan. Microsoft Windows-based point-and-click configuration utilities are becoming more common and provide substantial time savings for programmers and maintenance personnel. With these advancements in PLC technology, PLCs will continue to meet the needs of machine control applications. They will stay more cost-effective and easier to use than PC technology, or separate logic and motion platforms, and will do so in a much smaller package.

SureServo™ Servo Systems

Coming Soon

Available in summer of 2005, the SureServo AC servo systems range in size from 100W to 3kW continuous power and provide from .08 to 26.4 ft·lbs of peak torque. They can be powered with single or three phase 230 VAC. The SureServo drives can be controlled in position, velocity or torque mode. All SureServo motor sizes will be available with or without a 24 VDC holding brake.

Precise Positioning

SureServo systems are easily controlled via 'step & direction' or 'step-up/step-down' commands from any PLC with a high-speed output. Electronic gearing can be used to scale the incoming pulse frequency from the PLC. This allows the pulses from the PLC to command the exact amount of movement required for a specific application.

The SureServo drive's on-board indexer will allow the programming of up to eight unique motion profiles. Discrete inputs can be used to initiate any of these profiles. The built-in MODBUS interface will offer the flexibility of downloading customized motion profiles to the drive as they are needed. These profiles can be selected and executed based on additional MODBUS commands or via discrete inputs.

Complete Control

Eight programmable inputs and five programmable outputs assure real-time connectivity with any control system. Velocity and torque can be controlled with a ±10V analog input signal or with the onboard indexer. One analog output will be available and configurable for monitoring purposes.

Tune-up and Tune-in

Three tuning modes include: manual, adaptive easy-tune, and adaptive auto-tune. The adaptive modes allow the drive to adapt to dynamic load conditions during operation with little or no initial set-up required.

The SureServo drive parameters can be changed from the drive's built-in keypad or the PC set-up software. SureServo drives will communicate via a MODBUS interface across RS-232, 422, or 485 serial links. AutomationDirect will offer standard cable sets from 10 to 100 feet in length.

System prices will start around $700 for a 100W motor, drive and 10 foot cables.

The best value in Circuit Protection and Motor Controls

Quality products, low prices, great selection and same-day shipping!

AUTOMATIONDIRECT now carries a wide range of circuit protection and motor control components for your electrical systems. We offer Fuji Electric's DUO and Odyssey series motor control solutions, with over 250 parts in sizes up to 300 hp (at 480 VAC). The molded case circuit breakers and supplementary protectors give you high-quality, reliable circuit protection. These and all the products shown here are in stock and available for same-day shipping at our everyday low prices.

Contactors

Load switching up to 300hp

- 1/2 to 300 hp
- Compact frame sizes from 45 mm up to 166 mm
- Fuji SUPER MAGNET™ technology employed on the larger contactors for greater reliability
- 24 VDC , 24 VAC, 120 VAC and 240 VAC coils

A sample of parts and prices:

Basic Contactors		
Part Number	**Description**	***Price***
SC-E02-110VAC	IEC 9A, 110-120VAC coil	$13
SC-E05-110VAC	IEC 25A, 110-120VAC coil	$27
SC-E3-110VAC	IEC 65A, 110-120VAC coil	$63
SC-E5-100V	IEC 105A, 110-120VAC/DC coil	$161

Traditional Starters

(Contactor + Thermal overload relay)

Thermal overload relays

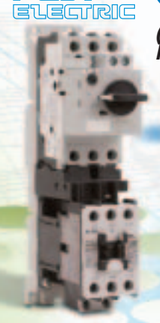
- Can be used with 1/2 to 300hp contactors
- Overload, open phase protection
- Ambient temperature compensation

A sample of parts and prices:

Traditional Starters		
Part Number	**Description**	***Price***
SC-E04-110VAC + TK-E02-1800	IEC 18A Contactor PLUS Thermal Overload Relay 12-18A	$43
SC-E2-110VAC + TK-E2-4200	IEC 40A Contactor PLUS Thermal Overload Relay 32-42A	$81
SC-E3-110VAC + TK-E3-6500	IEC 65A Contactor PLUS Thermal Overload Relay 35-65A	$106

A sample of parts and prices:

Manual Motor Starters		
Part Number	**Description**	***Price***
BM3RHB-004	Manual Motor Starter, 4A FLA overload trip rating	$43
BM3RHB-010	Manual Motor Starter, 10A FLA overload trip rating	$46
BM3RHB-025	Manual Motor Starter, 25A FLA overload trip rating	$54
BM3VHB-050	Manual Motor Starter, 50A FLA overload trip rating	$138



Combination starters

(Contactor + Manual motor starter)

Manual motor starters (MMS)

- Can be used with 1/2 to 40 hp contactors
- UL508E listed (group motor rating friendly)
- Circuit breaker functions plus overload relay functions in a highly compact unit
- Two frame sizes up to 63 amps
- Up to 50 kA breaking capacity at 480 VAC
- Rotary actuator
- Manual ON/OFF control with lockout capability
- Trip-free design

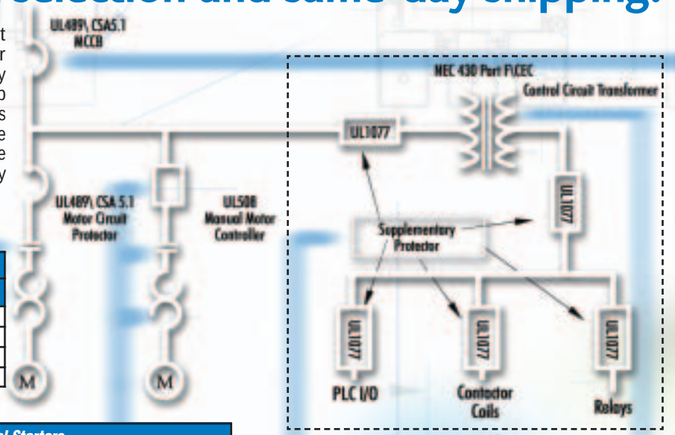
Motor Controls Head-to-head

Features	AUTOMATIONDIRECT Fuji Electric	Telemecanique	Allen-Bradley
9 Amp Contactor	$13 SC-E02-110 VAC	$94 LC1D09	$94* 100-C09D10
40 Amp Contactor	$46 SC-E2-110 VAC	$218 LC1D40	$210 100-C37D00
10 Amp Manual Motor Starter	$46 BM3RHB-010	$115 GV2P14	$196 140M-C2E-C10

*This product includes 1 N.O. Aux contact

All prices are U.S. list prices. AUTOMATIONDIRECT prices are March 2005 prices. Allen-Bradley prices taken from Publication A115-PL001B-EN-P September 2004. Telemecanique prices taken from website, http://www.squared.com, as of September 8, 2003. Price comparisons are made to closest competitor product specifications available at the time. Prices and specifications may vary by dealer and configuration. All product names, trademarks, and registered trademarks are the property of their respectivemanufacturers. Prices subject to change without notice. AUTOMATIONDIRECT disclaims any proprietary interest in the marks and names of others.

Visit www.automationdirect.com/motorcontrols for more information on our complete line of motor control products.



Supplementary Protectors

One-pole models $7.50
Two-pole models $15
Three-pole models $21

EATON Cutler-Hammer

- UL 1077 recognized
- 6 to 60 amp ratings
- Current limiting design for fast short circuit protection

Control Power Transformers

Starting at $39

- 100 to 500 continuous VA models
- Designed for high-inrush applications requiring reliable output voltage stability

Licensed by Eaton Electrical Inc., Manufacturer of Cutler-Hammer Products

MCCBs

Starting at $139

- 15 to 600 A ratings
- Patented contact conductor design with high-speed "blow-open" action
- UL489 listing
- Advanced arc extinguishing technology

Circuit Breakers Head-to-head

Features	AUTOMATIONDIRECT	Square D	ABB
100A Breaker			
Panel Area (mm2)	9,424	17,328	9,360
Ic kA @ 480/277V AC	22	18	20
List Price	$139 G3P-100	$587* FAL34100	$459** S1N100TL
225A Breaker			
Panel Area (mm2)	15,808	23,142	17,850
Ic kA @ 480/277V AC	35	25	25
List Price	$319 F3P-225	$1,650* KAL36225	$1,131** S3N225TW

All prices are U.S. list prices. AutomationDirect prices are from March 2005. *Square D prices are from Pricing Guide 0600PL9701 July 2002. **ABB prices are from AC 1600, March 2000.

Molded Case Circuit Breakers Technical Specifications

Circuit Breaker Type	Ampere Rating at 40° C	No. Poles	Federal Specification W-C-375B	UL Listed Interrupting Ratings (rms Symmetrical Amperes)				*Starting Price*
				AC (kA)			DC (kA)	
				240	480	600	250	
G-Frame	15-100	3	13b	65	22	-	10	$139
F-Frame	100-225	3	22a	65	35	18	10	$319
K-Frame	250-400	3	23a	65	35	25	10	$599
L-Frame	400-600	3	23a	65	35	25	22	$799

Visit www.automationdirect.com/circuit_protection for more information on our complete line of circuit protection products.

Non-fused Disconnects

Starting at $19

- Used for breaking and disconnecting equipment loads of up to 600 VAC
- SD1 series disconnects loads at nominal current range of 16-40A
- SD2 series disconnects loads at nominal current range of 63-125A

1-800-633-0405 | AUTOMATIONDIRECT

Technology Brief

Utilizing Business Tools

Improving Business Tools for Greater Customer Service

By Dave Hartig and the Communications Team
AutomationDirect

In today's competitive market, companies are always looking for ways to set themselves apart. The companies that truly succeed at this are those who continually deliver exceptional service and support while providing competitive prices. At AutomationDirect, we strive at being the best in all of these areas

To continue providing world class service and support to our customers, AutomationDirect has made three major technology improvements within the company this past year. Although all improvements were successful, there were some unexpected glitches along the way, some of which our customers experienced.

Updating our Helpdesk

The first system upgrade implemented was in the spring of 2004. The technical support team had been using a small Helpdesk system that was rapidly becoming less and less efficient. With more products to support, the volume of calls was increasing. The existing system, which used an Access database, was struggling to keep up with all the data entries, report requests, etc. There was a need for more advanced features for tracking customer concerns, product issues and more.

After careful consideration and research, the selection was made for a new technical support helpdesk product - HEAT (Helpdesk Expert Automation Tool). HEAT allowed us to move from the Access database to a SQL server database for more reliability, performance and functionality. The software is customizable, allowing us to meet specific needs of individual departments and users. One key feature is the ability to do reporting using almost any database query/reporting tool. HEAT also allows our Customer Response Assistants (CRA) to quickly assign calls to the right tech person based on their expertise in a particular product. This is a major benefit in efficiently serving a customer by quickly routing them to the product expert.

HEAT also has a tool that automatically notifies a tech person when a new call is assigned to him. It tracks all aspects of a call, including part numbers, serial numbers, problem description, problem solution and other actions to assist the tech person in serving his customer. This information is also useful for tracking any trends in product problems. HEAT has allowed us to respond quickly to our customers who call with technical support issues and is a key in successful communication. AutomationDirect has been awarded "Best Service in the Industry," in at least one product category, for four consecutive years by a leading industry trade publication. This has been possible by using such tools as a Helpdesk.

Installing a new phone system

As a direct company, we pride ourselves on service to our customers. A key component to this success lies in useful and effective communication

tools. With the growth of the business, we were starting to see various performance issues with the existing phone system, where capabilities and expansion options were limited. The technology was fast becoming outdated and it was time to invest in a more modern system. We began our search for a new and more sophisticated phone system that would satisfy all of our requirements.

In June 2004, we installed an Inter-Tel Axxess system. We can now track each call as it enters our system and follow the path it takes until the call is completed. The phone system is a feature-rich system that will provide AutomationDirect a growth path of 600+ users. Some of the most popular features of the Axxess phone system include ScreenPops, enhanced voice mail and detailed reporting.

ScreenPops, provided by the Inter-tel IVR, will allow us to provide faster customer service by displaying customer information to the call agent as the call is being answered.

The enhanced integrated voicemail system provides fast and clear voice messaging for system users. These new voicemail features include caller ID, record-a-call, undelete deleted messages and time/date stamps.

The real-time call traffic status gives supervisory level information on any call as it is processed through the phone system. This same information is gathered as historical data, providing detailed reports of all calls routed into our business. This feature gives us the ability to monitor call traffic and to staff accordingly.

To help make the transition to the new system smoother, we began training our employees internally by providing training classes with mock units. During startup there were phone system company representatives on-site for the first two days. This assistance was extremely helpful, as internal users had many special requests. This would have been a difficult challenge for our communications team without the outside assistance.

Commerce Center software replacement

The true heartbeat of a company is its business system. At AutomationDirect, this system is utilized by our sales, accounting, logistics and purchasing teams. Growth once again forced us to look at our existing system.

To ensure that a system will reliably fulfill our needs and support our growing company, a comprehensive inventory management/reduction, shipping/business module must be in effect. With the existing system and somewhat "stale" technology, the speed was not fast enough to satisfy a late-day shipping cut-off, and capacity problems were growing as speed continued to decline.

For a direct company focused on exceptional customer service this could be the most critical internal tool, so we began researching a solution to address as many requests as possible from both external customers and internal users. One of the requests from our customers was for same-day shipping on orders placed as late at 5:00 P.M. Our internal users wanted more features for storing various levels of contact information. The list was long and challenging.

In October 2004, we implemented an entirely new system, Commerce Center from Prophet 21. This new system allows us to better track customer information and customer history with impressive speed; reporting capabilities are much improved and there are no more capacity issues. Going forward, the platform will support a link which includes incorporating the telephone system for ScreenPops (mentioned earlier). When an incoming call is received, the system will link the caller information into the customer database. The agent's display immediately provides details of the incoming call, saving time. In addition, improved integration with our shipping system has contributed to our ability to now ship orders placed as late as 5:00 pm (eastern time) the same day. It's this cutting edge technology that allows us to continue to control costs and to provide our customers with the best prices possible.

In order to prepare for our new system, we began internal training with our sales, accounting, purchasing and logistics teams two months before implementation.

If you are beginning a system conversion as broad as this, you may want to consider over-allocating personnel resources during the test, design and preparation phase. We had many projects occurring simultaneously during our phase of the design and could have benefited by spending more time training in some areas before going live.

Ultimately, the goal of system improvements should be more efficient service without distancing the customer from the supplier. Technology that is implemented simply to reduce person-to-person transactions may feel isolating and cause frustration. Customer service tools that both enhance human interactions and allow efficient electronic interactions are the best application of new technology to create an enjoyable customer experience.

"All great questions must be raised by great voices, and the greatest voice is the voice of the people--speaking out--in prose, or painting, or poetry, or music, speaking out in homes and halls, streets and farms, courts and cafes. Let that voice speak and the stillness you hear will be the gratitude of mankind."

– Robert F. Kennedy

Tech Thread

Serial Ports for DirectLOGIC

A User's Guide to Configuring Serial Ports for DirectLOGIC PLCs: Part Two

by Robert Thornton,
Product Engineer
AutomationDirect

Part Two of the Two-Part Series

In the previous issue of Automation Notebook, Winter 2005 Issue 3, we discussed the communications capabilities of Port 2 on the DL06, DL250-1 and DL260 DirectLOGIC CPUs. We covered networking, wiring diagrams and protocols. In this issue we will discuss how to configure the communication port using DirectSOFT programming software while connected to the CPU.

Configuring Port 2

In the DirectSOFT software menu, select PLC (1). Then from the drop-down

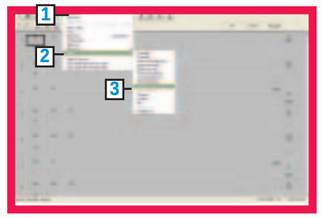


Figure 1

menu select Setup (2), then Setup Sec. Comm Port (3), as shown in figure 1.

The setup window (shown in figure 2) will appear.

Protocol setup

There are three protocols available: standard, non-sequence and remote I/O. Each of these protocols will require some configuration.

Standard Protocols **(figure 2)**

You will notice in figure 2 that K-sequence, DirectNET and MODBUS protocols (1) are all checked by default. These are the default protocols for the slave PLCs discussed in part one of this article. Select the desired protocol.

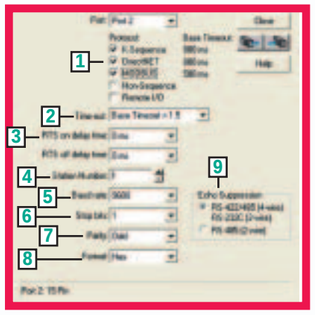


Figure 2

Time-out (2)

Time-out is the amount of time the port will wait for a response to a message it sent before it logs an error. It is only used when the PLC is the master device. Notice the selection is relative to the Base Time-out listed next to each protocol, i.e. for K-Sequence, Base Time-out x 1 = 800ms.

RTS on/off delay (3)

RTS (Request to Send) is a handshaking signal to notify another device that the asserting device would like to transmit. RTS on and RTS off delay can typically be set to 0ms for 4-wire networks. For 2-wire networks, the values should be increased to 5ms and 2ms respectively. See figure 3.

Station Number (4)

The station number is the slave number or address. This is the number that will be polled by the master on the network. Typically this is set to 1 for the master. Slaves can be addressed from 1 through 90 for DirectNET protocol or 1 through 247 for MODBUS protocol, depending on the slave and CPU.

Baud rate (5)

Baud rate is the rate at which data is transmitted across the connection in bits per second (bps). A good starting point is 9,600 bps. If no problems are encountered, then increase the baud rate to the maximum achievable without communication problems.

Stop bits (6)

Stop bits are extra bits which follow the data and parity bits to mark the end of the transmission. For older systems, the Stop Bit may need to be increased to 2, but 1 is usually the correct setting.

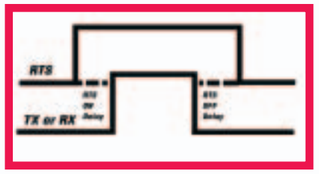


Figure 3

Parity (7)

Parity is a low level form of error checking that counts the number of 1's in the bit stream to ensure that none have been changed. The parity bit is turned on or off to achieve the correct number of 1's in the data packet; either odd or even. If the number of 1's is even when parity is set to odd, then the packet has been corrupted. This setting largely depends upon the required settings of the other equipment on the network.

The Baud rate, Stop bits and Parity must all be the same for every device on the network in order for communications to work properly.

Format (8)

DirectNET protocol requires that the Format be selected – Hex or ASCII. In other words, the data represents a hexadecimal number or an ASCII character. All of the other protocols ignore this parameter. If you want the fastest communication possible, select HEX mode. The same data is twice as long in ASCII format, so it takes longer to transfer. If you have a device on the network that requires ASCII, then choose ASCII mode. ASCII is not usually recommended unless absolutely necessary.

Echo Suppression (9)

In a half duplex 2-wire network, the receiver of the transmitting device must be disabled so that data is not "echoed" back to the receiver. This is called Echo Suppression. If you selected MODBUS or Non-Sequence as the network protocol, you must select either 4-wire or 2-wire. In effect, this is turning echo suppression on for 2-wire networks and off for 4-wire networks and RS-232.

Non-Sequence Protocol **(figure 4)**

Non-sequence protocol (1) allows the CPU to use port 2 to either read or write (depending on CPU model) raw ASCII strings to devices such as barcode readers and printers.

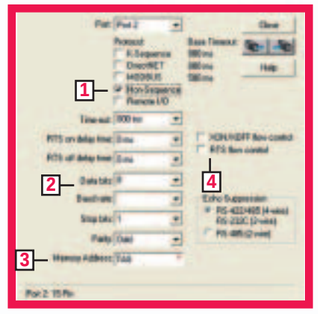


Figure 4

The time-out, RTS on/off delay, stop bits, parity and echo suppression are configured as mentioned previously.

Data Bits (2)

If Non-Sequence is the network protocol, the number of Data bits will have to be selected. The data bits are the portion of the bit stream transmitted that actually contains useful information for the receiving device. It is what is left after taking off the Start, Stop, and Parity bits. Select either 7 or 8 to match the number of data bits required by the other devices connected to the network.

Memory Address (3)

This is the beginning V-memory location to temporarily store the ASCII data coming in to the PLC. The Memory Address will consume nine consecutive V-memory addresses. The default is V0 (TA0). This must be changed or there will be a conflict between Timer T0 and the ASCII string.

XON/XOFF and RTS flow control (4)

Select XON/XOFF for software handshaking. It is essentially a software approach to RTS/CTS hardware handshaking.

Select RTS if the port has the RTS signal wired between all devices. As with baud rate, stop bits and parity, every device on the network must be configured the same in order for communications to work properly.

Remote I/O Protocol **(figure 5)**

The Remote I/O selection (1) is for use with the D2-250-1 and D2-260 CPUs only. It is used in conjunction with remote I/O slaves such as the D2-RSSS and T1K-RSSS to connect remote I/O bases that may be as far away as 1000 meters. There are only three settings for Remote I/O.

Station Number (2)

The Station number must be set to 0 for the port to operate as a remote I/O master.

Baud rate (3)

The baud rate is limited to 19.2K or 38.4K. Start with 19.2K baud and then change all devices to 38.4K once the communications are established.

Memory Address (4)

The Memory Address is the V-memory location to be used as the starting location of the Remote I/O configuration table. The value V37700 is recommended.

Additional information can be found in the Remote I/O manual D2-REMIO-M for configuring remote slave units on the network.

Saving the configuration to the CPU

Once all of the parameters are configured, they must be written to the CPU. This is done by selecting the icon located below the Close button. Select the icon that shows a blue arrow pointing 'to' the PLC.

Troubleshooting

If problems are encountered, first check the settings common to all devices such as baud rate, parity, stop bits, etc. Make sure you are starting with a low baud rate such as 9,600, especially for long cable runs. Next, increase the time-out on the master device, such as a PLC or operator interface. Check the cable connections and cable integrity. Lastly, check the cable routing to ensure it is not routed in such a way as to pick up electrical noise from low/high voltage AC systems or variable frequency drives. For RS422 and RS485, verify that all required termination resistors are installed and sized correctly. If you constructed your own cable, make sure that the RTS/CTS connections are jumpered together. Try increasing the RTS on/off delay times. Increase these values to 5 - 10ms. Also, check station number settings and make sure you are addressing the correct slave from your master.

If you are using radios, make sure they are capable of maintaining the packet integrity for the protocol you have chosen. You may have to adjust packet sizes, timing delays, etc. in the radios. Also,

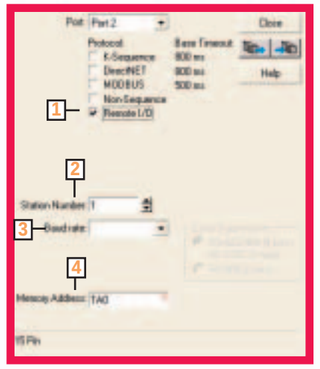


Figure 5

radios typically require longer delay times and time-out settings in the master.

For more information, refer to the following Technical and Application Notes posted on the technical support page of the AutomationDirect Web site:

AN-D2-002

CPU Communications Port Setup Parameters

AN-D2-003

DL06, D2-250(-1),D2- 260 to D2-240 RS-232 Communications wiring Diagram

AN-D2-004

DL06, D2-250(-1), D2-260 to DL06, D2-250(-1), D2-260 RS-232/RS422 Communications wiring

AN-D2-005

D2-250(-1) to Modem / RS-232 communications wiring diagram

AN-D2-006

Using the D2-250, D2-250-1, D2-260, and DL06 to Communicate to a printer/data terminal

AN-EZ-003

EZTouch, EZText RS 422/485 wire connections to DirectLOGIC PLCs.

AN-MISC-003

How to Connect DirectLOGIC PLCs through the MDM-TEL modem.

Technical Review
Control System Design

A Condensed Guide to Automation Control System Specification, Design and Installation
Part 2: Control Device Specification

by Tom Elavsky,
AutomationDirect

In Part 1, Winter 2005 Issue 3, we covered some safety aspects involved in the use of automated control systems and discussed some tips used in identifying which manufacturing equipment and processes can be automated.

In Part 2, we will cover how to specify the various devices required for controlling the equipment in an automated system. Your specifications need to include not only the "controlling" devices for your application, but also items such as the housing or enclosure for the devices, the type of wire required to meet the various codes, agency approvals required for safety and insurance purposes, environmental conditions, etc.

As stated in Part 1, special expertise is generally required to design, wire, install, and operate industrial automation control systems. Persons without such expertise or guidance should not attempt to design control systems, but should consider seeking the services of a qualified system integrator. Control systems can fail and cause serious injury to personnel or damage to equipment. The information in this series of articles is provided "as is" without a guarantee of any kind.

With that said, the first skill we need to develop in this effort will be the gathering of all the equipment parameters and specifications needed to specify the devices required to control the equipment. We need to be the proverbial detective who would ask questions such as;

- What is the operating voltage?
- What is the power rating?
- How much current does it draw?
- What is the operating temperature range?
- What is the relative humidity range?
- What are the mounting dimensions?
- What are the minimum mounting clearances?
- What is the duty cycle?
- How will the system be used?
- Who will be using the control system?

Control System Devices

The devices you need to specify in your control system will generally fall into one of three categories; input devices, output devices and the processing unit.

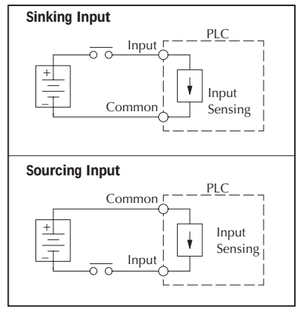
Input devices

Input devices are used to sense a condition, detect movement or position, indicate a limit or set point has been reached, sense intervention by an operator, detect an alarm, etc. Typical input devices may include limit switches, photoelectric sensors, pushbuttons, proximity sensors, an operator interface, etc. These input signals are generally in an ON or OFF state. We can look at an input from a device, such as a photoelectric sensor used to detect an obstruction, and state that when the sensor sees the obstruction, the sensor is ON; in other words we have a true condition. When the sensor is not obstructed, then the input is OFF; or we can say the condition is false. These types of signals are called discrete signals, meaning they are always one of two states; ON or OFF. They can be wired into a PLC input module and the PLC can be programmed to use the status of the signals to execute the logic to control the automated system. Or these same signals can be used in a "relay logic" system, where control relays are hardwired to create the system logic.

Of importance to our specifications are the ratings of these input devices:

- What is the operating voltage; 24, 120 or 240 Volt AC or DC?
- If they are rated for DC, are they sinking or sourcing?
- What distances can they sense?
- How much force can be applied to the actuator?
- How much current do they require?

As a note, most PLC DC input modules can be configured as sinking or sourcing [1].



Typical wiring for sinking and sourcing input devices **Figure 1**

Also keep in mind that when selecting a sensor device, such as to detect the presence of product or sense the end of travel for a mechanism, it is very important to consider the environment in which the sensor will operate. This should not only include temperature and humidity ranges, but in some cases, indoor or outdoor use, altitude, ability for the sensor to be washed down, etc. Photoelectric sensors are sensitive to the atmosphere in which they can efficiently work. If there is a lot of dust, dirt and/or mist in the air, then the optics can easily become dirty or coated, reducing their sensitivity and operating distance.

Output devices

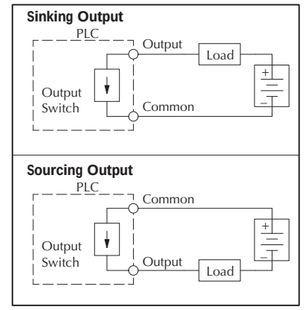
Output devices are used to control actions such as motion, start/stop of equipment like conveyors and pumps, on/off control of valves, operator alerts/prompts, status indications, etc. Typical output devices include relays, motor starters, pilot lights, operator interface graphics and numeric display, etc. These output signals, like input signals, are also discrete; either ON or OFF. The signals can be wired from a PLC output module to control the devices, such as starting and stopping motors, energizing a valve to control water flow, illuminating a pilot light to alert an operator to a condition such as "Bin Full", etc. Output signals can also be wired directly to a controlling device using hardwired relay logic.

Of importance to our specifications are the ratings of these output devices:

- What is the operating voltage; 24, 120 or 240 Volt AC or DC?
- If they are rated for DC, are they sinking or sourcing?
- What is the current draw?
- What is the duty cycle?
- What is the operating temperature range?
- What are the mounting dimensions?

For example, if our process uses a solenoid valve to control water flow to a wash station, we would need to know the operating voltage of the valve and how much current it draws. We also need to know not only the on-state current draw of a valve, but also the inrush current, so that we can properly specify a PLC output module or a control relay. Although a valve may be rated to draw 250 mA continuous current, it may have an inrush of 800 mA when first energized. If an output module has eight output points and each point is rated for 1 amp continuous duty, after thermal considerations, the entire output module has a total rating of 6 amps and therefore has a common fuse rated at 6 amps. If we had solenoid valves connected to all eight output points and our program called for them all to energize at the same time, the total inrush current would be 8 times 800mA or 6.4 amps, and most likely would blow the fuse. The solution could be to select an output module with a higher current rating or to use the ladder program to sequence the valves, preventing them all from being energized at the same time. Another option is to split up the valves between several output modules, using the remaining points to power smaller loads such as pilot lights. Certain output types may have derating curves depending on the ambient temperature and the number of outputs energized. Keep in mind that DC output modules can be sinking or sourcing type.

The processing unit



Typical wiring for sinking and sourcing output devices **Figure 2**

All control systems can typically be defined as having inputs, outputs and some form of decision making going on in between so that the outputs are controlled based on the status of the inputs. This brings us to our third category, the "decision making" element. This element can be performed by a PLC, where we have inputs, outputs and a central processing unit (CPU) that uses ladder logic programming to make decisions based on input status and the logical conditions in the program (see figure 3). A similar device that can be looked at in the same manner is a personal computer (PC). The keyboard, mouse, scanner, etc. would serve as input devices and the monitor, printer, speakers, etc. would be the output devices. The microprocessor used on the motherboard, along with its memory, the operating system, and the application program would serve as the decision making element. As a matter of fact, PCs are used in some automated control systems as the decision making element, together with industrial input and output (I/O) modules. These PC-based systems rely on the communication ports or Ethernet connections to monitor and control the I/O. The application software typically allows a programmer to develop a graphical interface that gives an operator interaction with the equipment or process. With some research and experience, you will learn how to determine how much "decision making" ability your control system requires. Cost restraints may require you to compare implementing the control system with either a PLC, PC-based control, or simple hardwired relay logic. But don't forget the fact that a PLC >>

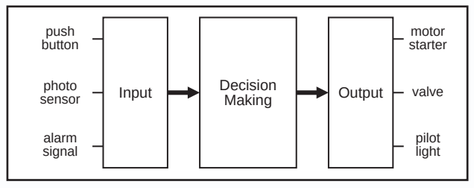


Figure 3

Technical Review

Control System Design Continued

or PC-based control system allows easier changes and future expansion[2].

Other device types

Another area of inputs and outputs involve the use of analog signals in a control system. Analog signals are variable and can represent a range of values. As a quick example, we may want to monitor the level of a liquid in a tank that is 100 feet tall. We can use a sensor that will produce a signal that is represented by a voltage range of 0 to 10 volts DC, with 0 feet being equal to 0 VDC and 100 feet being equal to 10 VDC. Analog signals are typically linear, so a 5 VDC signal would tell us the tank level is at 50 feet. The analog signal could be wired into a PLC analog input module, and in the ladder program we could compare the actual level to a set point and produce a discrete signal that would cause an output point to start a pump to raise or lower the level.

Inductive devices

When selecting a device to control a prime mover, such as an industrial motor to power a conveyor, or a valve to control a hydraulic cylinder, you will need to determine the ratings of the equipment:

- What is the operating voltage?
- What is the maximum current draw?
- What type of environment is it being used in?

MARATHON ELECTRIC

MODEL # AVE213THFW7726AA L FRAME 213TC
POLES 4 ENC TEFC CODE K DES A TYPE TRF INS H3
VOLTS 230/460 FL RPM 1770 FL AMPS 21.4/10.7
SF 1.0 DUTY CONT. TEMP. SENSORS NONE
SERIAL MAX. AMB. °C 40
MAX. SAFE RPM 4200 S.E. BRG. 309 O.S.E. BRG. 206 NL AMPS 13/6.5 ROTOR WK² .75

Hz.	HP	RPM	TORQUE	VOLTS	AMPS
4	.38	90	22.3	----	10.5
60	7.5	1770	22.3	460	10.5
120	7.6	3530	11.2	460	10.6
	R1	R2	X1	X2	XM
OHMS/PHASE	.707	.488	2.39	3.21	41.4

3 PHASE INVERTER DUTY AC INDUCTION MOTOR

An industrial induction motor may have ratings such as 230/460 VAC, 3-phase, 1725 RPM, a FLA (full load ampere) of 10.5 amps at 460 VAC, etc. This information can be obtained from the manufacturer's catalog or directly from the motor nameplate. In the case of a motor, you will need the ratings to choose the motor starter or possibly a variable frequency drive for either start/stop control or speed control of the motor.

Other considerations

There are other points to consider in the specification of devices being used in your automated control system – duty cycle, surge suppression, enclosure type, heating and cooling, power, environment, static electricity and agency approvals.

Duty Cycle

When using a solenoid valve, you will want to know its operating voltage, nominal current draw and current inrush to help select the type of output device required to control its operation. It is also important to have an understanding of the solenoid valve's duty cycle (time on vs. time off). We would not want to operate a solenoid valve rated at 50% duty cycle in a continuous mode with an on time of 10 seconds and an off time of only two seconds. The short off time would not allow for the solenoid to properly cool down.

Surge Suppression

Solenoid valves, motor starters, etc. make use of an inductive coil for their operation and the coil can produce high voltage spikes that can damage output devices and nearby electronic equipment. It is always recommended to use some form of surge suppression to eliminate these voltage spikes [3].

Enclosures

Selecting a proper enclosure is important to ensure safe and proper operation of your equipment. The minimum considerations for enclosures should include:

- Conformance to electrical standards (Reference NEC)[4]
- Protection from the elements in an industrial environment (Reference NEMA)[4]
- Common ground reference (Reference NEC)
- Access to the equipment (Reference OSHA)[5]
- Security or restricted access (Reference OSHA)
- Sufficient space for proper installation and maintenance of equipment

Heating/Cooling

Ensure that the devices used in your control system aren't subject to overheating, or if installed in a colder climate, the devices aren't being used below the listed low temperature operating range. Your control system, because of its physical location, may require you to have both a cooling system, such as an A/C unit, and a small heating unit as part of the same enclosure. This will ensure the devices are always operating within their temperature specifications. Basic thermal management is not difficult for most automated control systems. Investing a little thought during the specification stage can save you a great deal of redesign down the road.

DC Power

If using DC voltage from a power supply in your control system, consider using a power supply rated for at least twice the calculated load. This should satisfy one of the requirements if you need to have your control system UL 508 approved and will allow the power supply to operate at a lower temperature, thus increasing its life. >>

Environmental Specifications

The following table is an example of NEMA's common environmental specifications that generally apply to automation equipment. IEC also has a list of common environmental specification designations for enclosures and equipment[4].

COMPARISON OF SPECIFIC NON-HAZARDOUS APPLICATIONS INDOOR LOCATIONS											
PROVIDES A DEGREE OF PROTECTION AGAINST THE FOLLOWING ENVIRONMENTAL CONDITIONS	TYPE OF ENCLOSURE										
	1	2	4	4X	5	6	6P	11	12	12K	13
Incidental contact w/ encl. equip.	●	●	●	●	●	●	●	●	●	●	●
Falling dirt	●	●	●	●	●	●	●	●	●	●	●
Falling liquids and light splashing		●	●	●		●	●	●	●	●	●
Dust, lint, fibers, and flyings			●	●	●	●	●		●	●	●
Hose down and splashing water			●	●		●	●				
Oil and coolant seepage									●	●	●
Oil or coolant spray and splashing											●
Corrosive agents				●			●	●			
Occasional temporary submersion						●	●				
Occasional prolonged submersion							●				

Static Electricity

Most equipment and devices will operate down to 5% relative humidity. However, static electricity problems occur much more frequently at humidity levels below 30%. Make sure you take adequate precautions when you touch the equipment. Consider using ground straps, anti-static floor coverings, etc. if you use the equipment in low-humidity environments.

Agency Approvals

Some applications require agency approvals for particular components. Some of these required approvals are:

- UL (Underwriters' Laboratories, Inc.) [6]
- CUL (Canadian Underwriters' Laboratories, Inc.)
- CE (European Economic Union)

The requirements for any of these agency approvals need to be part of your specification and will determine the selection of most of your controlling devices.

Enclosure Lighting and Convenience Receptacle

It is always a good idea to include interior lighting for your control system enclosure or cabinet to help during routine maintenance to the control system. Provide a convenience receptacle inside the control system enclosure to supply power to test equipment, calibration equipment, etc.

Product Selection

Suppliers' literature and Web sites are an excellent resource for evalulating product specifications. For industrial control product selection information for AutomationDirect products, refer to

http://www.automationdirect.com/static/specs/productselection.html

Watch for Part 3, Automation Control System Design and Build, in our next issue.

Footnotes:

1 For "Sinking and Sourcing Concepts" refer to http://www.automationdirect.com/static/specs/sinksrc.pdf

2 For "Considerations for Choosing a PLC" refer to http://support.automationdirect.com/docs/worksheet_guide-lines.html

3 For more information on surge suppression for outputs, see chapter 2 of any PLC user manual, available on our Web site.

4 Information for the National Electrical Manufacturer's Association (NEMA) can be found at their Web site at: http://www.nema.org. NEMA is also being harmonized with the International Electrotechnical Commission (IEC) (Web site: www.iec.ch/) and other European standards. Additional information can be found at Global Engineering Documents' Web site at: www.global.ihs.com. Global Engineering Documents is also the source for obtaining NEMA, IEC and CE documents.

5 Additional information can be found on OSHA's Web site at: http://www.osha.gov/SLTC/controlhazardousenergy/.

6 Additional UL information can be found at: http://www.ul.com/controlequipment/devices.html.

FYI

Variable Frequency Drives

VFDs Frequently Asked Questions

by Keri Schieber,
AutomationDirect

AutomationDirect's technical support team has compiled a list of customer frequently asked questions for many of our products. The complete listing can be found on the technical support page of our Web site. Here are some of the frequently asked questions for variable frequency drives (VFD).

Q: What is sensorless vector control?

A: Sensorless vector control is a technique used in variable frequency drives to rotate the force vector in the motor without the use of a shaft position sensor. The goal of AC sensorless vector technology is to give the user "DC" like control while making traditional speed or shaft position feedback from the motor unnecessary. Sensorless vector control removes a major source of complexity and potential for failure, such as tachometer feedback, while simplifying many AC drive installations. The sensorless vector algorithm must be tuned to match the characteristics of the particular motor being controlled by the drive. This improves torque performance at very low speeds as compared to typical volts per hertz control.

Q: Does a motor need a chassis ground connection?

A: Yes, for several reasons. Chassis grounding is used for protection in the event of a short in the motor that puts a live voltage on its housing. Motors and other components exhibit leakage currents that increase with aging and a grounded chassis generally emits less electrical noise than an ungrounded one.

Q: What type of motor is compatible with inverters?

A: Inverter motor type must be a three phase AC induction motor. Preferably, you should use an inverter-grade motor that has 800V insulation for 200V class inverters, or 1600V insulation for 400V class inverters. For motor size, in practice it is much better to find the right size motor for your application; then look for an inverter to match the motor.

Q: How will I know if my application will require resistive (dynamic) braking?

A: For new applications it may be difficult to tell before you actually test a motor/drive solution. In general, some applications can rely on system losses such as friction to serve as the decelerating force, or otherwise can tolerate a long decel time. These applications will not need dynamic braking. However, applications with a combination of a high-inertia load and a required short decel time will need dynamic braking. This is a physics question that may be answered either empirically or through extensive calculations.

Q: What is ringing and what happens to the motor when I place it more than 50 feet away from the drive without a line reactor?

A: High voltage ringing (reflective voltage) occurs on all VFDs. With IGBTs replacing SCRs on smaller, more in-expensive drives, ringing has become more pronounced. This capacitive-coupling effect is caused by high speed switching (commutation). Distance greatly enhances the effect. Cables on the output side of the drive act like capacitors. When the IGBTs switch or produce the PWM output, the higher frequency part of the current will find a path through that capacitance. Think of the cable as a capacitor that increases in size as the cable length increases. Ringing is very detrimental to motors; it weakens the first stage rotor windings and shortens the life expectancy of a motor. This is especially true for motors under 10 hp. Typically they are machine wound, have thinner coats of varnish, and have neither phase nor end paper (I.E. aggregate insulation properties). That's why we always recommend a drive rated motor. Vintage and non-drive rated motors that are used with VFDs have a lifespan of unknown length. You simply cannot know what to expect from them. Long cable runs with ringing can add 10 to 15% to the drive's current rating, causing the drive to trip out on excessive current. The capacitance will also cause a voltage drop that may cause speed performance problems on the lower end of the speed scale (increased current demand for demanded torque). A few general guidelines: 1) Try to reduce distances as much as possible, 2) Use an output line reactor on cabled distances greater than 50 feet, 3) Always use a drive-rated motor.

Q: Is there a standard for inverter rated motors?

A: NEMA MG-1, Section IV, Parts 30 and 31. Part 30 pertains to fixed supply motors; part 31 pertains to inverter supply motors. Always talk to your motor manufacturer for additional details. Note: the international standard is IEC 60034-17.

Q: What drive power cable do you recommend and why?

A: Belden 29500 - 29507 cables are specifically designed for use with VFDs. Using the wrong cable can increase the detrimental effects from ringing due to capacitive coupling. Thermoplastic insulation, found in standard THHN cable, will break down over time if used to connect inverters to motors. The standing waves caused by pulse width modulation (PWM) will cause high voltage potential on single conductors. This renders corona (reflective/ringing voltage) in the air gaps between the conductors, which could break down and cause a system failure.

Q: Can a drive replace a softstart?

A: Yes. Softstarts are used for reduced torque starting and stopping of standard 3-phase induction motors (such as centrifugal pumps, compressors, ball mills, jar mills, fans, blowers and saws). If the motor is not adequately protected from sudden changes in rotational torque associated with starting and stopping, the current will be excessive to the system and the motor will surge, causing damage to all the equipment linked to it. Over the long term, this leads to increased over-current tripping and increased mechanical wear of gearboxes, clutches, transmission and conveyor systems. ANSI/IEEE Std. 141-1993 (Red Book) provides a comparison of different reduced voltage starting methods. An electronic softstart of VFD, although not listed, would have similar characteristics to the autotransformer starter.

Q: Can I run my drive at extremely low speeds?

A: Three major problems exist with both conventional methods of motor control and VFD control: 1) When a motor is directly coupled and run at a low speed, it becomes very inefficient. You could go with a high torque motor that is significantly larger than the standard and would have the same results most of the time. 2) Typical motors do not cool themselves well at extremely low speeds. The added heat buildup in the windings can cause premature motor failure. Check with the motor manufacturer for more details. 3) The third issue is load inertia, which is larger than that of the motor. The effects of all of these things increase greatly with a sloppy transmission system. A speed reducer or gearbox should be employed to solve this problem. It will match the inertial changes and increase efficiency. Speak with a technical resource about sizing the gearbox to meet your application needs.

Q: Are variable frequency drives phase sensitive?

A: The input wiring is not sensitive to phase. If you were to change one set of input leads, the rotation would not change. The opposite is true for the output of the drive. It is sensitive to phase, so changing one set of leads to the motor changes the direction of rotation.

Q: What is a line reactor and what will it do for my application?

A: A line reactor is a special type of inductor used on the line side or the motor side of a drive application depending on the specific circumstances. They are used on the line side of the drive to smooth inrush current, reduce noise, and to act as a buffer and protect the drive system. The line reactors have a 3% voltage drop based on impedance. This drop can be beneficial for drives on systems exceeding the rated input voltage of the drive. In this regard, the line reactor has been used to replace the much larger drive isolation transformer. Line reactors are used on the motor side of the drive to protect the motor by smoothing the drive output waveforms and by reducing ringing and capacitive coupling, especially with long cable runs between the drive and the motor.

Q: What is grounding and what reference material is available?

A: Equipment or conductor-enclosure ground refers to connecting the non-current-carrying metal parts of the wiring system or equipment to ground. This is done so the metal parts which a person might come into contact with are at or near ground potential. The grounding of motors is referenced in NEC article 430 part M and methods are described in article NEC 250.

Q: What are some of the common reasons why motors fail?

A: The EPRI Power Industry Study by General Electric in 1985 offered the following causes based on 6,000 utility motor failures: 41% were bearing related, 37% were stator related, 10% were rotor related and 12% were other causes. Other institutions like DOD and the IEEE came up with similar results.

Q: My pump is losing speed; does the drive have a problem?

A: Pumps are divided into three basic categories - centrifugal, rotary, and reciprocating. Take any of the three types and break them down further into four parts: the rotating element, the casing, the motor, and the drive. The rotating element has a shaft, sleeves, bearings and an impeller. The casing has a pump shell, wear rings, and shaft seals. The motor and drive are intuitive. Here is a basic remediation list: 1) the belts are slipping (if applicable); 2) the impeller is worn; 3) the impeller is loose on the shaft or the shaft is sheared; 4) the casing is worn; 5) the original motor was replaced with a slower model or with a greater amount of motor slip; 6) the requirements have changed beyond the design specifications of the system. Using a manual tachometer, verify if there is a speed problem. If all of the above has been investigated and a problem still exists, then you may need to increase the maximum frequency of the drive. Note that anything beyond 60 Hz will result in a shift from a constant torque to a variable torque situation. There is a low probability that the drive will detrimentally affect the intrinsic speed of the system.

Q: Is there a reference for application help?

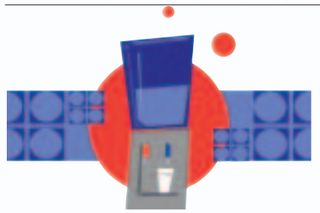
A: NEMA standards publication "Application Guide For Adjustable Speed Drive Systems".

Q: What is the difference between torque control and torque limiting?

A: Torque control can be done with any of AutomationDirect's PID capable drives. This would be a closed loop system using torque as the process variable. There should be both a torque reference and torque feedback signal. The user would establish a torque setpoint and configure the drive to maintain that setpoint. Many customers have used torque sensors, load cells, and current transducers to establish an analog input to the drive. Ideally, a vector drive would work better than a volts/hertz drive. A vector drive allows tighter speed regulation and better control in the lower speed range. Torque limiting can be done with AutomationDirect's Hitachi SJ300 series drive. Instead of using an external torque sensor, torque limiting uses the drive's internal current sensor. The operator would set the torque limit, and when that level is exceeded, the drive would act like a governor on a generator. The speed would be restricted until the appropriate level is again maintained. Mechanical devices, in addition to drives, are also employed for torque limiting, such as clutches, shear pins, gearboxes, etc.

The Break Room

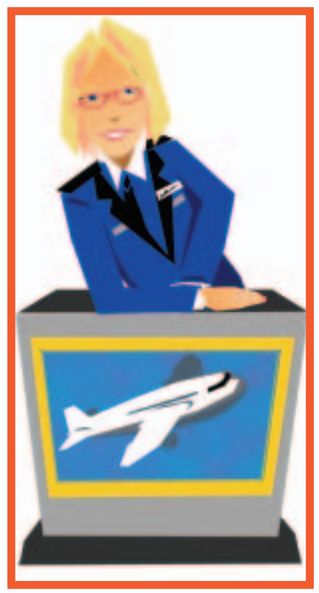
Humorous stories and Brainteasers



Customer Service with a smile

-found on the Internet

An award should go to the United Airlines gate agent in Denver for being smart and funny, and making her point, when confronted with a passenger who probably deserved to fly as cargo.



During the final days at Denver's old Stapleton airport, a crowded United flight was canceled. A single agent was rebooking a long line of inconvenienced travelers. Suddenly an angry passenger pushed his way to the desk. He slapped his ticket down on the counter and said, "I HAVE to be on this flight and it has to be FIRST CLASS."

The agent replied, "I'm sorry, sir. I'll be happy to try to help you, but I've got to help these folks first, and I'm sure we'll be able to work something out."

The passenger was unimpressed. He asked loudly, so that the passengers behind him could hear, "Do you have any idea who I am?"

Without hesitating, the gate agent smiled and grabbed her public address microphone. "May I have your attention, please?" she began, her voice bellowing throughout the terminal. "We have a passenger here at the gate WHO DOES NOT KNOW WHO HE IS. If anyone can help him find his identity, please come to the gate."

The man retreated as the people in the terminal applauded loudly. Although the flight was canceled and people were late, they were no longer angry at United.

Brainteasers

1. "Rebates on PLCs"

A company that sells overpriced PLCs and needlessly expensive AC Drives decides to offer their customers a rebate. They offer $250 to each PLC customer, and $400 to each customer who bought an AC Drive. Unfortunately, the company has lost track of the number of customers who have purchased each product, but they do know that a total of 5,392 customers are eligible for one rebate or the other (no customers qualify for both rebates). After the rebate period ends the company realizes that only 1/5 of their PLC customers and only 1/8 of the AC Drive customers have applied for the rebates. ***Can you determine the total amount of all the rebates to be paid by the company?***

2. "Husband and Wife"

A husband and wife have a combined age of 91. The husband is now twice as old as his wife was when he was as old as she is now. *What are their ages?*

3. "The Queen Attacks"

Place eight queens on a chess-board in such a way that none of the queens is attacking another queen. (Schuh)

(*check www.automationnotebook.com for a nifty Java applet to help you solve this one!)*

And thanks to all who visited us at National Manufacturing Week in Chicago. We'd like to congratulate the winners of the Automation I.Q. Challenge:

Laser Tool Kit Winners:

Sally Memmer
Kevin Brown
Doug Ward
Laura Johnson

And the winner of the drawing for the Apple iPod was Chuck Knecht.

Congratulations all!

Please visit **www.automationnotebook.com** for brainteaser answers.

Automation NOTEBOOK is a publication of AUTOMATIONDIRECT.com

Please tell us what you think...

Log on to www.automationnotebook.com, or send an email to editor@automationnotebook.com to share comments, express an opinion or provide ideas for future issues. We invite readers to participate in application stories, technical questions and Break Room humor. If you have a submission for any of these sections, or an article idea, please email us. All submissions will be reviewed and considered.

If you are a non-subscriber and would like to be included in the next mailing of AutomationNotebook, please select Subscription Information on the Automation Notebook Web site, and complete the details. You can also request FREE stuff, including our new 2005 catalog and our CD-ROM featuring the entire catalog and demo software. If you provide your email address, we will send news and product information from time to time as well.

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