Automation NOTEBOOK®

Your guide to practical products, technologies and applications

CHOOSING AN OEM OR A SYSTEM INTEGRATOR

WHEN A NEW PRODUCTION LINE IS NEEDED, WHICH IS THE BETTER PARTNER, AN ORIGINAL EQUIPMENT MANUFACTURER OR A SYSTEM INTEGRATOR?

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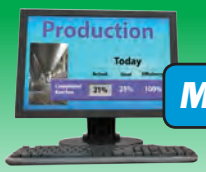
See things from a new Point of View

HMI/SCADA Software for PC-based visualization

Point of View is powerful software for developing HMI, SCADA, and OEE/Dashboard projects for your control system that can be deployed anywhere. Create graphical screens that are easily understood, plus show data, alarms, trends, and more. You get all this capability for a very practical price, no matter how small or large the system.



Management

Enterprise integration

Easily tie into ERP and "back-office" systems using built-in relational database connectivity.

Engineers

Save time

View your process from your desk or Web-enabled mobile phone using a standard browser (Internet/intranet including XML support). Based on HTML5, it can be used on most current tablets and phones.

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Starting at:
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PV-500-DEV
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Save money

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Point of View contains 18 built-in drivers for connection to the most popular industrial controllers: AutomationDirect's Productivity3000 and DirectLogic; plus many Allen-Bradley, Omron, Siemens, GE and Mitsubishi series. This software also includes a driver for Modbus communication.

Each Point of View package includes:

- one ***WEB*** thin client license
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Three software packages are available in 500, 1000, and 5000 tag count versions:

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Your guide to practical products, technologies and applications

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

Editor's Note

Are you persistent? Are you determined? How's your focus?

For the past year, my wife and I have been part of a group of about 10 other people in a project to restore the façade of "Tara", the stately mansion from the movie, "Gone with the Wind". On one or two Saturdays per month, we gather outside an old dairy barn south of Atlanta and work diligently to identify pieces and parts from this movie icon, with hopes of being able to reassemble as many pieces as we can and display them for movie fans. Our persistence has paid off; in early summer, our team leader began providing tours for the fans to see the tall windows, shutters, porch steps, etc.

Since the façade was moved from a backlot in Hollywood to Georgia in 1959, several people and organizations have tried to restore her but failed. Why? Maybe they lacked the persistence and determination needed for the job. Maybe their focus became blurred. But, not our team.

Each time we meet, we work together, and stay focused on the task at hand. That's not to say we lose focus on the big picture; it's more like working on a jigsaw puzzle a section at a time.

That's how it is in everyday business, too. When you think you've reached an impasse, you step back, see how much progress you've made and that gives you the determination to tackle the next section.

In this issue of NOTEBOOK, our Cover Story compares using OEMs over system integrators when replacing equipment. Our New Product Focus highlights our new Protos X field I/O; in our Tech Brief, learn important factors in choosing pneumatic cylinders for automation projects.

We have all this and more. As always, stop by the ever-popular Break Room for our brainteasers and then compare your answers at:
www.automationnotebook.com

TJ Johns
Coordinating Editor
editor@automationnotebook.com

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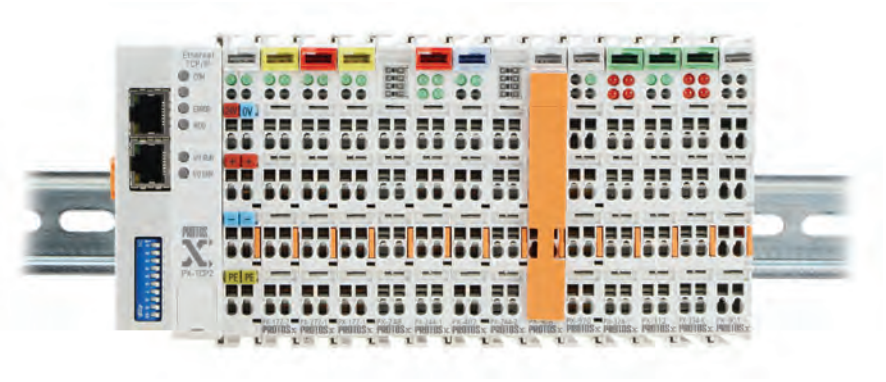
AUTOMATIONDIRECT ADDS SPACE-SAVING DISTRIBUTED I/O SYSTEM

PROTOS X™



AutomationDirect has added a new line of distributed field I/O to its product offering. The new Protos X expansion I/O allows you to easily add low-cost I/O points to your programmable logic controller (PLC) or PC-based control system without investing in additional controllers.

Designed to save space, a single Protos X system can save users up to 74% in I/O footprint inside an enclosure when compared to other I/O systems. The small form factor allows installation directly on or near equipment and connects directly to most PLCs, including all the Productivity3000, DirectLOGIC, and Do-more series. Allowing precise I/O count distribution, Protos X supports up to 255 terminals and is scalable from 2 to 4,080 points.

Bus couplers (interface modules) are available in Modbus RTU/ASCII and TCP versions allowing connection of up to 64 terminals per assembly, for a maximum 255 terminals total. Serving as the link between the Protos X I/O and the system's main controller, the Modbus RTU/ASCII slave bus coupler communicates via a 9-pin D-sub RS-485 port; the TCP server bus coupler communicates to the client via an RJ45 Ethernet port.

Starting at $34, Protos X I/O terminals (I/O modules), are available in two, four, eight and 16-point discrete versions, and two, four, and eight-channel analog versions. There are 12 discrete I/O terminals and 18 analog I/O terminals which include 4-20 mA, 0-10 VDC, and +/-10VDC versions, as well as Pt100 RTDs and Type J and K thermocouples.

Power feed terminals, starting at $18, are available in 24VDC and 120-230 VAC styles to add or change supply power to the terminal power bus; an available 24VDC power distribution terminal with 8 connection points (24V and 0V for each connection) provides access to the integrated 24VDC terminal power bus.

Easy-to-use configuration software (available as a free download) shows the auto-configured Modbus addressing, sets IP (Ethernet) address and communications parameters (serial). Users can also set/disable Watchdog timers, reset bus couplers and more; a communication cable ($56) is available for configuration of the bus couplers. Available bus expansion coupler terminals enable expansion of terminal assemblies with up to 31 expansion couplers in a group, depending on bus coupler chosen.

Protos X components are backed with a one-year warranty. Learn more about the Protos X distributed I/O system at **www.automationdirect.com/protos-x**.

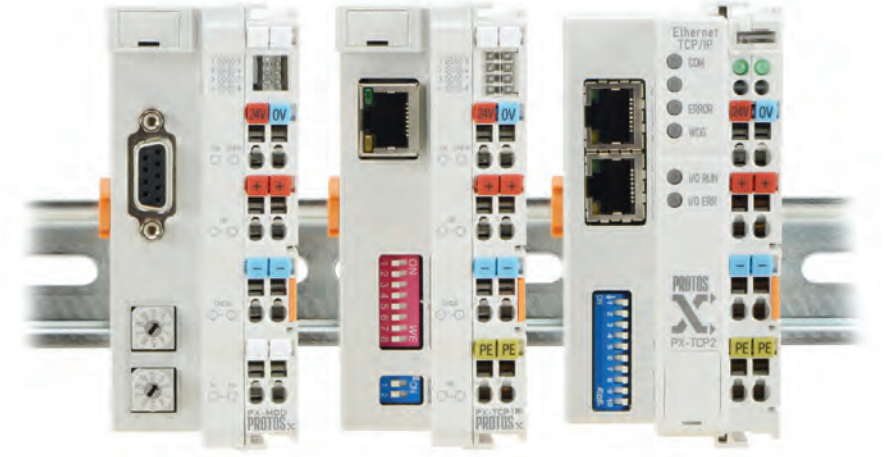
Protos X I/O FAQs

The Protos X compact, modular field I/O system allows a user to install remote field I/O devices without having to invest in another controller. The unique slim design and low cost of the Protos X I/O makes it the most practical distributed I/O available today.

Here we review some of the features and answer several frequently asked questions about the Protos X field I/O.

Q: What communications protocols are supported by the Protos X I/O platform?

A: Currently we offer three different couplers; all are based on Modbus protocol. At present we offer the serial Modbus RTU/ASCII coupler (PX-MOD) and two different Ethernet Modbus TCP couplers (PX-TCP1 and PX-TCP2). (**Figure 1**)



PX-MOD PX-TCP1 PX-TCP2

FIGURE 1

PX-TCP1 EXAMPLE NETWORK DIAGRAM

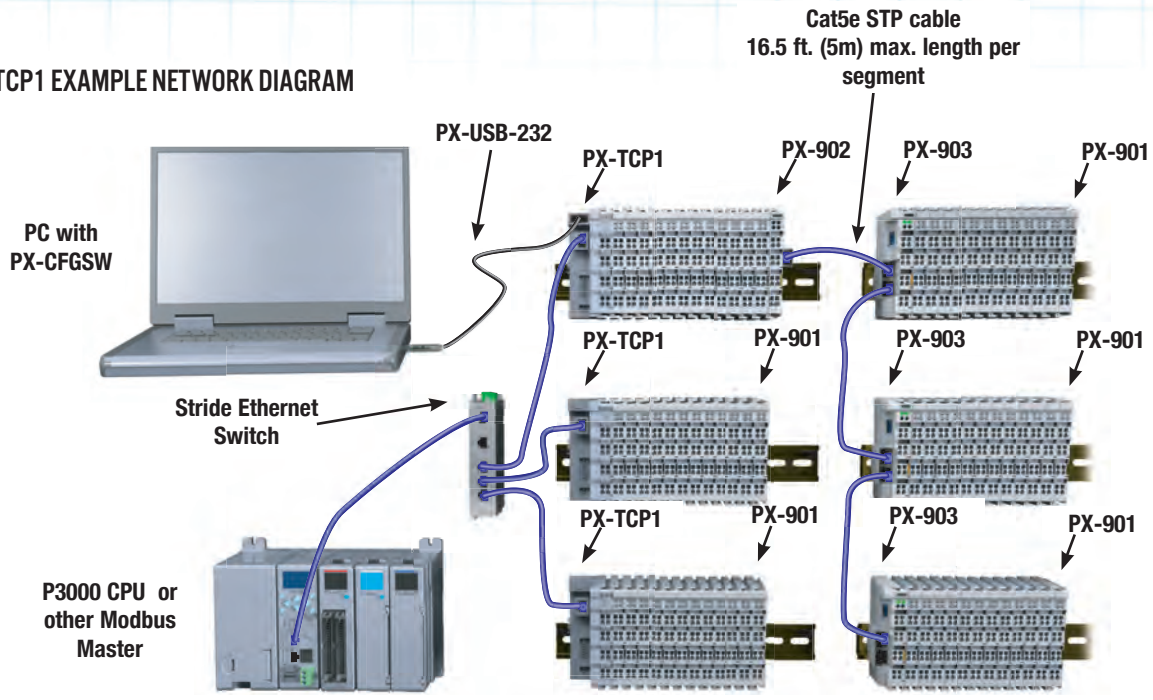


FIGURE 2

Q: What is the difference between the PX-TCP1 and PX-TCP2 Ethernet couplers?

A: PX-TCP1 is a single-port Ethernet Modbus TCP bus coupler that supports up to 64 continuous I/O terminals and is expandable up to a maximum of 255 I/O terminals when used with the PX-902 and PX-903 expansion terminals. (**Figure 2**)

PX-TCP2 is a two-port Ethernet Modbus TCP bus coupler that supports up to 64 continuous I/O terminals. It includes a 2-channel 10/100 Mbps Ethernet switch for connecting to the Modbus TCP Client or to another PX-TCP2. Both couplers support a maximum of 512 input and 512 output bytes. (**Figure 3**)

PX-TCP2 EXAMPLE NETWORK DIAGRAM

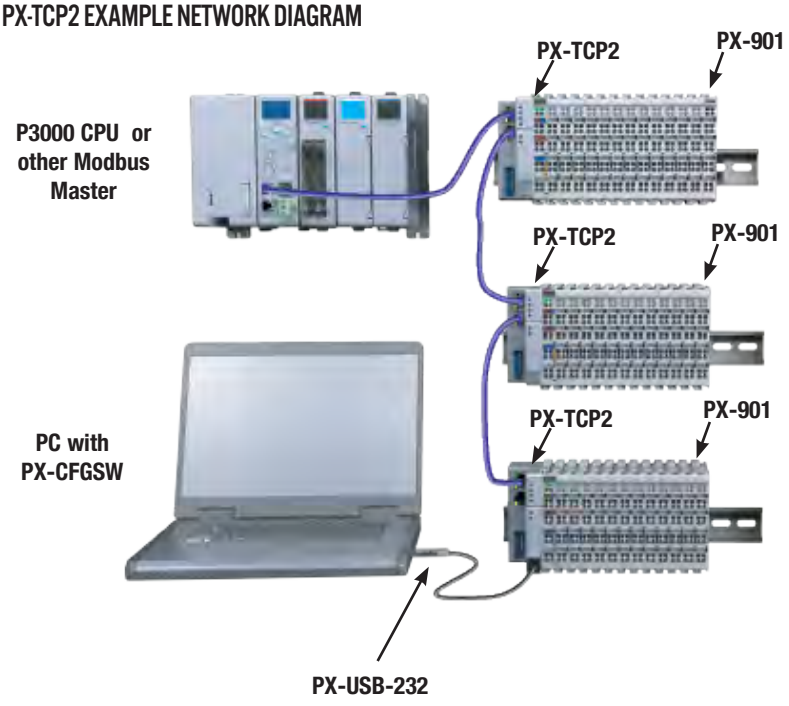


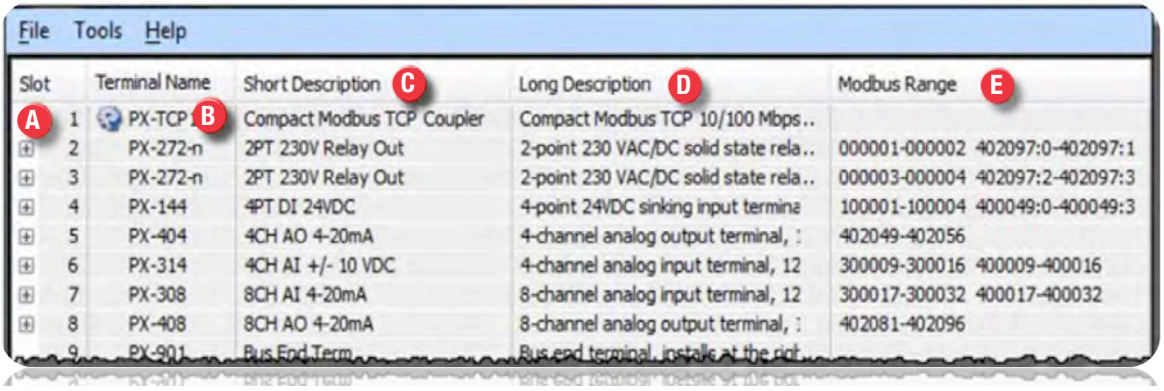
FIGURE 3

Q: Do I need a PX-901 end terminal with every system?

A: You do need an end terminal for each continuous row of I/O terminals. If you are not expanding to an additional row, or if you are using the PX-TCP2, the PX-901 is the correct end terminal. If you plan to expand beyond a single row, each row that is to be expanded should be terminated with the PX-902 bus expansion end terminal, which is used with the PX-903 bus expansion coupler. The final row of a multi-row configuration should end with the PX-901.

Q: How do I know what the Modbus address is for each of my I/O terminals?

A: It is necessary to connect to your bus coupler with the PX-CFGSW >>



A Slot: the physical location of the terminal
B Terminal Name: the part number of the terminal
C Short Description: description of the terminal
D Long Description: more details
E Modbus Range: the Modbus Address for the terminal

FIGURE 4

configuration software using the PX-USB-232 programming cable in order to read the connected I/O terminal configuration. The configuration software will give you the Modbus address of each I/O terminal. (**Figure 4**)

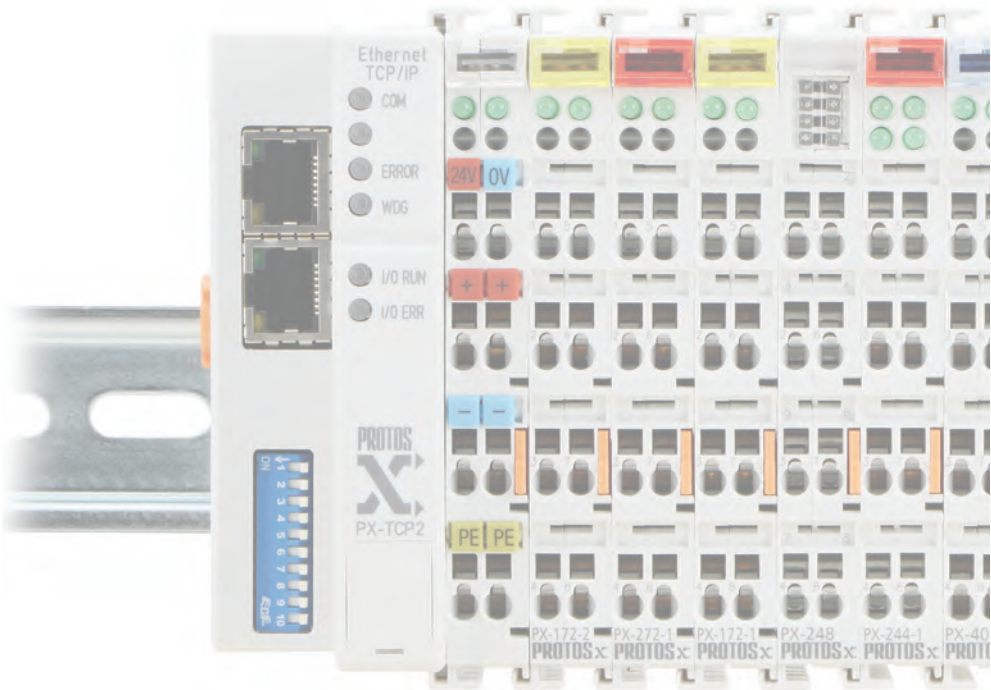
Q: What can be done with the configuration utility?

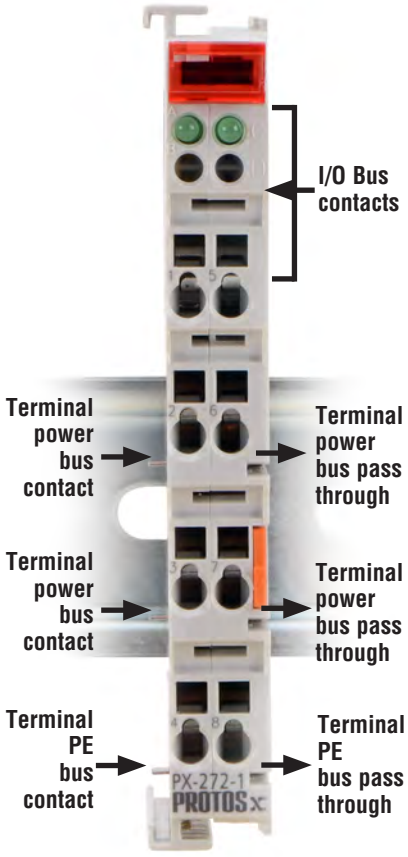
A: View your assembly's I/O configuration, including the Modbus addresses of each I/O terminal; view, set and modify the communications parameters; reset the coupler, if necessary; enable/disable watchdog timer and adjust watchdog timeout value.

Q: Are there any restrictions or concerns when assembling my Protos X I/O terminal system?

A: Yes, It is very important to understand the placement of the terminals in an assembly. Always start the assembly with a Bus Coupler and add terminals from left to right, ending with a Bus End Terminal or Bus Expansion End terminal, attaching each terminal as shown in the System Installation.

In an assembly there is an I/O Bus, which passes data from the Bus Coupler all the way to the Bus End Terminal via six contacts. There is also a Terminal Power Bus, which can provide power to the terminals and/or field devices via the terminal connections. Power is passed via two or three contacts located on the sides of the terminals. Not all terminals pass the Terminal Power Bus, and the voltages on the bus can vary. Because of this, there are four conditions to take into consideration. These conditions can be found in the General Specifications table for each terminal.
(**Figure 5, page 7**)





General Specifications	
Operating Temp	32 to 131 °F (0 to 55 °C)
Storage Temp	13 to 185 °F (-25 to 85 °C)
Relative Humidity	5% to 95%, non-condensing
Environment Air	No corrosive gases permitted
Mounting/ Orientation Restrictions	35mm DIN rail/None
Vibration	conforms to EN 60068-2-6
Shock	conforms to EN 60068-2-27/ EN 60068-2-29
Noise Immunity	conforms to EN 61000-6-2/ EN61000-6-4
Protection Class	IP20
Weight	60g
Dimensions (WxHxD)	12mm x 100mm x 68.8 mm (0.47 in x 3.94 in x 2.71 in)
A *Adjacent Mounting on Bus Terminals with Power Contact*	Yes, DC only
B *Adjacent Mounting on Bus Terminals without Power Contact*	No
C *Passes Terminal Bus Power*	Yes
D *Passes PE Bus*	No
*Agency Approvals**	UL/cUL File No. E157382, CE

To obtain the most current agency approval information, see the Agency Approval Checklist section on the specific part number's web page.

FIGURE 5

A Adjacent Mounting on Bus Terminals with Power Contact. Terminals that say Yes can be mounted to the right of a terminal that passes power. Some terminals will specify DC Only or AC Only and should only be mounted adjacent to a terminal that passes the same voltage.

B Adjacent Mounting on Bus Terminals without Power Contact. Terminals that say Yes do not use power from the Terminal Power Bus. These would be the Power Feed Terminals, Power Separation Terminal, and some of the Analog I/O Terminals.

C Passes Terminal Bus Power. Terminals that say NO do not pass power through the Terminal Power Bus. THese would the End Terminals, Power Separation Terminal, and some of the Analog I/O Terminals.

D Passes PE Bus. Terminals that say Yes use PE (earth ground) from the Terminal Power Bus. These would be the Power Feed Terminals and any Discrete I/O Terminals that support 4-wire field devices.

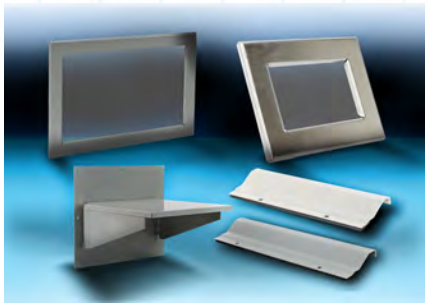
NEW SERIAL COMMUNICATIONS MODULE FOR THE PRODUCTIVITY3000 CONTROLLER

The Productivity3000 programmable controller is a high-featured system with advanced communication and data acquisition features. The P3-SCM for the Productivity3000 is a 4-port serial communications module with three RS-232 (RJ12) half or full duplex ports; port 4 is half-duplex and is selectable between an RS-232 (RJ12) connection or an RS-485 4-wire terminal block. All ports support Modbus RTU Master/Slave, ASCII In/Out and Custom Protocol up to 38.4K baud rate. Using multiple P3-SCMs (up to 11) in a Productivity3000 system provides additional serial ports to connect to many peripherals such as HMIs and message displays (C-more, C-more Micro, ViewMarQ, etc.), drives (GS drives, SureStep, SureServo, etc.), weight scales, printers and most any Modbus or ASCII device. The P3-SCM module is $285.00.

Learn more about the P3-SCM at:
www.automationdirect.com/productivity3000

MORE ACCESSORIES FOR HUBBELL-WIEGMANN ENCLOSURES

Starting at $37, drip shields protect door hardware from dripping water and settling dust. Steel and stainless steel window kits are used indoors on NEMA 12 and 13 enclosures. Kits are fully gasketed and start at $103. Heavy gauge steel folding shelves start at $165.



Learn more about the full line of Hubbell-Wiegmann enclosure accessories at:
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GENERAL PURPOSE SOLENOID DIRECTIONAL CONTROL VALVES

NITRA® pneumatic solenoid valves are available in a variety of configurations. With 33 new part numbers, there are now more valve choices in size and volume with all the same features and benefits of the existing valves. Ten additional smaller body sizes (all 1/8" NPT ports) and 8 additional larger body sizes (all 1/2" NPT ports) are now available. NITRA pneumatic solenoid valve prices start at $18..

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The 230/460 VAC MAX+ motors replace Permanent Magnet DC (PMDC) systems, multi-speed motors, single phase motors, and are a variable speed upgrade for fixed speed motors. The MAX+ motors with integrated encoder provide exceptional performance with AutomationDirect DURApulse or GS series drives. MAX+ series motors with encoder are UL Recognized, CSA Certified, CE Marked, have a three year warranty and start at $655.

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ProSense® SLT1 series submersible level sensors have a 1-inch diameter housing and are available in cable lengths from 30 to 140 feet and 0-5 to 0-50 psig sensing ranges. The 2.75 inch diameter SLT2 series is available in cable lengths from 30 to 100 feet and 0-5 to 0-30 psig sensing ranges.

SLT series sensors start at $299, have a one-year warranty, are CE marked and approved for intrinsically safe applications.

To learn more and about the ProSense SLT series submersible level transmitters, visit:
www.automationdirect.com/level-sensors

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AutomationDirect's new QM series photoelectric sensors are IP67-rated sensors available in three-wire NPN or PNP styles and with visible red and infrared versions. The mini-rectangular photo eye sensors are constructed with plastic housings and have either an attached two-meter output cable or an M8 quick-disconnect connector. The series includes diffuse, diffuse with background suppression, retroreflective, retroreflective for transparent objects, and through-beam styles. All retroreflective models include one rectangular reflector; through-beam models are sold as an emitter and receiver pair. All models have a selectable light-on/dark-on output setting; select models are fitted with an easy-to-use potentiometer for setting switchpoint distance. The QM series sensors start at $35, have complete overload protection, and are available in sensing ranges up to 30m. Backed by a one-year warranty, QM series photoelectric sensors are cULus, CE and RoHS approved.

To learn more about the new QM series photoelectric sensors, visit:
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IRONHORSE® ALUMINUM WORM GEARBOXES

IronHorse worm gearboxes with aluminum alloy housings offer a lightweight design available in 30 to 75mm frame sizes and gear ratios from 10:1 to 100:1. These gearboxes are ideal for reducing output speed or running two loads from one motor. IronHorse aluminum worm gearboxes start at $88.

View the complete line of IronHorse gearboxes at:
www.automationdirect.com/worm-gearboxes

ETHERNET/IP SUPPORT ADDED TO PRODUCTIVITY3000 CONTROLLER

The Productivity3000 controller now supports the ODVA's EtherNet/IP as a standard protocol. Through its embedded Ethernet port, the P3-550 CPU can support EtherNet/IP configurable as a Scanner or Adapter (or both simultaneously). The P3-550 CPU can communicate to devices using either Explicit messaging or Implicit "I/O" messaging methods. These two common implementations offer access to the majority of the EtherNet/IP devices available in the industry, including third-party controllers, drives and other I/O hardware. In Scanner mode, the P3-550 CPU supports up to 128 total connections with a maximum of 32 devices. Enabling the CPU to support and exchange EtherNet/IP messages simply requires completing fill-in-the-blank style configuration and Message instruction windows in the programming software.

Learn more about the P3-550 CPU and the ProductivitySuite programming software at:
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IP65-rated pre-assembled LED stacklights are available in two or three-light styles using red, green and yellow elements; prices start at $135. 98mm diameter tube mounted beacon lights include permanent/blinking/rotating LED models and halogen rotating mirror models. Prices start at $44. Signal horns with tone volumes from 83 to 108dB start at $38.

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IronHorse Farm Duty motors are designed for applications requiring high starting torque and moderate starting current, and are used to power agitators, augers, compressors, feeders, hay hoists, grinders, blowers and other farm equipment. These motors have robust cast iron end housings with rolled steel bodies and are classified as NEMA Design L, general purpose motors with TEFC (Totally Enclosed Fan Cooled) enclosures. The motors operate on single-phase 230VAC at 1800 RPM and are available in 2, 3 and 5 horsepower models. With a 2-year warranty, IronHorse farm duty motors start at $309.

Learn more about IronHorse motors at:

www.automationdirect.com/farm-duty-motors

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VACT series single-phase AC voltage transducers are available in two sizes; 150V range for monitoring 120VAC systems and 500V range for monitoring 208, 240, 277 or 480VAC systems. VDCT Series DC voltage transducers are available in 15V range for monitoring 12VDC systems and 50V range for monitoring 24, 36 or 48VDC systems. Priced at $135, the voltage transducers feature a 4-20mA output, are 24V powered and are 35mm DIN rail mountable. Made in the USA, AcuAMP voltage and current transducers are backed by a 5-year warranty.

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** *All components sold separately.*

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- **Drives feature on-board indexer and adaptive tuning modes**
- **Free set-up software**
- **2 year warranty**

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100W Servo Motor with connectorized Leads	$325.00 SVL-201		$558.00 TLY-A130T-HK62AA
Breakout Board Kit for CN1 Control Interface	$94.00 ASD-BM-50A		$263.00 2090-U3BK-D4401
10' Motor Feedback Cable	$49.50 SVC-EFL-010		$90.00 2090-CFBM6DF-CBAA03
10' Motor Power Cable	$29.50 SVC-PFL-010		$101.00 2090-CPBM6DF-16AA03
Configuration Software	FREE SV-PRO*		$75.00 2098-UWCPRG
Complete 1-axis 100W System	$986.00		$2,427.00

*SureServo Pro software is FREE when downloaded and is also available for $9.00 on a CD

All prices are U.S. list prices, AutomationDirect prices are from October 2014 Price List. The Allen-Bradley 100W system consists of part numbers shown in table above with prices from www.wernerelectric.com 10/29/2014.

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CHOOSING AN OEM OR A SYSTEM INTEGRATOR

When a new production line is needed, which is the better partner, an original equipment manufacturer or a system integrator?

By Dave Perkon,
an independent industry consultant

Many production facilities do not have the resources to plan, specify, design, build, start up, and validate new production equipment as it requires a significant number of mechanical engineers, controls engineers and technicians. On large projects, such as a high speed packaging line, a plant manager can select between two main types of partners; a machine builder OEM or a system integrator.

The table compares important characteristics of the two types of partners. Strong points for the system integrator include the ability to easily provide production lines with equipment from many suppliers, often typical of a large project. OEMs are a bit more concerned with the competition and less likely to work well with others. Another strong point to consider is many integrators have extensive control system design and programming capabilities acquired working with a variety of complex automated systems.

If the production equipment includes several machines from a single supplier, an OEM may be a better choice. The OEM will likely have detailed knowledge of specific, specialized processes related to their equipment. The integrator may have to re-invent the wheel where an OEM has already fully developed the process and knows all the secrets. The OEM knows their machines in a way not possible for a system integrator.

Choosing an OEM or System Integrator

CAPABILITIES	OEM	SYSTEM INTEGRATOR
Production equipment experience	High	Medium to Low
Automated production equipment knowledge	Medium to Low	High
Multi-discipline resource availability, such as mechanical engineering	High	Low
Project management	Medium to Low	High
Desire to partner with other OEMs	Low	High
Wide experience with automated production systems and control hardware suppliers	Medium to Low	High
Ability to connect plant floor to upper level systems such as MES and ERP	Medium to Low	High
Equipment cost	Low for their own	Higher
Factory acceptance tests on actual machines	With own machines	Not at all
Flexibility on machine selection	Limited flexibility	Maximum flexibility
Knowledge of specific production process	High	Medium to Low
Knowledge of local facility	Medium to Low	High
Manuals and documentation	Good for machine	Good for system

TABLE: CHOOSING AN OEM OR SYSTEM INTEGRATOR

OEMs - Experts with Specific Equipment and Processes

OEM equipment suppliers typically promote expertise with specific applications and processes as a benefit over system integrators.

In the Control Design December 2014 cover story "Machine Builders Vs. Integrators", Paul Strebig, controls engineering manager at USNR (www.usnr.com), is quoted. "The experience and history that OEMs have in their industry is a great advantage, since this knowledge allows them to select the best products and solutions for each individual customer," he says. "Most system integrators have limited history in a particular industry. Machine builders specialize in their industry, know how to be efficient, and have fast and effective installations and startup." USNR is located in Woodland, Wash. and manufacturers machines for wood processing, including everything needed to build an entire sawmill with 30 or more machine centers.

The manufacturer's strong knowledge and experience with their equipment is important. The OmniTurn (**www.omniturn.com**) CNC turning/milling centers are built by NC Electronics in Port Orford, Oregon. And they know their equipment and its interface well (**Figure 1**).

FIGURE 1: OMNITURN. THIS OMNITURN LATHE IS USED FOR MACHINING PINS, BOLTS AND RIVETS. OPERATIONS INCLUDE TRIMMING, TURNING AND THREADING WITH AUTOMATIC BOWL-FED PRODUCT AT A CYCLE RATE OF APPROXIMATELY 3.5 SECONDS PER PART. IMAGE COURTESY OF OMNITURN.

As George Welch, CEO of OmniTurn, explains in the cover story: "We worked directly with one customer to produce the simplest, most cost-effective solution. The OmniTurn CNC can be configured to interface with various controllers, as well as imaging and gaging systems. Because we are familiar with interfacing the Mitsubishi PLC with our CNC, and because we have experience machining parts on the lathe, we saved the customer time and money."

Welch comments that using an OEM eliminates finger pointing. "We accept responsibility for the entire system's hardware, and building the complete system," he says. "In other words, the buck stops with the builder. Additionally, training, service and repair, as required, are handled directly on a one-to-one basis without needing to train and equip a third-party developer."

In the same cover story, John Martin, VP of Engineering at custom machine builder ARC Specialties (www.arcspecialties.com) in Houston, Texas agrees. "Machine and robot builder OEMs that are vertically integrated hold a unique advantage over traditional system integrators. We take full ownership of a project and drive it from conception, design and manufacture, to integration and production. There is no mix of hands to point fingers in multiple directions, but instead only one responsible company that understands every aspect of the system." Typical of many OEMs, ARC Specialties has a large facility, allowing factory acceptance testing (FAT) of their equipment and production systems before shipment to their customers (**Figure 2**).

Often, OEMs have specific resources available to design, modify and support their equipment compared to a system integrator, says Paul Strebig in the cover story. "Machine OEMs are better qualified to provide production line system integration since they are able to have tight control of the mechanical, electrical and controls aspect of a project. This control over design allows an OEM to make changes to optimize a complete solution, whereas a system integrator will be stuck with the equipment they are required to commission."

The cover story continues with comments from Bob Fung, VP of engineering at Owens Design (**www.owensdesign.com**), a custom machine builder in Fremont, California. "System integrators generally buy existing hardware and put the system together. In general, we have a much stronger skill set and the ability to take on much more complex tools. We can create sections of a tool that a basic system integrator cannot."

It is common for an OEM to combine their standard machines with equipment from other suppliers to create a cell or complete production line. For example, Conroe Machine (**www.conroemachine.com**) is a manufacturer of high precision metal cutting machines (**Figure 3, next pg.**), and they often combine their machines with other OEM products to create all or part of an integrated production line. On a recent project, they designed and installed a hard-turning cell for measuring and sorting mud-motor bearings. They also added equipment to box and palletize finished product.

In the Control Design cover story, Matt Wicks, VP of Controls & Software Engineering at Intelligrated (www.intelligrated.com), a builder of material handling equipment in Chapel Hill, North Carolina, says, "The argument for independent integrators is they 'pick the best equipment' regardless of who manufactures it. On the surface this appears to open up competition and drive down initial purchased prices. In the long run, misapplication of equipment and conflicts between machine builders and integrators can lead to increased costs and project delays."

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FIGURE 2: ARC SPECIALTIES. ONSITE MACHINING AND MANUFACTURING CAPABILITY, AS AVAILABLE AT ARC SPECIALTIES, GIVE OEMS THE ABILITY TO ASSEMBLE AND TEST EQUIPMENT AT THEIR SITE. IMAGE COURTESY OF ARC SPECIALTIES.

Productivity

In Motion

Productivity3000 programmable controller

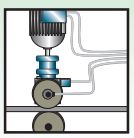
P3-HSI $329.00

P3-HSO $349.00

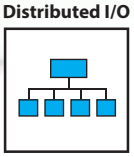
Advanced Discrete

Basic Process

Motion

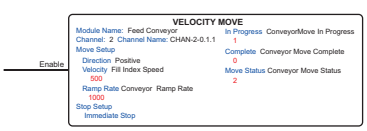


Distributed I/O



High-speed Motion Control

The P3-HSO (High-Speed Output) and P3-HSI (High-Speed Input) modules add high-speed and motion control applications capability to the Productivity3000 controller, with up to 1MHz input and output speeds, and pulse/direction, quadrature and step up/down modes.



Easy Hardware Configuration

Module configuration is a snap. Just drop your module(s) into the hardware configuration and use the software window to define each channel's behavior, status bits, limits and scaling, all without the need for any external configuration utility.

Simple Instructions

Our standard instructions are designed to make your everyday motion applications simpler. The Find Home, Set Position, Simple Move and Velocity Move instructions were created to get you up and running sooner. Capabilities such as Registration, Jerk Control and Channel Scaling were included to give you the flexibility to accomplish those jobs.

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FIGURE 3: CONROE. INTEGRATING MULTIPLE MACHINES, THIS TURNING CELL ENABLES PRECISION MACHINING TOLERANCES, WHILE A ROBOT AUTOMATICALLY TENDS THE TIGHT TOLERANCE TURNING, MEASUREMENT AND PACKING OPERATIONS. IMAGE COURTESY OF CONROE MACHINE.

System Integrators – Experts with Diverse Automated Systems

OEMs are experts with their specific equipment and processes, and can often successfully integrate their equipment into production lines, but system integrators also have extensive automation knowledge, and the wide variety of equipment and production process they work on extends their experience. Focusing this wide ranging automation experience on select projects has its benefits.

In the Control Design cover story, Joseph Snyder, president of Process and Data Automation (**www.processanddata.com**), a systems integrator in Erie, Pa, talks about how a system integrator's experience working with advanced automation systems is a key advantage.

"A packaging machine application that requires a couple of simple infeed and takeout conveyors would normally fall easily within the realm of an OEM", says Snyder. "But as the system complexity increases along with the number of unique players and parts, a system integrator might be critical to ensuring smooth connection between the pieces. On a very sophisticated system, the system integrator's experience in connecting to adjacent process areas and business systems might become very important, as most OEMs have not ventured into those arenas."

"I feel that the chief advantage of system integrators over machine builders when installing new lines is their superior automation system expertise, from using and integrating automation hardware and software from different suppliers, to tying the automation systems to higher level customer software such as ERP systems," notes Snyder in the cover story.

This automation system expertise can also help when specifying equipment vendors. "On a larger scale, the multi-platform experience of a system integrator will be hugely beneficial when selecting vendors because the overall production system may require multiple equipment manufacturers which, in turn, may mean the introduction of different control equipment suppliers," he adds in the cover story. "If nothing more, the project management discipline where most established systems integrators excel might be critical for simply keeping the project moving forward."

The cover story continues with comments from Del Younglas, owner of Texagon Services (**www.texagonservices.com**), a system integrator in Westlake, Texas. "Texagon Services can evaluate the project with the customer and make individual decisions of what component parts are to be retained and what should are to be replaced," he explains. "In a majority of Texagon retrofits the customer chooses to retain the existing motors and drives and replace the CNC controller only, which can be a significant savings. Most machine builders and OEMs that do retrofits remove all electrical equipment including the CNC controllers, motors and drives and replace them with their preferred complete system. Economically, this is not the end user's best choice."

A Plant's Point of View

Production facilities have several options when purchasing and installing machines. Essar Steel India (**www.essar.com**) in Gujarat, India, has experience with numerous options. As Anil Sharma, general manager, explains in the cover story: "When Essar builds new or adds to a production or packaging line, we've used all three methods: in-house expertise, an OEM, and a system integrator or engineering firm. It depends on the project."

"If it's a big project, an OEM contributes 90%, while the rest is contributed by in-house expertise and a system integrator. For very small systems, a local system integrator or engineering firm is used," adds Sharma.

Many facilities have in-house support personnel and use it when they can. Sharma comments in the cover story that there are both advantages and disadvantages to keeping new equipment projects in-house. "If the company uses in-house expertise there is the advantage of low cost," he says. "Employee knowledge increases, they remain technically updated, and it boosts employee confidence and morale. On the other hand, if we use in-house expertise there are disadvantages. Many times updated technology may not be adopted, the design may not be proper, it may take longer for implementation, and full technical support may not be there."

Due to their technical knowledge, Essar typically uses OEMs for integration. However, when possible, and commonly for smaller projects, local system integrators are used.

Final Decision

Sometimes the choice between a system integrator or an OEM is straightforward. On simple projects, with a single piece of equipment and related support hardware, an OEM is usually the better option. These types of projects are right in the OEM's wheelhouse as they have probably installed dozens or more similar machines. The experience and economies of scale are easy to identify.

As the complexity of the project rises, as when adding multiple production lines and a variety of machines and control systems, using a system integrator often becomes a better option. This is especially true if the system integrator can provide long term, local support after the equipment is installed and running. ■

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SIDEBAR: OEM BENEFITS

As an OEM machine builder in Appleton, Wisconsin, CMD (**www.cmd-corp.com**) designs and builds equipment for the blown film and flexible packaging industries (**Figure 4**). Their expertise includes converting equipment for plastic bags, film and pouches along with packaging automation and line integration services.

In the Control Design cover story, Chris White, project manager at CMD explains, "Our automation systems range from taking finished product from one machine and placing it into another machine, to fully customized automation using Cartesian and SCARA type robots."

Regarding integration services, White says, "CMD provides integration services ranging from integrating CMD equipment for specific product requirements, to integrating our equipment with various suppliers of upstream and downstream equipment. Types of equipment we may integrate to complete a line include dosing units, extruders, bag making equipment, conveyor systems, cartoners and case packers. We'll integrate manufacturing lines that contain CMD equipment, or a combination of CMD and other suppliers' equipment—any combination the customer requires to produce the best solution."

Chris suggests OEMs are well suited for equipment and process integration. "OEMs typically have a very thorough understanding of the equipment and processes involved to provide the best solution," he says. "Many times if an outside integrator steps in to integrate multiple pieces of equipment they will not fully understand the manufacturing process."

Not understanding the process thoroughly, especially during commissioning or servicing, can impact production. "If a production line is cartoning and casing rolls of bags automatically, what happens when the cartoner jams?" he asks. "An integrator without experience in the process may say 'if the line stops, clear the jam, and start the line back up.' They may not realize the difficulties of starting the line back up, especially if it's in line with an extruder, which may take a half-hour or more to get back into production."

FIGURE 4: CMD ROBOT. CMD PROVIDES CUSTOM DESIGN OF ROLLED-BAG AUTOMATION LINES AND SYSTEMS BASED ON CUSTOMERS' REQUIREMENTS. SERVICES ALSO INCLUDE MANUFACTURE, INSTALLATION AND INTEGRATION OF ROBOTS, END-OF-ARM TOOLING, CONVEYORS AND CONTROL SYSTEM AUTOMATION. IMAGE COURTESY OF CMD.

"An OEM integrator very familiar with the process will have provisions to keep the line running and to introduce product back into the system while clearing the jam," he notes. "Other things the integrator must consider are how to cull defective product; how to handle variances in product size, shape, colors and densities; and how to inspect for some of these items."

OEMs may also have a wider variety of engineering and technical resources available. "Typically a machine builder OEM is going to have access to machine tools to make mechanical integration parts," he explains. "The machine builder has purchasing leverage to buy manufactured parts and expedite deliveries of parts. For example, if a controller goes bad during integration, an OEM has access to a wide range of human resources with skill sets in all fields including mechanical, electrical, service and spare parts. System integrators may not have access to as broad of a range of human resources to solve any issues in a timely and efficient manner. These combined resources can be a very powerful tool during the integration/startup process."

SIDEBAR: INTEGRATOR ADVANTAGES

A system integrator in Covington, GA, AAA Absolute Automation and Electrical Services (**www.plccontrolsystems.com**), provides system integration services for production lines and custom machines. AAA ties the machine together with a supervisory control system typically using AutomationDirect (**www.automationdirect.com**) products.

In the Control Design cover story, Bob Swarner, ,a systems engineer at AAA says, "We've found AutomationDirect products are priced very competitively, and they've been very reliable. Their products are almost always in stock, and we can get them next day with free shipping for all but the smallest orders. We also like the fact that the software for some of their newer products is free, and the software that's not free is very reasonably priced. This is a large advantage over some other manufacturers."

Swarner comments that his company starts with customer requirements, or just a concept of how the equipment or process will operate. From the requirements or concept, they generate electrical schematics, build the control panels, integrate the system and provide system start up services. System documentation, operator manual, follow on service and support is also provided. "Our customer base consists primarily of small to medium sized manufacturing facilities, and we provide system integration services to control machines in integrated production lines."

In the cover story, Swarner suggests advantages integrators have over machine builders: "Typically, machine builders are very familiar with their machines and standard applications for it, but not with the specific production line where it'll be installed," he explains. "Since system integrators normally develop an ongoing relationship with a particular plant, they can be more familiar with the production process and people at a particular plant. This allows us to prevent problems that may arise during commissioning a new machine that's integrated with the rest of the process."

Better service and support are also a possibility when using a system integrator. "If an integrator is actively involved in maintaining and upgrading the production process at a plant, they'll generally be more familiar with any changes that take place that can affect the output from a particular machine," he says.

"A system integrator can provide better documentation for a system," he explains. "Typically a machine builder will provide good documentation for their machine, but many times will not spend time documenting how the machine is integrated into the rest of the process. This can cause major problems down the road – especially if the original people that worked on the machine installation are no longer with the OEM," adds Swarner.

AAA has close relationships with local manufacturers, and usually don't compete with machine builders in these cases. "We haven't seen machine builders crossing into the system integration territory in plants we service," he points out. "Typically, the machine is ordered with a standard controls package, and we make all changes and interfaces required to integrate it into the production process."

ETHERNET/IP PROTOCOL FAQS

By Jeff Payne,
Automation Controls
Product Manager, AutomationDirect

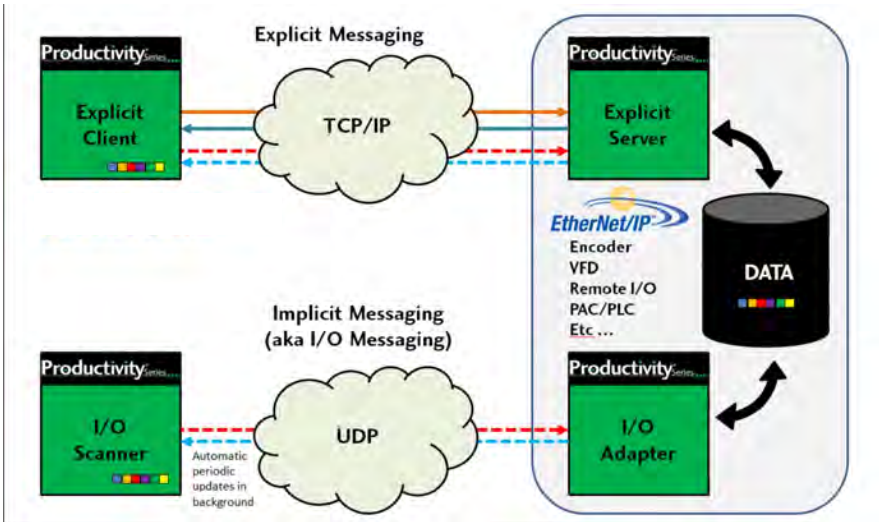

FIGURE 1

EtherNet/IP™ is a widely used industrial communications protocol governed by ODVA Inc. The EtherNet/IP protocol combines standard Ethernet technology with the media-independent Common Industrial Protocol (CIP) to create what is considered the world's number one industrial Ethernet network.

Here we review some of the features and answer several frequently asked questions about EtherNet/IP and its implementation in the Productivity Series P3-550 CPU.

Q: How do I know if my EtherNet/IP device will communicate with the P3-550 CPU?

A: The EtherNet/IP protocol implementation within the P3-550 CPU includes 4 major areas:

1) Explicit messaging Client,
2) Explicit messaging Server,
3) Implicit (I/O) messaging Scanner,
4) Implicit (I/O) messaging Adapter.

If your device supports any of these methods, they will communicate to the Productivity P3-550. (**Figure 1**)

Q: When is my P3-550 CPU used as an EtherNet/IP Scanner and when is it an EtherNet/IP Adapter?

A: There are a few terms that are used interchangeably within EtherNet/IP depending upon the method of communications used within the protocol. The table below identifies these terms based on the various areas. Consider whether your CPU is the data originator or the target, and whether you plan to use Explicit Messaging or Implicit Messaging. (**Figure 2**)

	EXPLICIT MESSAGING	IMPLICIT MESSAGING
Originator (Master)	Client	Scanner
Target (Slave)	Server	Adapter

FIGURE 2

Q: What is the difference between Implicit (or I/O) messaging and Explicit messaging?

A: Explicit messaging communicates using TCP/IP, which has greater overhead but is a more secure method of message delivery. Explicit messaging can be performed in two ways: Connected and Unconnected. This capability allows dynamic changes to the message request (the function, the type of data, the size of data, etc…) where Implicit does not. This should be considered for more non-time critical communications like configuration and setting parameters.

Implicit messaging communicates using UDP, which is a faster transport protocol, but there are no built-in verification methods. This is typically okay in applications where you are monitoring or updating a device status a few times a second, so if you miss one now and then you will usually never notice. Implicit messaging is performed as a "Connected" message only, so each end is pre-configured and knows implicitly what to expect without all of the additional packet baggage. To change the data being requested with the Implicit method requires a costly teardown of the connection and a re-connection. But once the Implicit messaging is up and running, it is faster because it sends data bi-directionally and has less overhead versus Explicit Messaging. >>

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Manual or electrically controlled, NITRA's directional control solenoid valve selection offers capacity and form factor flexibility to meet your system configuration needs.

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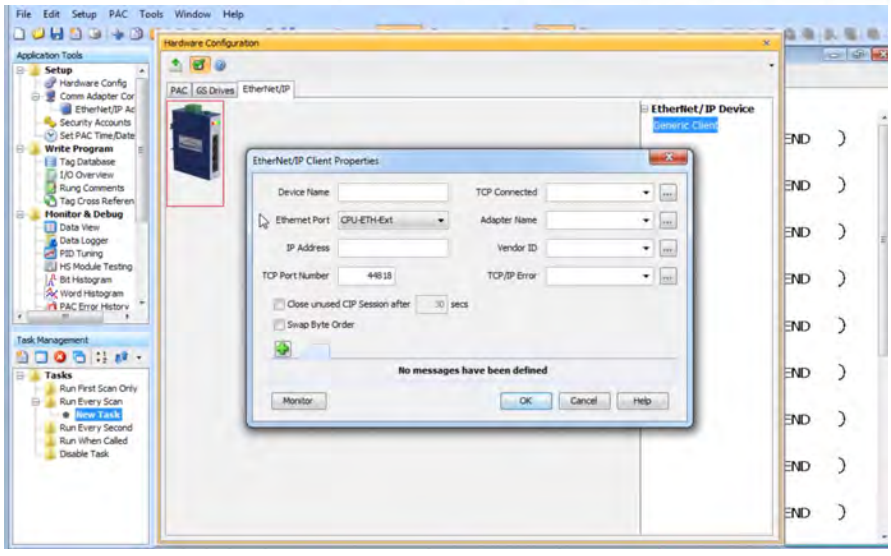

FIGURE 3

Q: How do I configure my CPU as an EtherNet/IP Scanner?

A: When setting up your Productivity P3-550 CPU as an implicit messaging scanner, you are configuring the system to automatically read data into a specified block of memory, very similar to a remote I/O configuration; like remote I/O, this setup is located in the Hardware Configuration. Simply click the EtherNet/IP tab and drag a generic EtherNet/IP client into your configuration. (**Figure 3**)

Q: What are the terms Service, Class, Instance and Attribute?

A: **Service**: What operations you can perform on the set of objects. (Get, Set, Reset, etc.)
Class: A template of like attributes. (i.e., a group of parameters)
Instance: A single object within the group or class. (i.e., parameter 31)
Attribute: A specific object detail; i.e. a specific parameter characteristic (Name, Value, Min, Max, etc.)

Q: Where can I find the Service ID, Class ID, Instance ID and Attribute ID for my EtherNet/IP Explicit Message Instruction?

A: Each EtherNet/IP device vendor must create an Object or Table of attributes that defines their device. The vendor's documentation will outline and define each required ID in their tables. (**Figure 4**)

FIGURE 4

Q: How many EtherNet/IP scanners and/or adapters can I have?

A: Each supporting Productivity Series CPU will accept a total of 4 EtherNet/IP Adapter or Server configurations and up to 32 Scanner or Client configurations.
- See the Productivity Suite help file topic: P259

Q: How many total EtherNet/IP connections can I have?

A: 128, which are comprised of your 32 devices with 4 connections each.
- See the Productivity Suite help file topic: P259

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AUTOMATION IMPROVES ALTERNATOR TEST SYSTEM

An auto parts rebuilder uses off-the-shelf automation components to test remanufactured alternators quickly and efficiently

By Bernie Galhoff
Senior electrical engineer, Motorcar Parts of America

Opening the hood of your car will reveal a mass of cables and hoses running around the engine block. Somewhere in there is an alternator, which helps keep your car supplied with electric power when it's running.

When an alternator goes bad, most mechanics will replace it with a used unit that has been remanufactured, and it might have come from our company, Motorcar Parts of America (MPA, www.motorcarparts.com) in Torrance, California. Given the number of units that have come through our shop and the expertise we've gained, many of our remanufactured alternators are better than the original as we have found ways to eliminate many design weaknesses over the years.

The practice of rebuilding engines and subassemblies has been going on for decades, and MPA is a major supplier of replacement starters, alternators, wheel hub assemblies, and bearings. Over the years, as engines have become more sophisticated, so has the remanufacturing and testing process.

Rebuilding an alternator from a current or recent model car is a complex process, one that demands thorough testing to ensure that performance requirements are met. Given the cost pressures always present in anything related to the automotive industry, companies that want to compete as rebuilders must be able to carry out the remanufacturing and test processes quickly and predictably. Mechanics and auto part store chains will quickly drop a supplier that causes customer dissatisfaction by supplying substandard components, so world class quality is a must.

There are thousands of alternator types in use given the variety and age of cars on the road. Even so, as part of our customer service, MPA promises 100% end-of-line testing of all remanufactured alternators. Handling a huge range of sizes, capacities, and case design form factors requires an automated testing procedure that can step through and record a series of tests faster and more positively than with manual operations, which is why we employ automated test systems.

Custom Built Test System

Since an automated alternator test system isn't an off-the-shelf item, MPA has had to design and build much of its own test equipment. At present, MPA has rebuilding and testing recipes for more than 3,000 alternator models. This includes parts catalogs, performance parameters, test protocols and other information. To implement these test recipes in an automated fashion, MPA recently installed a new alternator test bench, built in-house with the help of automation distributor and system integrator Quantum Automation (**www.quantumautomation.com**) in Anaheim, California.

Any company with a complex project like this one needs to choose the right vendors to supply the required hardware and software components. To assist in the selection process, we chose Quantum Automation as our partner because they employ a sophisticated sales support staff that we knew would point us in the right direction. Quantum's sales engineer Mike Kavanagh was particularly helpful throughout the project, starting with the design phase and assisting through startup and commissioning.

We live in a world driven by ever evolving technology and constant changes with new applications and solutions. It's therefore a must to consult with highly trained and trusted partners before beginning any automation project. Foresaking this step could result in sourcing the wrong hardware or software.

Design Considerations

Testing a given alternator requires mounting it in the test stand, generally using the same mounts that are used with the engine. This requires drop-in retainer inserts that mate with each specific alternator case design. Electrical connections have to be made to simulate a load (**Figure 1**),

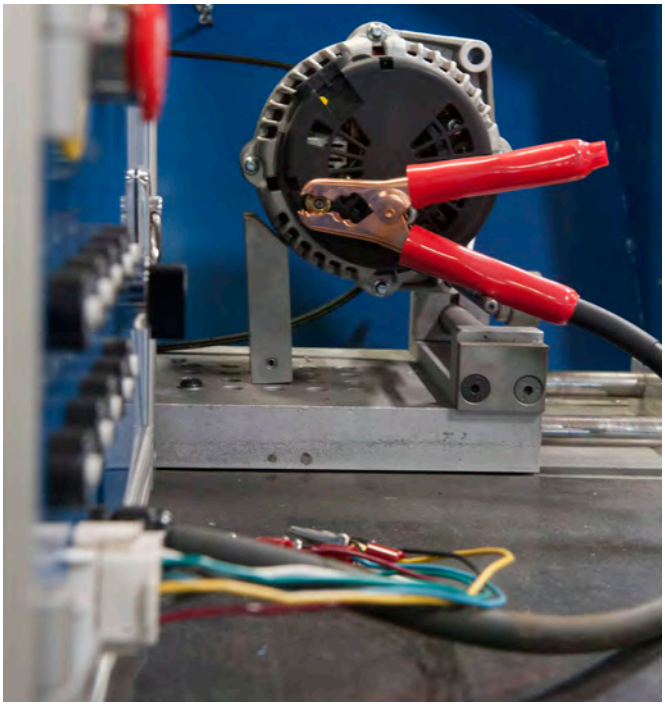

FIGURE 1. ELECTRICAL AND DATA CONNECTIONS ARE MADE BETWEEN THE TEST SYSTEM AND THE ALTERNATOR AFTER IT'S MOUNTED IN THE TEST STAND

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- GE SNPX
- Omron Host Link Adapter (C200/C500), FINS Serial and Ethernet
- Selected Mitsubishi FX Series, Q Series
- Siemens S7-200 PPI and S7-200/300 Ethernet (ISO over TCP/IP)

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along with data connections that communicate with the ECU (engine control unit).

The testing protocol includes spinning the alternator at specified RPM values and checking its output in volts and amps, both AC and DC. Running an alternator at full load requires the safe dissipation of high currents. A unit for a luxury SUV has to be able to power a huge number of accessories, so total output can easily be 200 A or more. The testing machine also has to talk to the unit, giving it digital instructions and receiving information using CAN bus, just as the ECU would in normal use in a vehicle.

Driven by a Stock Controller

A sophisticated controller is the heart of the test system, in this case an AutomationDirect (www.automationdirect.com) Productivity3000 Programmable Controller (**Figure 2**). Operators control and monitor the test system via a touchscreen PC running Web Studio Human Machine Interface (HMI) software from InduSoft (www.indusoft.com); the PC is connected to the controller via Ethernet (**Figure 3**).

All of the testing parameters have to be programmed into the controller, with some of the more commonly used programming routines standardized as function blocks for reuse from one program to another. An in-house designed printed circuit board communicates CAN-based data to the alternator that simulates what the engine would send in normal use.

FIGURE 3. THE TEST SYSTEM INCLUDES A TOUCHSCREEN PC RUNNING HMI SOFTWARE, WHICH ALLOWS OPERATORS TO SELECT RECIPES AND PERFORM OTHER INTERACTIONS WITH THE SYSTEM.

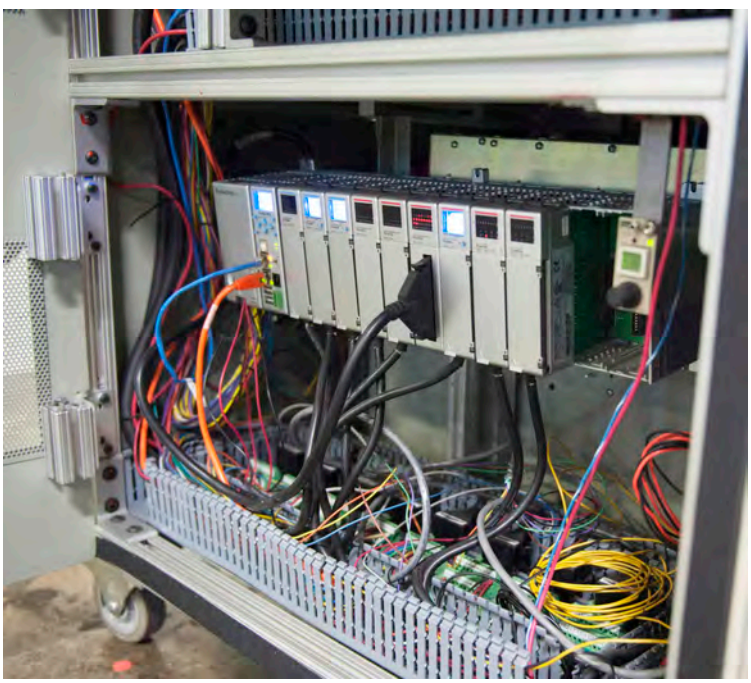

FIGURE 2. A PROGRAMMABLE CONTROLLER AUTOMATES THE TEST SYSTEM, MONITORS ITS OPERATION AND GATHERS TEST DATA. HIGH PROCESSING SPEEDS, SOPHISTICATED DATA HANDLING AND HIGH-LEVEL PROGRAMMING OPTIONS WERE A MUST TO MEET SYSTEM REQUIREMENTS.

The test system also has a main drive motor that spins the rotor. Given the variety of units that must be tested, the motor has to operate over a wide speed range to match what the alternator would see in normal use. An AutomationDirect GS drive is able to control the speed as needed, although making the right connection to the Ethernet port on the controller required conversion to the RS-485 serial communication required by the GS drive.

Designed for Easy Operation

In day-to-day use, an operator has a production lot of specific alternators to test. After inserting the correct mount to affix the alternator to the test stand, the operator calls up the parameters for the specific alternator from the 3000+ alternators in the database using the touchscreen HMI. The HMI provides the appropriate test screens for the specific alternator, and the operator interacts with the HMI as required during the test procedure (**Figure 4**).

FIGURE 4. THE TOUCHSCREEN HMI IS PROGRAMMED TO LEAD THE OPERATOR THROUGH THE TEST PROCEDURE BY FOLLOWING A SERIES OF LOGICAL STEPS.

The test system first performs its own self diagnostics before beginning the actual testing process. If a specific alternator fails, the test system is sophisticated enough to diagnose which component failed or if there is another defect. It can identify this by determining which step the process was at when the failure was spotted. The quality technicians can then trace down the root cause and see if it was a component failure or some other issue. Appropriate corrective actions can then be performed according to MPA's test procedures.

The testing program has to be fast and reliable. Once set up, testing technicians can completely test a unit in less than 90 seconds, performing about 1000 tests per day. These 1000 tests generate upwards of 250,000 total data points, and all of that information is uploaded to a larger database in the corporate server database.

Handling Large Amounts of Data

Given that the test system has about 100 I/O points and given the amount of data that has to be gathered in a short time, the controller and the HMI have to process the data quickly and efficiently. This is complicated further since the kind of data collected when testing an alternator is different than what is typical with most industrial automation systems.

So, we had to add numerous signal conditioners, solid-state relays, and other interfaces to convert the alternator test data into formats that the controller can handle. Communications between the controller and the HMI also have to be fast, which isn't a problem when using 100Mb Ethernet communications.

Designing, building, and programming a unit of this complexity was not an easy undertaking, but doing it using standard industrial hardware and software made for a relatively inexpensive project. In years past, the only practical approach was using proprietary hardware and software that was more costly, more difficult to program and harder to maintain. Earlier versions of a test system with this level of complexity would typically have cost two or three times what this one did, and would not have had the same capabilities. That's the value of using off-the-shelf components to build a custom system.

Based on our experience using the Productivity3000 controller and the Web Studio software, we are looking at other parts of our manufacturing and test processes where we can increase production or improve quality through a higher level of automation. The ability to design, build, and program production and test systems like this in-house, using primarily off-the-shelf industrial automation products, has given us a lower cost threshold and allowed us to consider applications that we would have considered too costly before.

PNEUMATIC CYLINDER DESIGN FACTORS

Properly sizing both the cylinder and related components prevents damage, improves performance, and cuts cost.

By Pat Phillips
Fluid Power & Mechanical Products
Product Manager, AutomationDirect

Pneumatic systems are widely used for many reasons. They're durable, clean, affordable, and fairly easy to install and maintain. They move loads in a variety of ways: pushing, pulling, lifting, lowering, and rotating. And they can handle widely varying payloads. While not ultra-precise in terms of positioning capabilities, they are accurate enough for countless applications.

However, the relative simplicity of pneumatic systems can be deceptive when it comes to selecting components. There are thousands of types, sizes, and variations of cylinders and valves, from off-the-shelf versions to custom designs. The sheer number of choices can be overwhelming, especially when options such as sensors are added to the mix.

Taking the time to choose the right components for a job helps ensure good performance, lower expenses, improve cycle rates, and prolong equipment life. This article examines the parameters – load, force factor, speed, and sequencing, as well as the impact of other components – that engineers should take into account when selecting a cylinder for a pneumatic system.

Cylinder types

Although there are many types of cylinders, their construction is fairly similar. Basically, a cylinder is a sealed tube. It contains a rod, attached to a piston, which extends through an opening at one end. Compressed air enters through a port at one end of the cylinder, causing the piston rod to move. At the other end, a second port lets air escape. Understanding the basics helps to show how different applications affect the cylinder and piston rod.

The first step in choosing a cylinder is deciding whether to use a single- or double-acting style. As the name implies, single-acting cylinders use compressed air to move the load in one direction, such as lifting an object. With single-acting cylinders, air is supplied to only one side of the piston, while the other side vents the air to the environment. A spring (or, in some cases, gravity) returns the piston to its original position once air pressure is removed.

A double-acting cylinder uses compressed air to power the rod in both directions and move a load, such as opening and closing a gate. This type of cylinder uses more energy, but it's well suited for loads that require both pushing and pulling.

However, force calculations can get complicated. In single-acting cylinders with a spring, the spring force opposing the push or pull increases as the stroke progresses. And in double-acting cylinders, push and pull forces are not equal, as designers must account for the rod area in making force calculations. Manufacturers' catalogs often list push and pull values for both double-acting and single-acting cylinders, with and without springs, simplifying calculations for users. >>

>>

FIGURE 1: TO AVOID EXCESSIVELY HIGH SYSTEM PRESSURE, EXPERTS GENERALLY RECOMMEND LARGE CYLINDERS FOR HEAVY OR FAST-MOVING LOADS

Load and speed

The load is the primary consideration when determining cylinder type and piston size. (**Figure 1**)The piston area (force factor) multiplied by the air pressure in the cylinder gives the available force.

A general rule is to select a force factor that will produce a force 25% greater than the load to help compensate for friction and losses. Pneumatic systems are quite forgiving in terms of oversizing, but using components that are too big adds unnecessary expense in terms of both purchase price and energy consumption.

The bore size (force factor) determines force at a given pressure. The operating pressure, which in a plant can typically range from 10 to 150 psi, is the first consideration when selecting a bore size.

Another important consideration is the amount of force that the application requires. Suppliers often provide charts to assist with calculating bore size. If the bore diameter is between sizes, fluid-power experts recommend rounding up to the next size.

It's also important to remember the bore diameter squares the thrust delivered. For example, a two-inch diameter cylinder has four times the power of a one-inch diameter unit. Therefore, doubling the bore quadruples the thrust.

In addition to load, designers must also take into account the speed at which the load will move. When compressed air flows through a system, there are pressure losses due to friction against the tube wall, flow around bends, and restrictions in valves and fittings (to name a few issues). Higher speeds result in greater pressure loss as the air must flow faster through the valves, tubing, and ports. Attaining higher speeds also requires that the cylinder deliver more force in a shorter amount of time. A force that exceeds the load by 50% or more may be required to reliably move a load at high speeds.

For example, a typical air compressor might supply air to a system at 100 psi. In an application with a slow-moving load, the actual pressure available at the piston might be reduced to no less than 90 psi. With that same load moving at a much faster rate, the available pressure could drop as low as 70 psi.

Pressure losses can be remedied by increasing pressure, but this must be done with caution. Too much pressure creates stress on the cylinder and could possibly damage the cylinder, as well as the load. In these instances, it's better to choose a larger cylinder. (Figure 1.) Also keep in mind that raising system pressure means the compressor must work harder, increasing energy consumption of the overall pneumatic system.

Heavy Loads

With heavy loads, the size of the piston rod is as important as the cylinder size and air pressure. A common problem is overloading the rod, which often happens when pairing a heavy load with a long cylinder rod. During horizontal motion the load will hang off the end of the rod, which may cause the rod to bend when fully extended. When lifting a heavy vertical load, the piston rod may even buckle if it's too small.

Cylinders are designed primarily to push or pull a load, so supporting heavy side loads requires extra planning. Keeping the cylinder thrust as close as possible to the centerline of the piston rod should be factored into the design.

Another consideration is the rod length. Strokes of about 24 inches and longer can compromise a long, skinny rod. In this case, the best solution is to choose a bigger cylinder. Some manufacturers also offer cylinders with oversized piston rods, which can be more economical in some cases.

Also consider cylinders with guide rods in difficult loading situations. With blocks and rods mounted parallel to the piston rod, guided cylinders prevent the piston from rotating and increase load-carrying capacity, thanks to the added support of the guide rods and additional bearings. This is important when a system is subjected to large side loads or requires highly accurate controlled linear motion. (**Figure 2**.)

Finally, rodless cylinders in which the load sits on an external carriage that slides along the tube can also be used for applications with long strokes, heavy loads, or high moment loads. These cylinders come in a number of different configurations and their compact size makes them a good fit in tight spaces.

Getting the valves right

Valves control the switching and routing of air in a pneumatic system. Aside from controlling the flow of compressed air, valves also direct the flow of the

FIGURE 2: GUIDED CYLINDERS PREVENT DAMAGE WHEN DEALING WITH HEAVY SIDE LOADS, AND THEY ALSO PROVIDE MORE PRECISION.

exhausted air. Many types of valves are used in pneumatic systems, with the specific application dictating the best choice.

One common mistake in designing a pneumatic system is to properly specify the cylinder but undersize the valve. Properly matching the valve and cylinder is imperative, since the cylinder won't move as intended if the valve is too small. With higher speeds, airflow must be increased to move the load quicker, and that often means a valve with higher flow capacity.

Most valves come with a flow coefficient (Cv) rating. In essence, the bigger the Cv, the more air flows through the valve. The valve rating should typically be selected for a 5-psi pressure drop at the required flow rate to drive the cylinder at the desired speed.

Flow-control valves work well at controlling cylinder speed. These can either be adjustable restrictors on the control-valve exhaust ports or special valves mounted on or near the cylinder. Cylinder-mounted flow controls have a one-way bypass built in to allow free flow in one direction and restricted flow in the other. For the best results, install these valves to give free flow into the cylinder and restricted flow out.

Improving cycle time

Position switches and sensors can improve overall pneumatic performance. In a system with multiple pneumatic actuators operating in sequence, position sensors that indicate the piston location in each cylinder will promote shorter, more-reliable cycle rates.

Simple switches such as reed, Hall-effect, and magneto-resistive switches are all commonly used as position sensors on pneumatic actuators. Regardless of the type, they all detect the piston position as the cylinder approaches the end of the stroke.

Without sensors, unnecessary stops (time cushions) must be built into the timing of the system. This is the result of air-supply variations and other factors. In a plant, airflow might be slightly less during the afternoon as compared to the morning. This means in the afternoon it might take a fraction of a second longer to complete the stroke, which could disrupt the timing of other steps in an operational sequence. To adjust for these and other variations, low-cost sensors should be included in the design. Adding such sensors will result in shorter cycle times, smoother operation, and higher operating efficiency.

Pneumatic systems remain popular due to their low entry and maintenance costs. While they're relatively simple, weight, force, speed, and other requirements must be considered at the design level to ensure proper operation. Given the many different types of cylinders, valves, and sensors, taking the time to determine the right components in a pneumatic system – and how they interact – will result in better performance in both the short and long term.

Considerations for effective cylinder performance

Account for each of these factors when designing pneumatic cylinders into machines, robots, and any other piece of equipment:

Load – A force at least 25% greater than the load is typically necessary to make up for system pressure losses.

Force factor – The force factor is simply the area of the cylinder piston. Force factor times air pressure equals the force produced by the cylinder.

Speed – Higher speeds require a greater force margin to overcome increased system pressure losses.

Sequencing – Adding sensors can shorten cycle times by eliminating time delays.

Other components – Available pressure at the cylinder can be affected by system compressor, filters, regulators, control valves, and all connecting piping. Right-sizing these components helps ensure the best performance from a cylinder. ■

TECHNICAL COLLEGE STUDENTS UNDERSTAND PROTECTIVE RELAYS

By Tony Kuphaldt
Bellingham Technical College

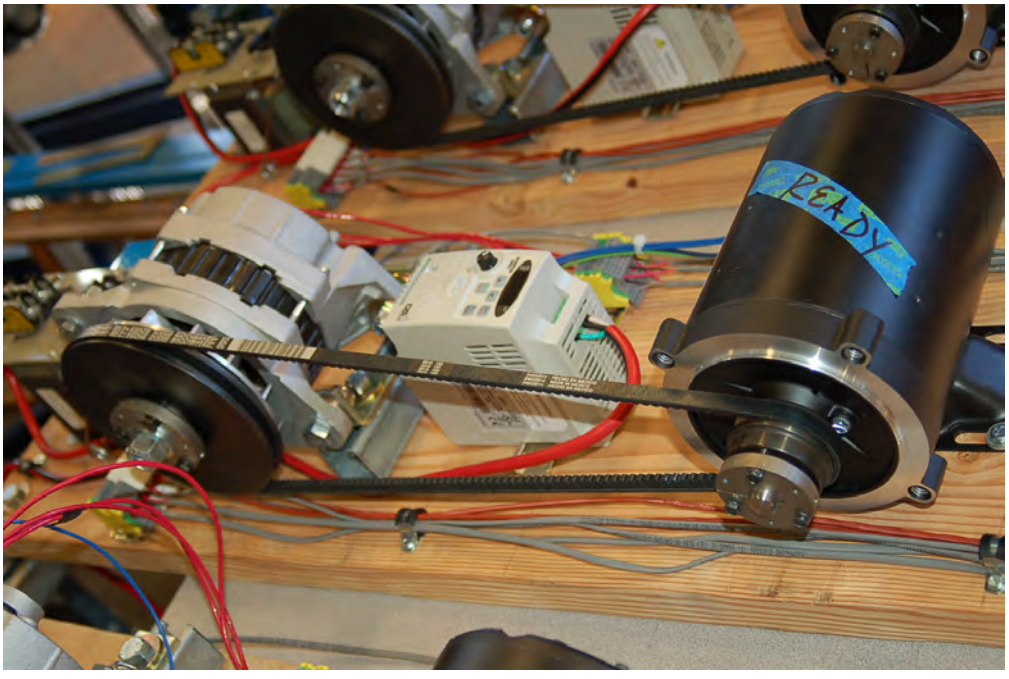

FIGURE 1: 3 PHASE GENERATOR DRIVEN BY VFD AND AC MOTOR

Protective relays are specialized devices designed to sense abnormal conditions in electric power systems, commanding circuit breakers to trip or close when needed. These relays are absolutely essential to the reliable operation of the electric power generating stations, substations, transmission lines, and distribution systems that comprise any large-scale electric power grid; they are increasingly finding application in process industries for the protection of plant-scale electrical power systems and large electric motors.

Despite the widespread application and importance of protective relays, however, technician-level education for protective relays is scarce in the United States. Most relay technicians receive their education either through military programs such as the U.S. Army's "Prime Power", the U.S. Navy's "Muse", or through apprenticeship programs offered by electrical utilities. Only a handful of public colleges offer any protective relay coursework at the technician (2-year) education level; and Bellingham Technical College (BTC) recently became one of them.

Part of Washington state's Community and Technical College system, Bellingham Technical College is a two-year professional/technical college. Among the various Associate degree program options offered by BTC is Instrumentation and Control Technology. The curriculum for this program is dynamic, changing to reflect the ever-evolving needs of industry.

In recent years, industry advisors for BTC's Instrumentation program began recommending more exposure to three-phase electrical power systems in the curriculum. Motor controls and variable frequency drives (VFDs) were the first curricular additions addressing this request, and AutomationDirect products figure prominently in BTC's lab facilities as a result. Thanks to encouragement and support from protective relay technicians at Snohomish PUD, a large public utility in Washington state, protective relays were the next addition to the Instrumentation program designed to enhance students' understanding of three-phase power systems.

Snohomish PUD generously donated a number of General Electric and Schweitzer Engineering Labs brand protective relays necessary for BTC's Instrumentation lab, but in order to teach this subject in any realistic capacity those protective relays must have something to protect. In other words, the Instrumentation lab needed its own three-phase power system built on a small enough scale that students could safely operate and test it.

Design work on this project began in early 2014, led by Tony Kuphaldt, an instructor of Instrumentation. The system consists of Delco-Remy alternators (normally used in heavy equipment and big-rig trucks) modified to output three-phase AC power, driven by Marathon AC motors and GS1 series AC drives supplied by AutomationDirect. (**Figure1**)

Each generator has a maximum output power of about 200 watts, and simulates the operation of a generating station on a real three-phase power grid driven by some prime mover, such as a diesel engine or turbine. Six of these generating stations were built by students, and then linked together through circuit breakers to a common set of power conductors to form a grid. Students operating the generators must manually adjust the speed of each generator to synchronize it with this grid, and then manually close the generator's circuit breaker to place it online.

FIGURE 2: FRONT PANEL AT GENERATOR STATION WITH PROTECTIVE RELAY INTERFACE

A Schweitzer model 551 overcurrent protective relay (**Figure 2**) installed at each station monitors generator current and trips the circuit breaker if that current becomes excessive.

Additionally, each generating station is equipped with an AutomationDirect Do-more PLC (**Figure 3**) connected via Ethernet to a C-more HMI (**Figure 4**) to form a SCADA system for this miniature power grid. From the central HMI students monitor generator and circuit breaker statuses, adjust generator (VFD) speed, and record breaker tripping times in milliseconds.

The main factor in choosing AutomationDirect products for this project was price: no other manufacturer of PLC or HMI hardware even comes close to AutomationDirect in terms of cost, and there is no ongoing licensing fee for the AutomationDirect PLC or HMI configuration software.

The ease of digital communication using the Do-more PLC was also a factor in its selection. Not only can the PLC processor be programmed via USB cable, but its Ethernet capability makes the SCADA network easy and fast to set up. Also, its serial Modbus RTU interface allows students to communicate directly to the Schweitzer protective relays. With only a few rungs of ladder logic code, students were able to read integer registers from the relays as well as write bits to them.

FIGURE 4: C-MORE HMI PANEL

In future iterations of this project, each generator PLC will read live phase current data from its protective relay and send that information to a central SCADA PLC which will make load-balancing decisions, sending speed change commands to each generator to ensure the load is equally distributed.

FIGURE 3: DO-MORE PLC AND CONTROL PANEL

During the summer of 2014, a dedicated Protective Relays course (INST 233) was offered for the first time at BTC as an elective. Students programmed each generating station's PLC and corresponding HMI screen in the PLC/HMI courses preceding the protective relays course, and then during the protective relays course the students worked on the commissioning, configuration, and testing of the relays themselves.

BTC's plan for next year is to expand this miniature power grid to include substations linking the six generating stations to low-power loads simulating customers on the power grid. Once again, each substation will have its own PLC to integrate it with the grid's SCADA system, allowing students to monitor and control the operation of the grid from a central location.

If you would like to watch videos of this project's construction and testing, visit the BTC Instrumentation YouTube channel. Simply search the video archive at **www.youtube.com/BTCInstrumentation** for "Miniature three-phase AC power grid". You'll find a number of videos there showing different stages of project completion, as well as important principles related to three-phase AC generators and protective relays.

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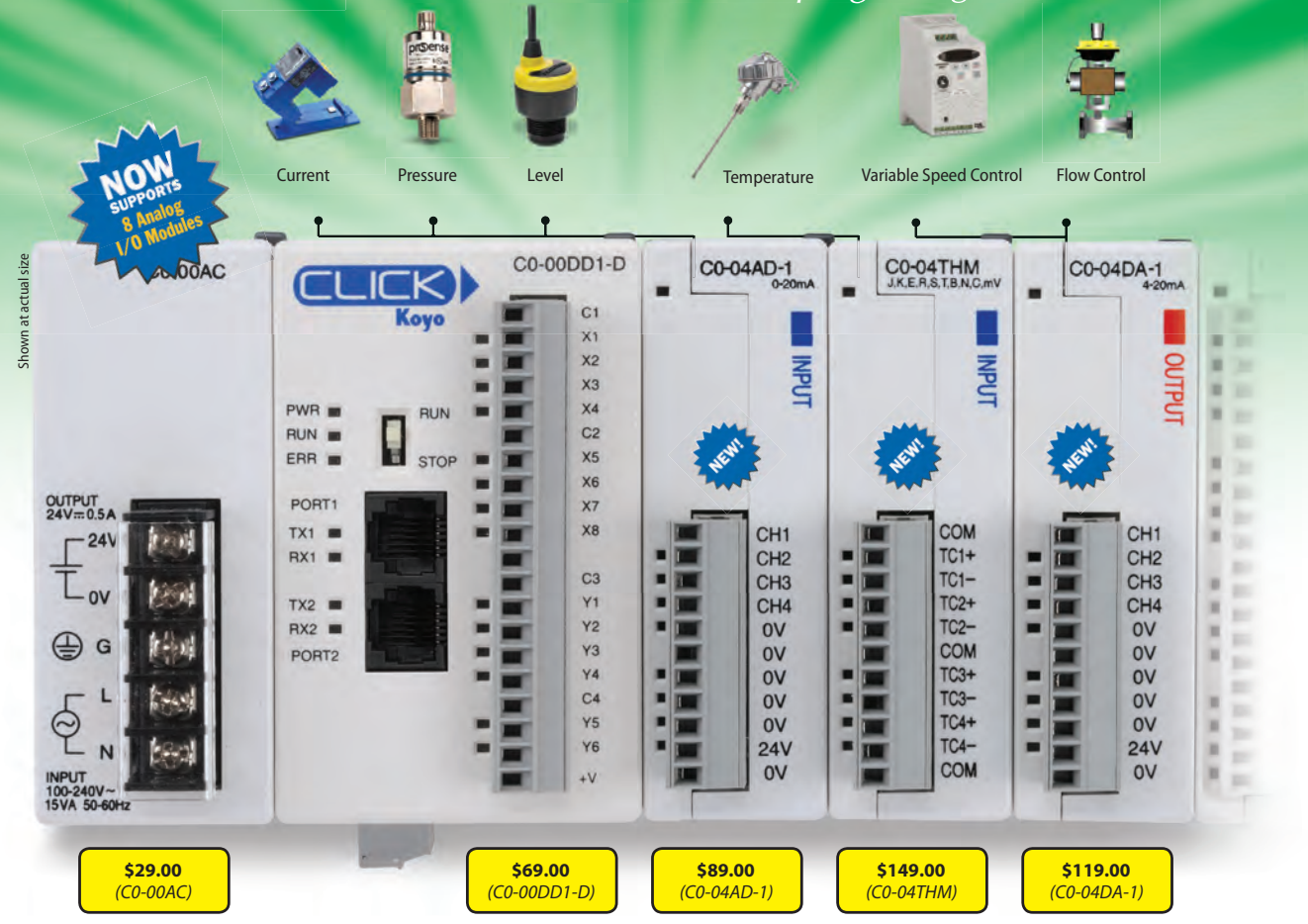

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Brainteasers

1.) Fitting Splitting

Two engineers went to the AutomationDirect Web store and bought 30 NITRA pneumatic quick-disconnect fittings (some with chrome-plating, some without). As they discussed divvying up the cost, Fred pointed out that his portion of the order contained half of the chrome-plated fittings, but only one third of the plain fittings. He also declared (correctly) that his portion of the order totaled $27.

Four chrome-plated fittings cost the same as five plain fittings. ***How much was Wilma's portion of the order?***

AutomationDirect sells pneumatic fittings at some of the lowest prices anywhere. We maintain excellent stock levels and have convenient package quantities for large or small orders. And take a hint from Fred and Wilma: they spent more than $49 and thus qualified for our FREE two-day shipping!

2.) ZipPort Assort Report

An eccentric customer called our Sales department recently and said "I have exactly $200 to spend on ZipPort Multi-wire Connector accessories. I need some Cable Glands ($1 each), ten times that many Couplers ($2 each), and fill the balance of the order with Threaded Adapters ($5 each)". Our sales staff took his order with no further information about the quantities required. ***How many of each product did we ship?***

ZipPort heavy-duty multi-wire connectors are used wherever there is a need for secure, simple and time-saving connections within machinery and facilities. The connector housings are made of die-cast aluminum for all sizes (with metal or thermoplastic size 3A housings) and offer excellent protection against dirt, moisture and mechanical stress. Multi-wire connector inserts make it possible to easily connect signal, power, and data connections. **http://www.automationdirect.com/multi-wire-connectors**

3.) In a (lock) Box With a Fox

We installed one of those "wall-mount combination lock boxes" at our community center recently. It holds the key to the storage shed, and allows anyone who knows the code to remove the key from the lock box and open the shed. But it started a water cooler discussion amongst the engineers at the office as we debated the potential number of combinations. At first glance, it seems simple, there are 10 buttons (0-9) and the manufacturer recommends a four digit code (user-selectable), so the number of possibilities would be 10,000, right? Not so fast … in this case, there are two extra rules: Due to the mechanical nature of the lock, you can only use a given number once in your user-selected code AND this is the real kicker: order is unimportant. So code 1234 is the same code as 4321 or 4231.

So, what is the total number of distinct 4-digit combinations possible for this lock?

4.) Extra Credit:

It turns out that the lockbox will accept codes of any length (although some lengths would seem foolish). ***What is the number if you consider all of the other length combinations (i.e. 3-digit, 5-digit, 6 digit, etc.)?***

The first two puzzles are credited to Sam Loyd (1841 – 1911). Apparently, he was quite the character: **http://en.wikipedia.org/wiki/Sam_Loyd**

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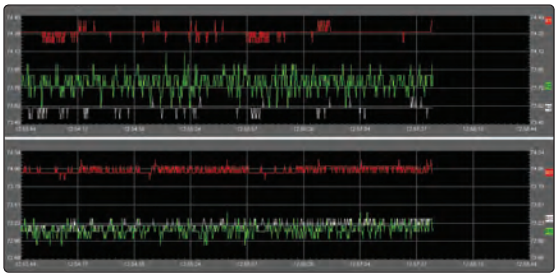
- *PID View window allows precise tuning of your PID loops*
- *Data View window monitors your chosen program elements - discrete or analog I/O, and system parameters*
- *View Trend Data in its own view as well as within specific ladder instructions like PID, RAMPSOAK, and High/Low Alarm*



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