Automation NOTEBOOK®

Your guide to practical products, technologies and applications

ARDUINO VERSUS BRX PLC IN INDUSTRIAL AUTOMATION APPLICATIONS

PG. 18

EFFICIENT PLC PROGRAMMING DRIVEN BY PROGRAMMING SOFTWARE

PG. 26

www.AutomationNOTEBOOK.com Fall 2017 | Issue 38

COPLEY HIGH SCHOOL'S AUTOMATION SUCCESS

PG. 32

Don't break the bank...

...use CLICK PLCs and save.

Now with ETHERNET starting at $129

CLICK Micro PLC unit - approximately 2"(W) x 3"(H) x 3"(D)

Customer Feedback:

"This little PLC is superb!!!
Now with Ethernet and online programming it is almost unstoppable...I have 14 running and will be adding more. In Love with this thing!"
Paul in OCONOMOWOC, WI

"Have used this model Click in many small applications, and it has worked, reliably, for many years. We even talked some customers out of using "programmable relays" for they are not as versatile or as cost effective as this PLC."
Todd in ONTARIO, CA

See more reviews under the Reviews tab on the CLICK PLC units' product page at www.automationdirect.com

CLICK - The almost free PLC

The CLICK micro-brick PLC is undoubtedly the best PLC value in the industry. With basic models starting at just $69.00 and FREE programming software, CLICK is by far the most practical PLC for the smallest of applications.

- Basic PLC units with 14 discrete I/O points and 2 serial ports ***starting at $69***
- Standard PLC units with 14 discrete I/O points, 3 serial ports and a real time calendar/clock - ***starting at $99***
- Analog PLC units with 8 discrete I/O points, 4 analog I/O channels and 3 serial ports - ***starting at $129***
- Basic Ethernet PLC units with 14 discrete I/O points, 1 Ethernet port and 1 serial port - ***starting at $129***
- Standard Ethernet PLC units with 14 discrete I/O points, 1 Ethernet port and 2 serial ports - ***starting at $149***
- CLICK PLC units can also be expanded up to 142 discrete or 52 analog I/O total
- All CLICK PLCs use our FREE programming software with a simple but practical instruction set

Get more than you paid for . . .
www.CLICKplcs.com

money-back 30 day guarantee
FREE Technical Support
FREE software and manuals
2 YEAR WARRANTY

READERS' CHOICE AWARDS 2017 control design

Order Today, Ships Today!

VOTED Best in SERVICE 15 YEARS

AUTOMATIONDIRECT.com
1-800-633-0405 the #1 value in automation

Automation NOTEBOOK

Your guide to practical products, technologies and applications

Contributors

Publisher Tina Gable

Managing Editor Joan Welty

Coordinating Editor Tina Gable

Design Manager Justin Stegall

Contributing Writers

Bill Dehner
Hiba El Rassi
Doug Reneker
Dennis Sloatman

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
9:00 a.m. to 6:00 p.m. EST

www.automationdirect.com

If you are a non-subscriber and would like to be included in the next mailing of AutomationNotebook, please visit: **http://library.automationdirect.com/information-should-be-free/** and complete the details. You can also request FREE stuff, including our 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 interest, and we look forward to hearing from you.

Editor's Note

The robots are coming! The robots are coming! Well actually…they're already here. Technology is always on the move and advances in robotics have made them an integral part of today's world. From automated manufacturing, to self-driving cars, to vacuum cleaners, robots have infiltrated and will continue to infiltrate our everyday lives. The good news is that Skynet is still years away from their first prototype (that was for all of our Terminator fans :). Although some have tried to label robots and automation as the newest boogeymen on the block, as they are often the primary scapegoat for high unemployment numbers, automation is nothing to fear. With many schools focusing on STEM curriculums, the future of automation holds a lot of exciting opportunities and career possibilities. Just think, 15 years ago being a Mobile App Developer was unheard of. But just as with smartphone technology, when any technology advances so does the need for designers, engineers, builders, and maintainers. Even though no one can be certain what the future holds, except Sarah Connor (sorry, I'll stop :), here at AutomationDirect we are keeping a close eye on what may be waiting just around the corner.

This issue of NOTEBOOK is loaded with interesting articles including our Cover Story which details a real-world comparison of our BRX PLC to the Arduino microcontroller in an industrial application. The Tech Brief article explores some of the great features and recent additions to our FREE Do-more Designer Software package while the Feature Story explores how device centric programming and top-down configurations can greatly improve programming efficiency. The User Solution highlights how PLCs are becoming a popular control solution in radio broadcasting and our Business Notes focuses on fostering STEM education in our local schools. You'll also find information on our newest products, such as new unmanaged and managed Ethernet switches, power supplies, micro HMIs, pressure sensors, pneumatic total air prep (TAP) modules, and lots more. Don't forget to test your knowledge in the issue's Break Room. Try your best at completing the fun puzzles and compare your answers at **www.automationnotebook.com**

editor@automationdirect.com

Table of Contents

NEW HIGH-VALUE BRX PROGRAMMABLE LOGIC CONTROLLER

New BRX PLC platform has been added to the Do-more line of programmable logic controllers. Starting at $199, the compact BRX PLCs offer outstanding features including built-in data logging, motion control, serial and Ethernet communication, an interchangeable (hot-swappable) communications port and integrated high-speed I/O. Support for EtherNet/IP, Modbus RTU and TCP, ASCII and custom protocols is also included. Designed as standalone controllers with expansion capabilities, these micro PLC units are available in four distinct form factors: M series (no onboard I/O), 10-point series, 18-point series and 36-point series.

The BRX M Series, starting at $287, is a simple (no built-in I/O) controller that can be used for a variety of purposes including machine data logging. Ethernet communication is included in the M Series which can be expanded with user-selected I/O modules if needed. The BRX 10-point series, starting at $199, includes all of the standard features with the addition of 10 onboard discrete I/O points. The 18-point series, starting at $249, contains 18 total onboard discrete I/O and the 36-point starts at $299 with 36 built-in discrete I/O points. BRX controllers with onboard I/O are offered with AC, DC, and relay configurations, as well as with software-selectable analog I/O and Ethernet options. High-speed I/O is also built in to every BRX PLC unit with onboard DC I/O.

All BRX PLC units have an additional slot for a hot-swappable Pluggable Option Module (POM). These POM modules, starting at $27, are available in USB, Ethernet, RJ12 RS-232, 3-pin RS-485 and 3-pin RS-232 versions and allow for on-demand networking changes as communication needs change.

The BRX platform requires no base or backplane and the PLC units can be expanded with up to 8 additional I/O modules (depending on model). Multiple discrete and analog/temperature I/O expansion modules are available, allowing the BRX system to expand up to 164 discrete or 70 analog I/O points total. The stackable design of the BRX platform allows users to purchase only the I/O required for their particular application.

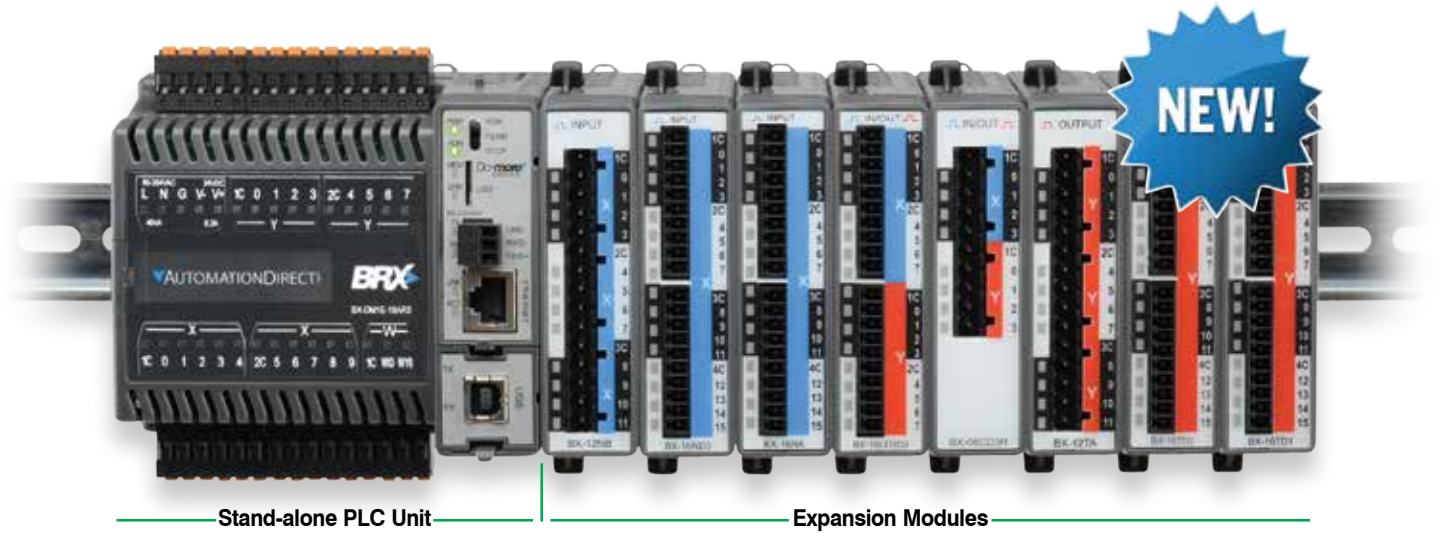
Programming the new BRX PLC is easier than ever with the updated free Do-more Designer programming software. Enhanced with many new features including a convenient dashboard for easy navigation, integrated video help and improved email capabilities, Do-more Designer is the highly advanced yet easy to use programming software for all Do-more family PLCs. Field-friendly tools like the PLC simulator, Trend View and PID View are also available in the software to help keep processes online and systems running smoothly.

Starter kits, priced at $425 for the serial communications version and $489 for Ethernet, are available for the new BRX PLC platform and include everything needed to get started. Every BRX PLC unit or starter kit purchased also comes with a certificate for 30 days of free online training.

BRX PLC hardware is engineered, manufactured and supported in the U.S. by industrial automation veterans. With hardware design and fabrication facilities located in Tennessee and Florida, the BRX PLC platform delivers high quality at a very attractive price.

To learn more about the new BRX PLC platform or to download the free Do-more Designer software, please visit:
www.BRXPLC.com

BRX The 1st micro PLC with a can-do attitude



The new BRX Micro PLCs are determined to get it done!

The new BRX PLC family incorporates many high-level features in a small, solid package - allowing it to stand strong no matter the challenge. Loaded with options and using the very popular Do-more! DM1 technology as its engine, this micro controller packs a big punch for a little price!

READERS' CHOICE AWARDS 2017 control design

Starting at
$199.00
(BX-DM1-10AR-D)
with 10 built-in discrete I/O

The BRX PLC family offers:

- Advanced motion control
- Robust data logging
- Onboard serial and Ethernet ports
- Discrete, high-speed and analog I/O
- Expansion capabilities
- Interchangeable communications port
- Free programming software (with simulator)
- Integrated video help
- Free technical support
- Much, much more...

CPU and I/O Comparison	AutomationDirect BRX PLC	vs. Allen-Bradley Micro 800	vs. Siemens S7-1200	vs. IDEC FC6A
PLC Unit (with Ethernet)	$473.00 BX-DM1E-36ED13-D	$642.00 2080-LC50-48QVB	$814.00 6ES7 214-1AG31-0XB0	$550.00 FC6A-C40K1CE
(28) 24VDC Inputs	$38.00 BX-08ND3 (8-pt DC IN module + 20 DC IN on PLC unit)	Built-in (28 DC IN on PLC unit)	$443.00 6ES7 221-1BH30-0XB0 (16-pt DC IN module + 14 DC IN on PLC unit)	$95.00 FC6A-N08B1 (8-pt DC IN module + 20 DC IN on PLC unit)
(20) 24VDC Outputs	$45.00 BX-08TD1 (8-pt DC OUT module + 16 DC OUT on PLC unit)	Built-in (20 DC OUT on PLC unit)	$443.00 6ES7 222-1BH30-0XB0 (16-pt DC OUT module + 10 DC OUT on PLC unit)	$140.00 FC6A-T08K1 (8-pt DC OUT module + 16 DC OUT on PLC unit)
(4) Analog Inputs	Built-in (4 Analog IN on PLC unit)	$149.00 2080-IF4	$330.00 6ES7 234-4HE30-0XB0 (4IN/2OUT Analog combination module)	$359.00 FC6A-L06A1 (4IN/2OUT Analog combination module)
(2) Analog Outputs	Built-in (2 Analog OUT on PLC unit)	$89.00 2080-OF2		
Total System Price	$556.00	$880.00	$2,030.00	$1,144.00

All prices are U.S. published prices. AutomationDirect prices as of 7/15/2017. Allen-Bradley, Siemens and IDEC prices taken from www.rapidself.com 7/15/2017.

BRX PLC Designed, Manufactured, Supported in the USA

2 YEAR WARRANTY

30-day Money-Back Guarantee 30 day

FREE Technical Support Located in USA

Do-more! DRIVEN

www.BRXPLC.com

Order Today, Ships Today!

VOTED Best in SERVICE 15 YEARS

AUTOMATIONDIRECT.com
1-800-633-0405 the #1 value in automation

RECENTLY ADDED PRODUCTS

WIDESCREEN TOUCH PANELS ADDED TO THE C-MORE HMI LINE

AutomationDirect's C-more EA9 series of touch screen HMIs now includes 7-inch widescreen TFT models. These WVGA panels fit the same enclosure cutout as the EA9-T6CL panels and are direct replacements with larger screen area (800 x 480 pixels). The C-more 7-inch widescreen touch panels, starting at $465.00, are equipped with 800 MHz CPUs, 64k colors, and reliable 50,000-hour non-replaceable backlights. Hardware options include three serial ports plus one 10/100BaseT Ethernet port on the full-featured EA9-T7CL model, one serial port plus one 10/100BaseT Ethernet port on the basic EA9-T7CL-R model, two USB 2.0 ports (one type A, and one type B), and one slot for SD memory card. An audio output port, when attached to an amplifier and speaker(s), can play warning sounds or pre-recorded messages (full-featured model only). All touch panels are 12-24 VDC powered; an optional attachable AC power adapter is available to power the panels from a 100-240 VAC 50/60 Hz voltage source.

All models are NEMA 4/4X and IP65 rated (when installed properly; for indoor use only) and are programmed using the EA9-PGMSW programming software, priced at $99. For more information, visit:
www.automationdirect.com/C-more

MORE LOW-COST RHINO POWER SUPPLIES

AutomationDirect's RHINO PSL series DC power supplies are plastic low-profile switching supplies available with 5, 12 and 24 VDC adjustable outputs. Designed to fit in shallow-depth enclosures, these power supplies have power ratings from 7.5W to

91W for use with many DC powered devices including PLCs, HMIs, Ethernet switches and more. Additional features include universal 90 to 264 VAC input voltage, integral DIN rail mounting adapter, DC-OK LED indication, and output current limitation. Screw terminals are provided for simple and quick wiring terminations.

Starting at $25.00, the RHINO PSL series is UL508 listed for demanding industrial applications and most models are UL60950-1 recognized for NEC Class 2 compliance in industrial, commercial and residential applications. To learn more, visit:
www.automationdirect.com/dc-power-supplies

STRIDE SE2 SERIES UNMANAGED AND MANAGED ETHERNET SWITCHES

Stride SE2 series unmanaged and managed Ethernet switches provide reliable connectivity in applications too tough for commercial grade switches including ones with drastic temperature changes, electrical interference, and corrosive environments. The new SE2 series unmanaged switches offer up to 16 ports and include models with Gigabit Ethernet and SFP options; select models are IP65 rated to withstand wash down environments. These unmanaged Ethernet switches feature a "plug and play" design with no user setup required and immediately start operating once powered up and connected to

the network. Starting at $75.00, SE2 series unmanaged switches have a wide operating temperature range and are available with a 12-48 VDC or 18-30 VAC redundant power input, reverse polarity protection, and IP30 metal cases.

The new Stride SE2 managed switches allow networks to be configured to assure the highest performance and security levels. These switches provide Modbus TCP and EtherNet/IP management capability. SE2 Series managed Ethernet switches include 8-port (2 versions with fiber optic ports) and 16-port fast Ethernet switches; and an 18-port Gigabit switch. The 8-port switch and 18-port Gigabit switch models have SFP fiber optic ports for additional fiber connectivity at fast Ethernet or Gigabit Ethernet speed. Starting at $429.00, SE2 series managed switches have a 5-year warranty, are UL/cUL 508 and CE approved, and meet UL hazardous locations (Class I Div. 2) standards. For more information, visit:
www.automationdirect.com/ethernet

C-MORE MICRO HMI TOUCH PANELS WITH BUILT-IN ETHERNET

The new 3 and 4-inch C-more Micro touch panels display text, graphics, and bitmaps to effectively communicate critical HMI data to the operator. Now with Ethernet functionality built-in, these panels can easily inte-

grate into today's industrial networks.

Priced at $198.00, The EA3-S3ML C-more 3" Micro touch panel has a 3.1-inch STN LCD monochrome display and twelve selectable LED-driven backlight colors. It features a 128 x 64 pixel display, and five user-defined function keys with red LED indicators. The panel can display up to 10 lines by 32 characters of static text and up to 10 lines by 21 characters of dynamic text with embedded variables and phrases mixed with graphics.

The EA3-T4CL C-more 4" Widescreen Micro touch panel (priced at $269.00) has a 4.3-inch TFT LCD 480 x 272 pixel display (WQVGA) and a palette of 32K colors for customizing objects, screen backgrounds and displaying bitmap graphics. This 4-inch widescreen panel has a built-in Alarm Control setup that activates beep, backlight flash, customized alarm banner, and red LED blinking. Both the 3-inch and 4-inch touch panels have two serial communications ports, one micro-USB programming port and one built-in RJ45 Ethernet port.

These new panels are programmed using the free downloadable EA-MG-PGMSW programming software. The panels are NEMA 4/4X and IP65 rated (for indoor use only) and are backed by a full two-year warranty. Learn more by visiting:
www.automationdirect.com/C-more-micro

NEW LINE OF DIGITAL PRESSURE SENSORS

AutomationDirect's ProSense® line of sensing products now includes the EPS series of digital pressure sensors ideal for industrial pressure measurement and indication in both gas and liquid applications. EPS-series sensors are available with measuring ranges from vacuum up to 5800 psig. Selectable engineering units such as bar, mbar, kPa, MPa, inches of water column, and inches of mercury can be shown on the digital display. The compact and robust design and construction of the ProSense EPS series withstands extreme shock and vibration, provides high accuracy and reliability, and incorporates the best combination of overpressure, burst pressure and long term stability for each measuring range.

Encased in a stainless steel housing, the EPS-series sensors have a high IP67 ingress protection rating, and achieve their atmospheric pressure reference at the 4-pin M12 electrical connection. The standard 1/4" NPT male process connection allows for direct installation without requiring extra fittings. With no moving parts such as pistons or springs that can stick or break, two solid state switch outputs provide a reliable alternative to mechanical pressure switches; on certain models, the second output can be configured as a scalable analog signal turning the unit into a combination pressure switch and transmitter. The built-in two-color digital display is easy to read from a distance and provides indication of measured pressure and switch setpoints. The display can be set to change color between red and green based on measured value or output status and rotated 180° for inverted installations; two large bright LEDs indicate output status. For optimum visibility, the sensor housing can also be rotated 345° after installation. Simple pushbutton setup allows easy and quick configuration prior to installation without the need for a separate pressure reference gauge. Prices for these digital pressure sensors start at $234.00; available accessories include a protective cover and mounting bracket.
To learn more, visit:
www.automationdirect.com/pressure-sensors

ADDITIONAL SURGE PROTECTION DEVICES

AutomationDirect has extended its offering of surge protection devices to include Mersen's Surge-Trap® Type 1 STXR series. With its small, compact design and line or load installation flexibility, this series is the perfect fit for branch panel and/or individual equipment protection.

The one-piece device requires no

assembly and can be used at the machine or the main panel to protect equipment from downtime and/or damage associated with power spikes and surges. Available in 120-600VAC models and a 200kA short-circuit current rating, these devices are ideal for use in ANSI/UL Type 1 or 2 SPD installations, such as AC distribution, power supplies, drive protection, fire alarms, control panels, and more. Designed with industry-leading Mersen TPMOV® technology, the STXR series provides up to seven modes of protection. Additional features include an LED status indicator, ¾-inch knockouts with three-foot leads for easy installation, and a NEMA 4X enclosure for outdoor or indoor use; an optional mounting bracket is available for surface mount applications. Starting at $98.00, the STXR series surge protection devices are UL and CSA approved.
Learn more by visiting:
www.automationdirect.com/power

PATLITE PRE-ASSEMBLED LED STACK LIGHT SIGNAL TOWERS

AutomationDirect now offers Patlite® pre-assembled stack lights in 25mm, 30mm, 40mm and 70mm sizes. Patlite stack lights offer high intensity LED illumination and prism-cut lens design for enhanced visibility from any direction and are ideal for use in applications such as machine tools, packaging machines, conveyor systems, loading docks, retail center check outs and more.

continued p. 9 >>

When commercial grade just won't cut it...

...get Industrial Managed Ethernet Switches **for less** from AutomationDirect.

Stride®

NEW! SE2 Series Industrial Managed Ethernet Switches

Commercial grade Ethernet switches have their place, but the harsh environment of the industrial world is not one of them. Don't risk your time, reputation, and money on managed switches that can't handle the extreme temperatures, unreliable power, hazardous locations or excessive vibration that exists in industrial facilities. Get the most out of your network and your dollar with affordable and reliable Stride Industrial Managed Ethernet Switches.

It's not just the low price, but the exceptional value you get with Stride Ethernet Switches that makes them so popular. With Stride Managed Ethernet Switches you get all this and more:

- **Enhanced network security**
- **Fail-safe networking with intelligent redundancy**
- **Traffic filtering for streamlined, efficient communication**
- **Helpful troubleshooting tools and statistics**
- **Modbus TCP and EtherNet/IP management capabilities**
- **Web-based configurations**
- **Gigabit Ethernet (GbE) models available**
- **FREE technical support for the life of the product!**

FREE shipping - orders over $49 2-day Shipping

5 YEAR WARRANTY

30-day Money-Back Guarantee 30 day

Research, price, buy at:

www.automationdirect.com/ethernet-switches

Order Today, Ships Today!

VOTED Best in SERVICE 15 YEARS

AUTOMATIONDIRECT.com

1-800-633-0405 the #1 value in automation

continued from p. 7

Patlite stack lights can be purchased in one to five tier LED module assemblies (depending on the series). These pre-assembled units offer the convenience of not having to configure and order separate components. Starting at $79.00 and ideal for tight spaces, the 25mm ME/MES series of super slim, rust-free aluminum body signal towers is designed to be direct mounted. One to four pre-assembled LED module versions are available. With an ABS resin main body, 30mm MP/MPS series signal towers offer superior impact and heat resistance. Priced from $79.00, they are designed for direct mounting and have a double insulation for enhanced durability and safety. One to four pre-assembled LED module versions are offered and an optional add-on alarm buzzer is available. 40mm LCE series signal towers (starting at $99.00) feature low maintenance and energy efficiency using LED technology. These signal towers are available in 2 to 4 tier models and two built-in alarm models are also available with selectable sound patterns.

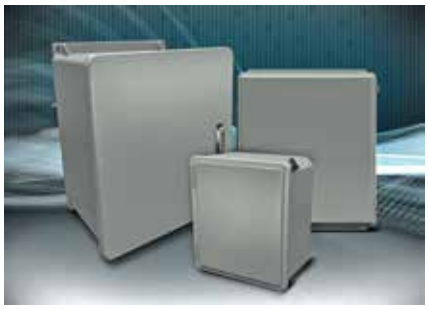
The 70mm LS7 Series features a smooth body surface that reduces adhesion of water and dust. There are no exposed screws, shafts or other metals making these signal towers adaptable in many environments. This series is IP69K-rated suitable for high pressure and high temperature wash down environments. Priced from $139.00, the LS7 series is offered in 3 tier and 5 tier versions and models are available with two separate alarm buzzers .Optional /replacement accessories include LED modules, mounting brackets and poles, O-rings and center assembly screws.

For more information, visit:

www.automationdirect.com/stacklights

MORE FIBERGLASS AND POLYCARBONATE ENCLOSURES

We've added more than 250 chemical and corrosion resistant fiberglass NEMA Hubbell-Wiegmann enclosures to our extensive line of quality enclosures. Excellent for industrial/commercial applications and ideal for watertight environmental installations. Prices starting at $30.50 (HW-N4X332) and shipped directly from factory.



In addition, we've added more Integra Premium series NEMA polycarbonate enclosures featuring Integra's unique T-Rail accessory mounting system. These lightweight enclosures are watertight, durable, impact resistant, non-corrosive, non-conductive, and chemical resistant. Polycarbonate construction also allows for easy installation and modifications. Integra enclosures are UL approved, CE, RoHs, and REACH compliant. Prices starting at $27.50 (P4043-P10), Integra enclosures are in-stock and available for same day shipping; free shipping for orders over $49.00, and some exclusion apply. Learn more by visiting:

www.automationdirect.com/enclosures

NEMA RATED LIMIT SWITCHES FROM EATON

An expanded limit switch offering includes F25 Series NEMA limit switches from Eaton. These limit switches are NEMA 3, 3S, 4, 4X, 6, 6P, 13, and IP67 rated for operation in a variety of rugged industrial environments.

All F25 Series NEMA limit switches consist of three modular, interchangeable, plug-in components: operating head, switch body, and wiring receptacle. Operating heads (side rotary, top and side push, and wobble stick) are mounted on top of the switch body in any of four positions. The plug-in component design allows a damaged switch to be easily replaced in the field without rewiring (the wiring remains intact in the receptacle).

Eaton NEMA limit switches have a die-cast zinc housing, 90-degree adjustable head and are fully assembled right out of the box. Snap action 1 N.O., 1 N.C. and 2 N.O., 2 N.C. contact versions are available on all limit switch units. Nine versions of side rotary limit switches are available with fixed and adjustable length stainless steel levers and Nylatron or metal rollers. Also available are adjustable spring stainless steel rod and 6-inch Nylatron loop side rotary switches.

Six versions of metal plunger (side push and top push) limit switches are available; along with three types of 360-degree rod and spring (wobble head) limit switches. Eaton NEMA limit switches start at $89.00 and have a 1-year warranty. All assembled limit switches are UL Listed, CSA Certified.

For more information, visit:

www.automationdirect.com/limit-switches

NEW LINE OF DIGITAL TEMPERATURE SENSORS

The ProSense® line of instrumentation products now includes the ETS series digital temperature sensors. The ETS series combines a precision RTD sensing element, measuring electronics, and process fitting all in a single stainless steel temperature transmitter probe.

Four standard probe insertion lengths and two integral male NPT process threads are available and allow direct mounting to the process or thermowells, eliminating the need for separate probe mounting or adapter fittings. Two solid state switch outputs with no moving parts provide a reliable alternative to mechanical temperature switches. Select models allow an output to

continued p. 10 >>

continued from p. 9

be configured as a scalable analog signal, turning the unit into a combination temperature switch and transmitter.

A built-in 4-digit display provides indication of the measured temperature. Two yellow LEDs indicate output switch status. The sensor housing can be rotated up to 310° after installation and the digital display can be electronically flipped 180° for inverted installations. Simple pushbutton setup allows the ETS sensors to be easily and quickly configured prior to installation without the need for a separate temperature reference. Free ProSense XT-SOFT software can also be used to program the ETS sensor's parameters.

ETS series Digital Temperature Sensors start at $146.00. Learn more by visiting: **www.automationdirect.com/temperature-transmitters**

TOTAL AIR PREPARATION (TAP) UNITS AND ETHERNET/IP (EIP) MODULES

AutomationDirect's line of NITRA pneumatics now includes new Total Air Prep (TAP) units and NITRA Ethernet/IP protocol compact modular valve (CMV series) modules. Both TAP units contain an automatic drain air filter with clogged filter indicator, relieving regulator, lockable shut-off valve, pressure gauge and air dump. Electric models also have an adjustable electric soft start / shut-off valve and an adjustable pressure switch with indicator LEDs. Starting at $171.00, TAP units have a 0 to 120 psi pressure range and are IP65 rated and CE approved.

Two versions of the multi-functional filter-regulator assembly offer a common small footprint regardless of piping requirements. Units ship with 1/2" NPT inlet/outlet ports. Optional NPT or BSPP port inserts in sizes 1/4" thru 1" are available (sold separately). Any combinations of port sizes are available all in one small footprint.

Also available, new NITRA Ethernet/IP (EIP) protocol modules have been added to the NITRA CMV Series of compact modular solenoid valves. Two models (single 3/8" input and dual 3/8" input) are available. These Ethernet/IP communication end plates permit daisy chaining of as many CMV manifold banks as needed by using the Ethernet/IP connection vs. hardwiring. The EIP units are IP65 rated using M12 connectors for communication and M8 connectors for supply power. NITRA configuration software for use with the CMV series Ethernet/IP modules is available on CD, USB and as a free download. EIP Ethernet/IP modules start at $549.00 and have a 2-year warranty. For more information, visit: **www.automationdirect.com/pneumatics**.

NSF CERTIFIED POTABLE WATER SOLENOID VALVES

AutomationDirect's family of potable water components (valves, regulators, fittings, tubing and hoses) now includes potable water solenoid valves. These NS-Series NSF (National Sanitation Foundation) certified valves (from GC Valves) are an excellent choice for food and beverage grade potable water applications. Stainless steel or thermoplastic bodies and synthetic seating and sealing materials makes NS series valves suitable for use with a variety of liquids, oils and gases. Valve operation is normally closed (N.C.) and open when electrically energized. The valves can be mounted in any position and a spring loaded plunger assures positive shutoff. Three types of 2-port (2-way), 2-position NS series valves are available. NS201 and NS211 series are piloted diaphragm valves; NS201 series valves can also operate under zero pressure differential. NS201 and NS211 series valves have 316L stainless steel or Noryl bodies and are ported for 3/8, 1/2 or 3/4 inch NPT. These valves are available with 120VAC, 24VAC or 24VDC solenoids.

NS301 series valves are direct acting with an armature that acts directly on the valve orifice to control fluid flow and does not require a minimum pressure to operate. These valves have 303 stainless steel bodies and 1/4 inch NPT ports. They are available with three orifice sizes and solenoid voltages of 120VAC, 24VAC or 24VDC. Cost-effective NS301 series valves are an excellent choice for potable water applications up to 400psi.

Replacement coils are available with either an 18mm (DIN 43650A) style wiring plug or a 1/2 inch conduit and 24-inch cable. Valve repair kits and complete valve rebuild kits are also offered. NS Series potable water valves are made in the USA with prices starting at $73.00. The valves are NSF, CE, CSA, UL recognized and NEMA 4/4X protected. Learn more by visiting: **www.automationdirect.com/water-components**.

NEW LINE OF PRECISION LIMIT SWITCHES

AutomationDirect has added a new line of high precision limit/position switches from Metrol. Traditional limit switches and even electronic proximity sensors are limited in terms of accuracy and repeatability. These cost-effective, ultra-precise mechanical limit switches have repeatability down to 10, 5, 3, and even 0.5 microns (μm) depending on the specific model.

Along with their high precision, these stainless steel limit switches are also some of the smallest switches/sensors available. Their tiny size allows them to be mounted in extremely tight locations. With a 4mm diameter barrel and length of only 12.8 mm, model BP4SWA is the smallest precision limit

switch on the market.

In addition to the 4mm smooth barrel, these switches are also available in 5mm and 6mm smooth barrel, as well as M5, M6, M8, & M10 threaded barrels. While the smallest versions use "core wire" due to space constraints, larger models include rugged 2m or 3m pigtail cables and have LED indicators built-in.

Five precision limit switch series are available: precision touch with 3 micron or 5 micron accuracy; high-precision touch and tool setter with 0.5 micron accuracy; ball plunger with 10 micron accuracy, and high-temperature rated with 10 micron accuracy and operating temperatures up to 200°C. Precision limit switches are priced from $39.50 and have a 1-year warranty. Learn more by visiting: **www.automationdirect.com/precision-limit-switches**.

CURRENT TO PNEUMATIC (I/P) TRANSDUCERS ADDED

NITRA NCP Series electro-pneumatic transducers from AutomationDirect convert a 4-20 mA current signal (I) from a PLC or other controller to a linear pneumatic output pressure (P). Used in paper and paper converting, food and drug, petrochemical, HVAC, textile, and energy management industries, NCP Series I/P transducers provide highly reliable and repeatable operation of pneumatic valve positioners, valve actuators, air cylinders, damper and louver actuators, web tensioners, clutches and brakes.

These NITRA I/P transducers are rated for installation in NEMA 4X (IP65) environments and approved for hazardous locations. The NCP series I/P transducers are available in output pressure ranges up to 120 psig for industrial pneumatic and process control applications. NCP1 series transducers can be direct or bracket mounted and have a 1/2" NPT female conduit connection with wire leads.

Compact NCP2 series I/P transducers can be direct or bracket mounted and have a 1/2" NPT female conduit connection with wire leads or field wireable DIN 43650 electrical connector; optional pipe and DIN rail mounting kits are also available. NITRA I/P transducers start at $275.00 and have a 1-year warranty.
Learn more by visiting:
www.automationdirect.com/process-measurement

INDUSTRIAL CAT5E M12 ETHERNET PATCH CABLES

AutomationDirect has released a new series of Ethernet cables for industrial communications applications. Ethernet is a multi-purpose communication protocol that has become the data standard for the industrial market. AutomationDirect offers several PLCs, HMIs and drives that support the Ethernet protocols for data distribution, software programming and configuration.

The new high-flex, shielded M12 Ethernet CAT5E patch cables have a TPE (thermoplastic elastomer) jacket ideal for typical industrial applications. This Ethernet cable is flame retardant, chemical resistant and resistant to welding sparks.

The data rate for these Ethernet cables is 100Mbps full duplex, making them ideal for the AutomationDirect products and other devices that support Ethernet communications. Several connection choices are available including male straight to male straight, male straight to male 90°, male straight to RJ45, and male 90° to RJ45. The cables are available in 0.6m, 1m and 3m lengths and have a -40° to +80°C (-40° to +176°F) temperature rating.

Starting at $19.00, M12 Ethernet patch cables have an ingress protection rating of IP65/66K/67 and are cULus, CSA approved. Learn more by visiting:
www.automationdirect.com/cables

PROSENSE DIGITAL PRESSURE GAUGES

ProSense DPG1 digital pressure gauges are ideal for industrial and general purpose applications requiring an accurate and reliable device with easy to read digital display. These DPG1 gauges have a 4-digit, 2" x 3/4" LCD display and 2-button operation. The display can operate in a continuously on mode, or an auto shut-off mode to lengthen battery life. The display's backlight turns on for 15 seconds whenever the on/off button is pressed. The gauge is battery powered (batteries included) and battery life is up to 2 years (auto shut-off mode) or 2 weeks if the display is on continuously. A rubber boot is included for added gauge protection and the process connection is 1/4" NPT.

Gauge accuracy is +/- 0.5% of full scale with available pressure ranges from 0 - 15 psig to 0 - 5000 psig. Pressure unit selections include psi, mH2O, mmHg, mbar, kPa, bar, kg/cm^2, MPa. ProSense DPG1 digital pressure gauges are priced at $100.00 and have a 1-year warranty. Learn more by visiting:
www.automationdirect.com/pressure-gauges

To see all our recently added products visit: **www.go2adc.com/whatsnew**

THERE'S A VIDEO FOR THAT

By Bill Dehner, AutomationDirect

Embedding videos is just one way AutomationDirect's free Do-more® Designer Software (**www.go2adc.com/designervid**) does more. One of the big steps for an automation professional is understanding how to control a machine, and a huge part of that is becoming proficient with development environment for the PLC.

Whether a new or seasoned programmer, what's needed are the easy to use yet powerful development capabilities (**www.go2adc.com/brxsoft**) provided by the Do-more Designer Software. A point and click Dashboard to simplify configuration and access to the program, documentation, communications, I/O, CPU, memory and devices is just the beginning. There are configurable data views and trend views, along with code and PID process simulators. There are also system logs and monitoring tools, cross references and layered security features to understand and configure.

Learning how to use a powerful development environment for PLCs, such as Do-more Designer Software, may seem overwhelming. Fortunately, there are videos to illustrate. When the Do-more Designer Software is initially opened, the Start Page has five short videos explaining everything you need to get started. This includes a Welcome, Quick Start, Troubleshooting, Architecture and Helpful Hints video.

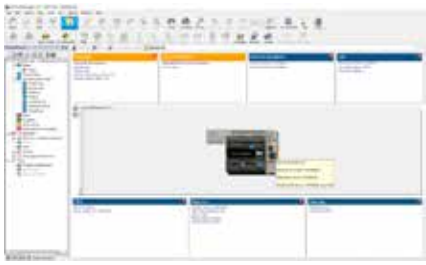
If more training and information is needed, a video search and download utility provides quick access to well over 100 videos for help with system, program, instruction, motion, communication, HMI, device and other areas of interest. An Internet connection is all that's needed to access the videos, or the videos can be downloaded for times when Internet access is not available.

Quick Start

So you open the box, power up your new BRX PLC, and download the latest version of Do-more Designer Software. Now what? Watch the Quick Start – Connect, Enter, and Download a Simple Program video. (**www.go2adc.com/designer-quickstart**)

Plug the USB cable into a Do-more PLC and connect it to a computer. The video shows it is not much different than inserting a flash drive into a USB port on a PC. It automatically connects to a previous project, or a new offline or online PLC project can be created.

If creating a new online PLC project, click ADD and select the one and only PLC connected, and give the link a name. The video then leads you through the steps required for creating a new on-line project. The Dashboard that appears within the software, including an image of the PLC, makes it easy to configure all parts of the controller.



There are even play or run buttons for videos embedded in the Dashboard. Just click on play and a list of videos appears.

The Quick Start video also provides a quick example of writing a program and accepting it so it is ready to be written to the PLC. Do-more Designer checks the program. The user then saves it, writes it to the PLC, and switches to RUN mode. The program could also be downloaded to the built-in simulator to test it without hardware, a very useful feature.

Troubleshooting the PLC Hardware and Program

A Troubleshooting icon (**www.go2adc.com/designer-troubleshoot**) is also available from the Start Page in Designer. Click on it and watch the video describing the many Do-more Designer tools available to troubleshoot and debug your PLC programs.

continued p. 15 >>

Affordable Process Control

Productivity®2000

With the Productivity2000 PLC you get everything you need and more for accurate control of your process - all for a fraction of what you'd pay elsewhere.

- Measure - A wide array of analog modules is available to measure temperature, voltage and current, all with high-contrast, real-time data displays for non-invasive (no meter required) measurements.
- Control - **FREE** tag name based programming software and 50MB of user memory provides practically limitless PID loops, with easy-to-configure function blocks and built-in auto-tuning.
- Track - Keep track of your process with up to 32GB of data logging available with every Productivity2000 CPU.

Analog I/O
starting at:
$101.00
P2-04DAL-2 (4-channel)

FREE shipping - orders over $49 · 2-day Shipping · 2 YEAR WARRANTY · FREE Technical Support

Get more than you paid for:

www.Productivity2000.com

FREE Apple® iOS **PACDATA** App
Monitor your process anytime, anywhere.
Available now in your Apple app store.

READERS' CHOICE AWARDS 2017 control design

VOTED Best in SERVICE 15 YEARS

Order Today, Ships Today!

AUTOMATIONDIRECT.com
1-800-633-0405 the #1 value in automation

PNEUMATICS and ETHERNET

Two worlds collide to save you time and money.

NITRA® PNEUMATICS

EtherNet/IP-ready CMV Series Compact Modular Valves

EtherNet/IP End Plates start at: $549.00 (CMV-E1X-4X)

Now you can install control valves wherever you choose without unwanted wiring expense. With the new NITRA EtherNet/IP-ready CMV valve system you can control banks of valves via simple Ethernet connections.

- Save money and time with EtherNet/IP instead of hard wiring individual valve signals
- EtherNet/IP end plates available with single or dual 3/8"inputs
- IP65 rating using standard M12 (Ethernet) and M8 (power) connectors
- Daisy chain as many manifold banks as needed
- FREE configuration software
- 2-year warranty

Valves start at: $70.00 (CMV-B1L-1A)

Mix up to 16 valve sizes as needed (16 solenoids max) per manifold assembly:

- 3-way/2-position, 5-way/2-position and 5-way/3-position valves available
- Four port size combinations
- Single (spring return) or dual solenoids per valve
- Locking manual operator
- NBR / Buna-N gaskets and O-ring
- End plates and intermediate modules are available to provide additional flow, alternate supply pressure, and/or supplemental exhaust (as needed).
- 2 year warranty

Research, price, buy at:

ww.go2adc.com/eip

Also Available

Cylinders

Total Air Prep

Tubing and Hose

Order Today, Ships Today!

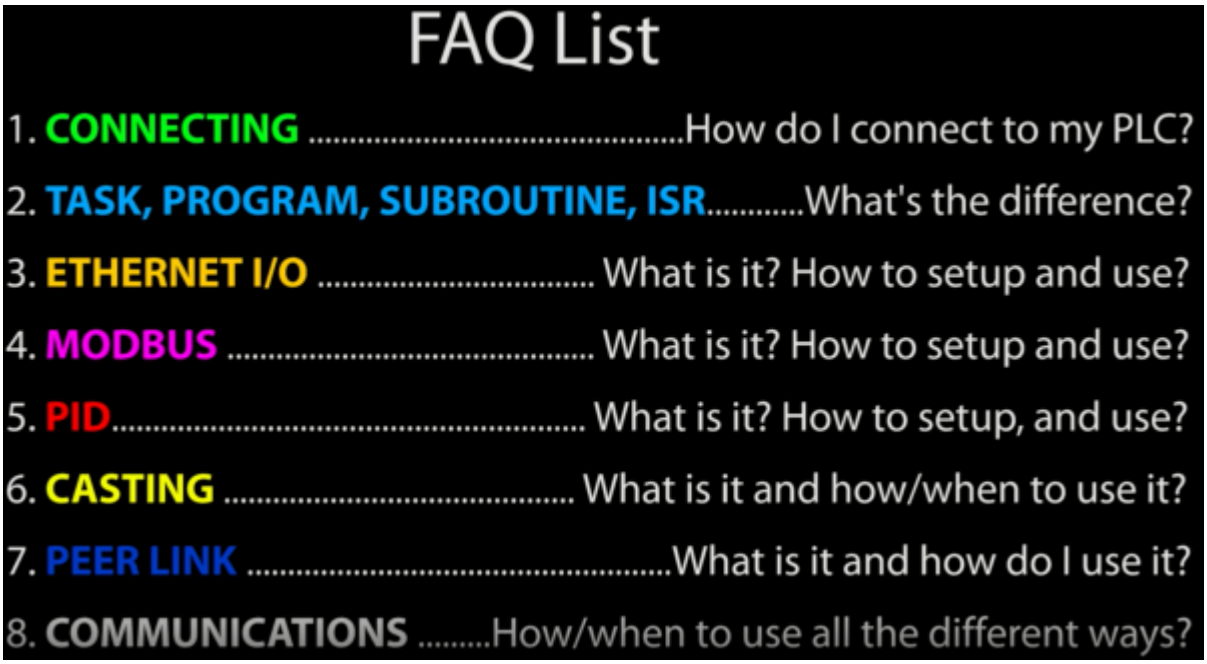
VOTED Best in SERVICE 15 YEARS

AUTOMATIONDIRECT.com

1-800-633-0405

the #1 value in automation

continued from p. 12



The troubleshooting video provides several examples showing how to find problems and fix them quickly. It helps make sense of the large amount of information displayed in the Dashboard. If there is a warning or something is out of place, just click on the troubleshooting video. It and the proper dialog opens to help solve the issue.

The video also talks about how to use Dataviews to quickly see what's happening in the program. Program it to just see what you want without having to open the whole data table and search for a particular piece of data. The list of tools is impressive, and tools not covered in the troubleshooting video are covered in other videos, which can be found using the video search and download utility accessed on the Start Page.

System Architecture

The Architecture icon (**www.go2adc.com/designer-architecture**) on the Start Page opens another important video to help with understanding three key things about the Do-more Designer architecture: devices, memory and system configuration.

Do-more is device centric. The device, a software interface to your program that controls the hardware, is similar to a printer driver. Configure the device and it talks to the hardware. The memory is typed, meaning a Do-more knows what each memory location's purpose is within the program.

Much of this code is created automatically when a device is configured, such as a high-speed counter input module. System configuration is a top-down process to configure and modify the hardware, devices, servers and memory usage. System configuration should be done in this order -CPU, I/O, module, device, I/O mapping and memory configuration- because each item in the configuration can affect an item below it in the hierarchy.

Helpful Hints

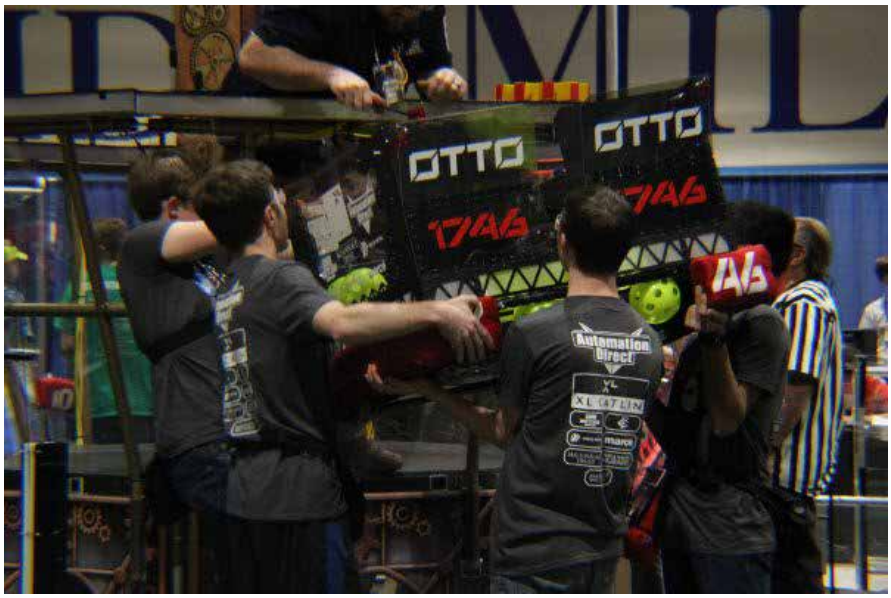
A final video icon on the Start Page is Helpful Hints (**www.go2adc.com/designer-hints**). This video includes a list of the most common questions AutomationDirect's support team receives related to a Do-more PLC. It shares the answers to these eight questions.

If after review of the many videos and extensive help files you still need help with Do-more Designer, don't worry, it's readily available via phone. Just contact AutomationDirect's free award-winning support team during regular business hours, and they will be happy to help you spend less and do more with AutomationDirect. ■

FULL CIRCLE

By Joan Welty,
AutomationDirect

Robotics is so much more than robots. If you subscribe to any of our media channels then I'm sure you know about our involvement with after-school robotics programs in our community. These programs prepare students for careers in the STEM (Science, Technology, Engineering and Math) fields by getting them excited and engaged when it comes to not only learning new skills, but actually putting those skills to work. Students are responsible for all aspects of robotic design and get to apply what they have learned in a team environment. Putting their newly gained technical skills to the test, while at the same time gaining presentation, financial management and business experience, helps them get a jump start in their careers. The students in these programs compete on a regular basis and have had numerous successes in robotics competitions all over the world. And many have developed a passion for engineering or even, like John Welsch, discovered their calling in life.

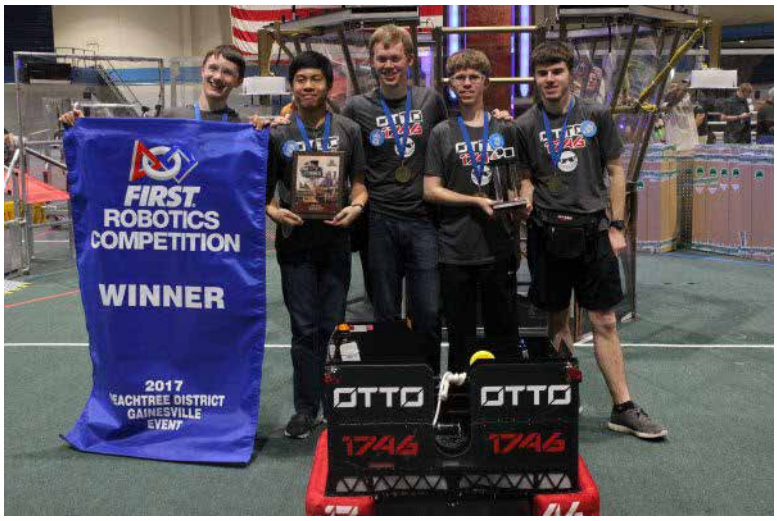


In a recent article for the Atlanta Journal Constitution, John Welsch describes his path from president of his high school's robotics club to the technical teaching position he currently holds. Welsch has come full circle, from student to teacher, with his passion for robotics and STEM. As he states in the article, "I knew I wanted to come back and work with the next generation of students." AutomationDirect has been directly involved with local school robotics for over a decade, donating both time and resources in an effort to give back to the community we serve. With AutomationDirect's funding and teachers like John Welsch, robotics programs have flourished in 5 high schools, 10 middle schools and about 15 elementary schools in Forsyth County, Georgia. As Welsch notes in the article, "In my program alone, I had 50 7th and 8th graders last year. I also have 240 students in classes where we do robotics, too. Having it in class has also changed my numbers; last year, it was 60-40 boys to girls, and this year, I'm looking at the opposite. Robotics have really become a big part of what the students do here, and I love what it does for them."

To read more about John Welsch's story and how robotics in school is impacting future generations, check out AJC's full article here: **http://www.ajc.com/news/local/making-the-grade-robotics-comes-full-circle-student-becomes-teacher/INQPsRXXmIT6O26bzSQerL/**

To read more about AutomationDirect's support of robotics and how it all started, go to this article:
https://library.automationdirect.com/automationdirects-support-robotics-now/

Or click the link below to hear Rick Folea's interview on a local radio station regarding the success of these programs. Rick is one of the many AutomationDirect employees involved with robotics and has been a pivotal part of their success.
https://library.automationdirect.com/keeping-kids-engaged-in-stem-with-automationdirect-and-robotics/



DRIVE In Efficiency, DRIVE Out Cost.

AC and DC drives at great prices

Volts/Hertz AC Drives

GS1 & GS2 Series starting at $99.00

- Dynamic braking & PID control
- Support for analog and discrete input, plus relay output
- Removable/relocatable keypad (GS2)
- RS-485 MODBUS communication
- Single and three-phase input
- 1/4 to 10 HP

Sensorless Vector AC Drives

Durapulse® Series starting at $242.00

All GS series features (above) plus:

- Sensorless vector control w/autotune
- Supports optional encoder feedback for enhanced speed control
- Smart keypad stores all parameters
- Three-phase models: 1 to 100 HP
- Single-phase input on select models

Soft Starters for AC Motors

Stellar® Series starting at $119.00

- Three-phase models from 5A to 477A
- Intelligent Energy Recovery System (iERS) reduces power consumption
- Reduced mechanical stress extends the life of the machinery
- Fast setup for a wide range of applications

Ironhorse® DC Drives

Starting at $60.00

- Input voltages: 12/24/36/48 VDC 12/24 VAC, 24/36 VAC, 115/230 VAC and 120/240 VDC
- Output voltages: 12/24/36/48/90/180 VDC
- Output current up to 20A
- Available in open frame and NEMA rated enclosed versions

Also Available

DC Motors and Gearmotors

AC Motors

Fuses, Filters, Line Reactors, Braking Units and more…

Research, price, buy at:

www.go2adc.com/drives

AUTOMATIONDIRECT.com

1-800-633-0405

the #1 value in automation

ARDUINO VERSUS BRX PLC IN INDUSTRIAL AUTOMATION APPLICATIONS

By Doug Reneker

A low-cost Arduino microcontroller is no match for an AutomationDirect BRX PLC, even in this simple flow control application. Imaging how far the gap would widen in more complex systems.

In the world of garage or basement automation and robot builders, numerous low-cost microcontrollers and related software are used for real-time control. Arduino and Raspberry Pi are perhaps two of the most popular out of dozens of options (Figure 1). These open-source controllers are available from several suppliers, but using them in a real-time industrial control application takes considerable time and effort.

That's Industrial?

Figure 1: Although both the Arduino (top) and Raspberry Pi provide various proficiencies, they don't include features often needed for use in industrial automation applications.

Some industrial users might imagine these microcontrollers as a substitute for an entry-level PLC. In the Control Design August 2017 cover story Arduino vs. PLC for industrial control (**http://www.controldesign.com/articles/2017/arduino-vs-plc-for-industrial-control/**), author Doug Reneker says, "If an Arduino can control a robot for a STEM competition entry, why can't it control an industrial robot, or a simple machine? If it's possible to buy an Arduino for as little as $20, why spend hundreds on a PLC? An Arduino can do lots of things, but as I discovered, making it work in even a simple industrial application is easier said than done." Doug Reneker is a circuit designer, recently retired as a senior manager at Arris, a provider of broadband communications equipment for internet providers and consumers.

This article compares automating a simple flow loop using an Arduino microcontroller, and then with an AutomationDirect BRX PLC. While the microcontroller may be able to do the job, additional hardware and significant program development is required. A purpose-built industrial controller, such as the AutomationDirect BRX, can do the job much more easily.

Real-time Control with Arduino

According to the Control Design cover story, the Raspberry Pi is effectively a miniaturized Linux-based single-board PC, whereas an Arduino is more like a PLC in some respects. While either platform looked suitable, Reneker settled on the Arduino for this project, which is closed-loop control of flow generated by a pump. A sensor measures flow and sends data to the Arduino, which adjusts a control valve actuator to maintain the setpoint. This is one of the most basic industrial analog automation functions, and often uses a PID loop as the control algorithm, says Reneker in the cover story.

The application requires just PI control capability because reading a process variable from a flowmeter and adjusting a valve to reach and maintain a setpoint does not typically require use of the derivative in the PID equation. It's a simple control loop, but using an Arduino in a real-world industrial process can get complicated.

"The Arduino is a bare-bones device, as befits its price, but it does have extensive capabilities if the right program can be written to match the application," notes Reneker in the cover story. "It's a totally blank slate for a programmer, with no native capabilities or function blocks ready to upload," he says. Not only did he need design and build hardware to connect to the instruments, he had to create the PI algorithm from scratch using Arduino programming.

The Arduino includes discrete and analog I/O, but the signal types and ranges are limited. Analog input range is 0-5 V, and the analog outputs are pulse-width modulation (PWM). While these limited signal levels work for regulating motor speed or modulating a temperature control loop, they are not the most common range for typical industrial applications. A common industrial analog signal level is 4-20 mA current, the standard used in the demonstration project. This required a significant design effort for implementation with the Arduino.

Don't Take Current Loop for Granted

According to the Control Design cover story, the demonstration equipment uses standard off-the-shelf industrial components: a Rosemount 3051SFP Integral Orifice flowmeter and Fisher Easy-Drive control valve, both provided by Emerson Automation Solutions (Figure 2). These were not selected for any specific capabilities or characteristics beyond their physical size. They are both very common types of components, making them very appropriate for this demonstration.

Development Project

Figure 2: This small flow control application included a flowmeter and valve.

continued p. 20 >>

Ethernet-ready Micro HMIs *FOR LESS!*

C-more®

C-more Micro HMI Panels

With their low price, free software (with simulator), small form factor and now built-in Ethernet capability, C-more Micro panels are undoubtedly the best value in industrial micro HMIs.

NEW EA3 3" Micro HMI features:

- 3.1" STN LCD monochrome touch-screen display
- Twelve selectable LED-driven backlight colors
- Five user-defined function keys
- Serial, USB and Ethernet Ports
- 2-year warranty

NEW EA3 4" Widescreen Micro HMI features:

- Widescreen 4.3" touchscreen display
- 32K colors
- Serial, USB and Ethernet Ports
- 14MB memory
- 2-year warranty

30-day Money-Back Guarantee

FREE Technical Support

FREE shipping - orders over $49

Research, price, buy at: ***go2adc.com/CmoreMicro***

VOTED Best in SERVICE 15 YEARS

Order Today, Ships Today!

AUTOMATIONDIRECT.com

1-800-633-0405 the #1 value in automation

continued from p. 18

"The first step is converting the 4-20 mA signal coming from the flowmeter to 0-5 V, or better, 1-5 V to retain the live zero," explains Reneker in the cover story. "This is not an uncommon situation, and converters are available from multiple sources. However, in keeping with the DIY character of the experiment and to keep costs down, I created one from scratch (Figure 3). It was built on an Arduino prototype shield to mount on top of the main board. A simple 250-Ohm resistor converts the 4-20 mA signal to 1-5 V."

Custom Circuit Required

Figure 3: This custom analog signal converter board needed to be designed, built and then stacked between the Arduino controller and small HMI display for the flow control application to work.

A challenging task when using an Arduino in this industrial application was converting the PWM analog output to 4-20 mA. "The lack of commercial solutions suggests this isn't a common conversion, so I had to build this converter from scratch," says Reneker in the cover story. "I decided to electrically isolate the 4-20 mA current loop output using a two-channel optoisolator to allow more flexibility in connecting with other current loop devices (Figure 4). This leaves the problem of powering the circuit, as it is isolated from the power supplies. This was solved by powering the circuit from the current loop itself, using a voltage-reference integrated circuit."

A low-pass filter was used to filter the Arduino's 500 Hz PWM analog output and relating harmonics. The filter provided a dc signal proportional to the duty cycle of the PWM signal. An op-amp then converted the low-pass filter output to a current.

Adding to the Stack of Hardware

In the cover story, it was noted that an Arduino has no power supply, nor does it have any type of human-machine interface (HMI), but it can use a small graphics display "shield" added to the stack of devices, with a screen size of about 1.75 by 2.25 inches (Figure 5). Adding an HMI to the Arduino requires custom programming to display useful information. With a PLC such as the AutomationDirect BRX, several HMI hardware choices are available, with each only requiring simple screen configuration.

Terminating wiring to the Arduino required extra hardware and tools. While the supply power was connected to terminals, I/O was not a simple terminal and screw connection. Small gauge wires, crimp terminals, a crimp tool and three different width (pin count) electronic header connectors were needed. Mounting the Arduino boards also required some custom mounts as there is no commercially available Arduino enclosure with an industry standard DIN-rail mount.

Custom Circuit Required PWM to 4-20 mA Diagram

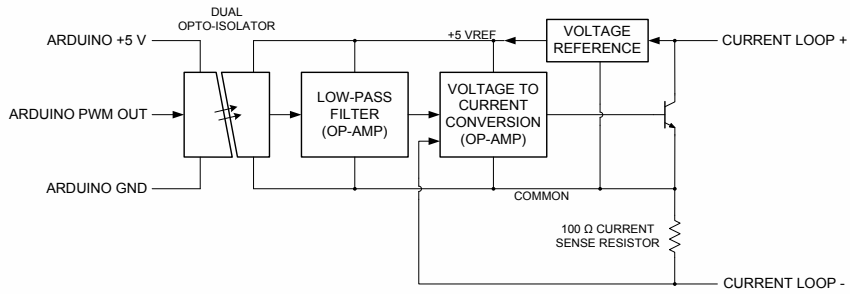


Figure 4: While PWM works well in some applications, in many industrial processes or machines it must be converted to a voltage or current loop, in this case with a custom circuit board.

Difficult to Display

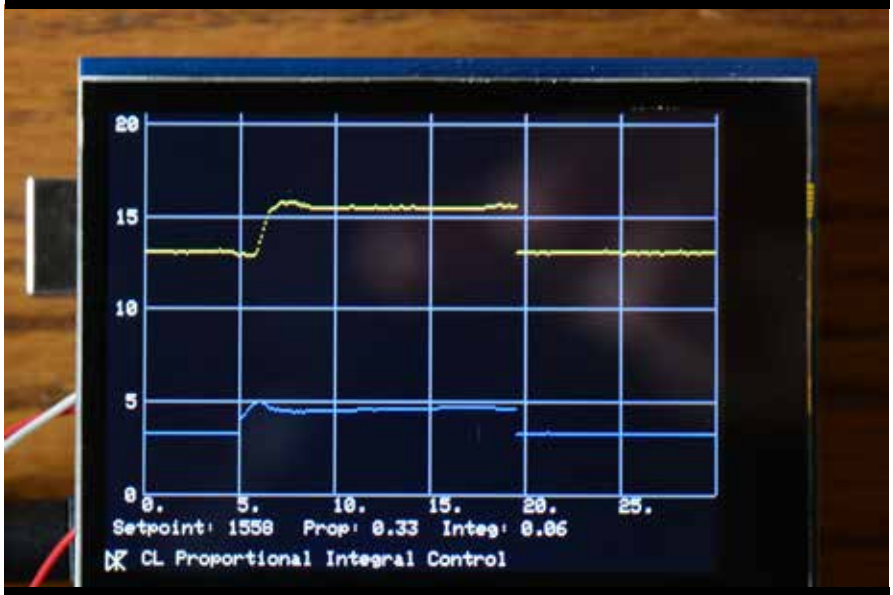


Figure 5: A small display screen was mounted to the top of the Aruino board stack to indicate loop performance, but required custom coding to draw the grid and trend line.

A standard 24 Vdc power supply powered the flowmeter and control valve in this demonstration project, but the Arduino doesn't accept this standard voltage level. A linear regular was needed to regulate the 24 Vdc down to the 12 Vdc required by the Arduino (Figure 6).

Time to Program

Reneker briefly described how he wrote the PI algorithm and simple display program in the Control Design cover story. "Writing code to implement the PI algorithm on the Arduino had to be done from scratch but was relatively simple," he says.

"The current loop input is read, the difference between the setpoint and the input

Additional Power Requirements

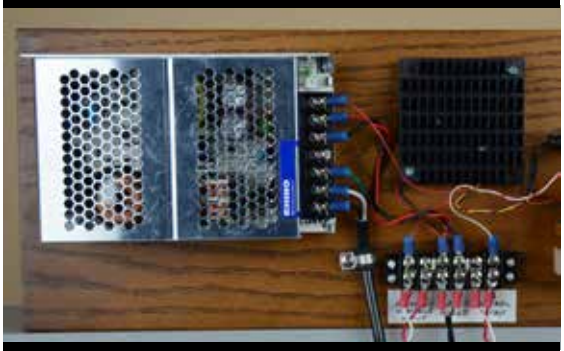


Figure 6: The PLC, flowmeter and control valve worked on 24 Vdc, a typical industrial voltage, but a 12 Vdc regulator, mounted to a heat sink was needed to power the Arduino.

evaluated, the integral and proportional corrections are calculated, and the result is sent to the PWM current loop output."

According to the cover story, to view operation of the control circuit, Reneker "wrote a program to use the small display to indicate both the process variable—read via the current loop input—and the control output as a function of time. This provides a direct view of the performance of the control system."

There were additional analog inputs available so three potentiometers were connected to provide adjustable operating parameters (Figure 7). This included a water flow setpoint and the P and I action – the proportional and integral gains for the control loop – to adjust stability and response time.

Process Adjustments

Figure 7: Potentiometers were used to adjust the setpoint and tune the P and I coefficients during testing.

Arduino Process Control

The flowmeter included a local display indicating gallons per minute flow rate and inches of water differential pressure across the meter, providing provided a simple indication of loop operation (Figure 8). "The PI algorithm performed as expected, and the loop can be tuned by manipulating the potentiometers to adjust the two control factors," says Reneker in the cover story. "Flow control exhibited the normal characteristics, good and bad, of PI loops."

Reneker used a flow bypass valve to force changes to the process, requiring the control loop to adjust the flow control valve to maintain the setpoint. He also created a program for the Arduino display to display a trend of the control loop. However, the display is very small and would be difficult to read in a factory application.

https://youtu.be/9KJ-bQ2TPIQf

We Have Flow

Figure 8: The indicating flowmeter transmitter's local display was used to verify flow control loop performance.

After running the demonstration project process, Reneker found the custom PWM-to-current-loop converter he built was the main bandwidth limitation. "The necessity to use a low cutoff frequency to adequately filter the PWM limits how fast the Arduino can respond to a change in conditions," says Reneker in the cover story. "The 100 ms (10 Hz) sampling interval works well, once the proportional and integral gains are adjusted. If the bypass valve is open, it robs roughly half of the input flow from the system, but the Arduino adjusts the control valve to achieve the desired flow within a few seconds. With steady water flow, the system is stable, without any indication the control valve is making adjustments."

The Arduino did okay controlling the simple loop control in the demonstration project, but it didn't inspire confidence for use in a real factory. If it was properly designed as an industrial-grade controller, like a PLC for example, it would be able to handle continuous operation inside a control enclosure on the plant floor. It needs to survive the heat, cold and vibration. The Arduino doesn't seem to have been designed with this type of operation in mind as it appears quite fragile. Its use on the factory floor should be carefully reviewed, even if and when industrial-strength Arduinos emerge.

Industrial-Grade BRX PLC

For comparison, the second part of the demonstration project used a PLC, in this case a BRX Series PLC (BX-DM1E-10ED23-D) from AutomationDirect, to control the process loop (Figure 9, next page). This is an objective comparison between an Arduino controller and a PLC because Reneker had no prior experience with PLC programming or knowledge of ladder logic. Implementing the BRX in this application would have been much easier for an experienced PLC programmer.

The AutomationDirect BRX controller has the ability and reliability to execute the many logic operations and communication requests often needed in industrial applications. Although not used in this demonstration project, the BRX series controller can provide data logging, motion control, high speed I/O with processing, and customizable communications to meet the demands of industrial automation machines and process.

The BRX PLC has one analog input and one analog output (current/voltage selectable), along with a mix of 10 discrete I/O points. All connections are through removable terminal blocks on a 5-mm pitch. Analog and discrete expansion modules are available but were not needed.

The BRX also includes a built-in Ethernet port. This provided easy programming access, via Ethernet, between the PLC and Windows-based PC running the Do-more Designer software. This full-featured software programming tool for Do-more CPUs such as the BRX can be downloaded free at **http://support.automationdirect.com/products/domore.html**

PLC Configuration and Installation

With the software loaded on the PC, it was connected to the PLC via Ethernet. 24 Vdc power was also connected and applied to the PLC. The Ethernet IP address

continued p. 22 >>

continued from p. 21

A PLC is an Industrial-grade Controller

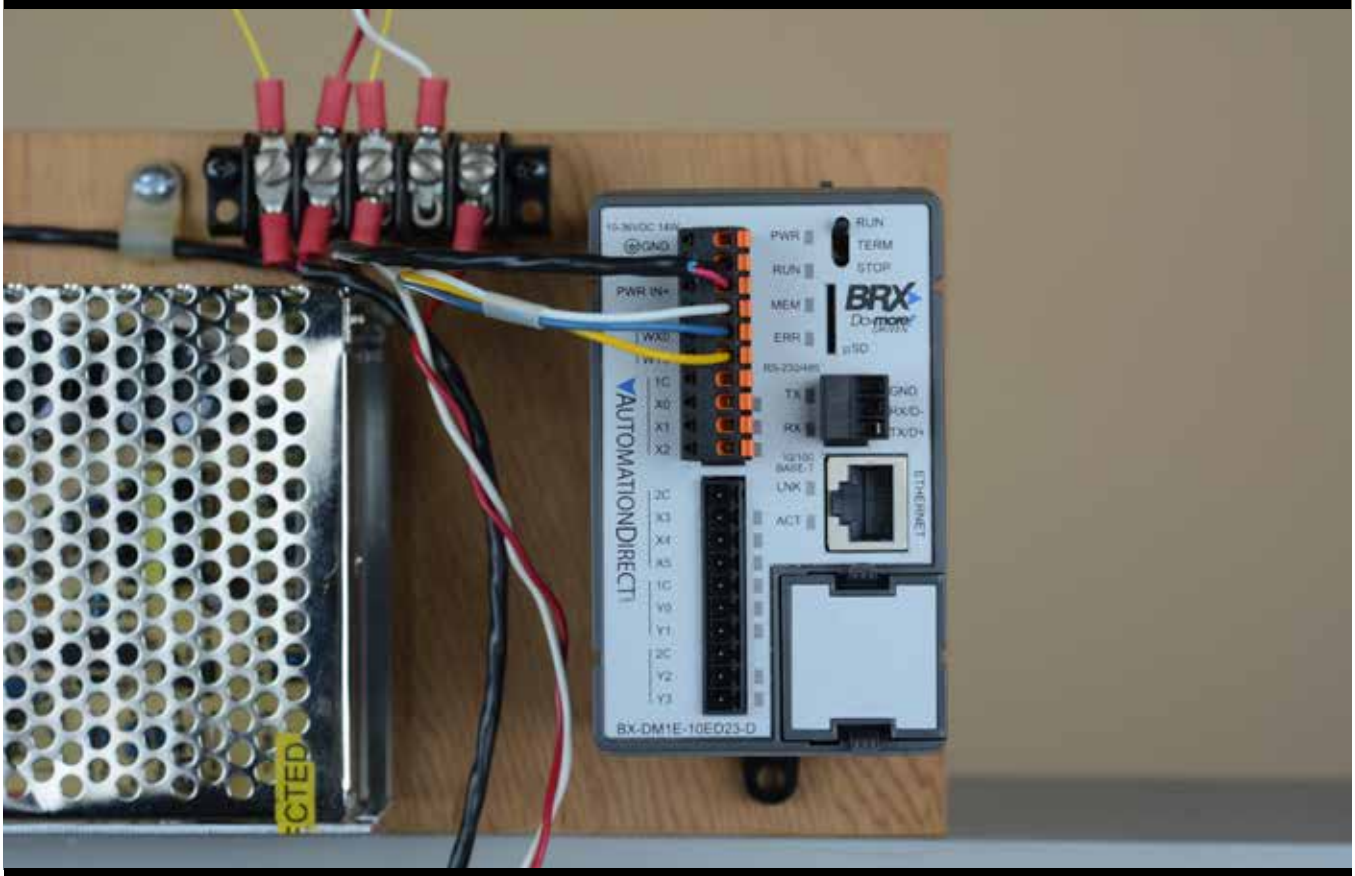


Figure 9: The AutomationDirect BRX PLC easily handled the flow control loop application with built-in, easy to connect and configure I/O. Free Do-more Designer software providing quick configuration and programming.

of the PC was determined using the ipconfig command. The Do-more Designer software was then used to give the PLC a unique IP address on the same network subnet.

As noted in the cover story, Reneker was not familiar with ladder logic, so he needed to learn it. "Chapter 10 of the BRX PLC Hardware User Manual includes a step-by-step example of programming a simple timer using ladder logic," says Reneker. "Working through this exercise provided a nice introduction to the software and to the basic programming structure of the PLC."

Instead of designing and building a custom PWM-to-current analog output interface, as needed for the Arduino, the Do-more Designer software provided a simple, fill-in-the-blanks configuration window to set the analog output to 4-20 mA. A couple of rungs of ladder logic were created, and then the analog output function was quickly verified with a multimeter.

The PLC includes a modular, interchangeable and run-time configurable PID instruction. This efficient logic instruction provides easy to access parameters such as filters, scaling, ramp-soak tables and alarm handlers. Instead of buying a display and custom programming a trend screen, which was required with the Arduino, the PLC's PID trend views graphing the control loop response can be viewed on the PC, saving time with tuning and troubleshooting.

"The PLC offers a sophisticated PID instruction, allowing the various loop parameters to be set for manual or automatic control of the loop," says Reneker in the Control Design cover story. "A very simple control loop was created by connecting the analog output back to the analog input, again using the milliammeter. Associating the PID instruction with the scaled analog input and output allowed the PLC to learn the PID function without handling several gallons of water. Active PI control was verified by "robbing" a bit of the output current with a resistor and watching the BRX PLC compensate."

It was simple to integrate the analog signals to the PLC. For the analog input to the PLC, 24 Vdc was added to the flow sensor current loop. The PLC analog output provided the loop power, so it was connected directly to the control valve.

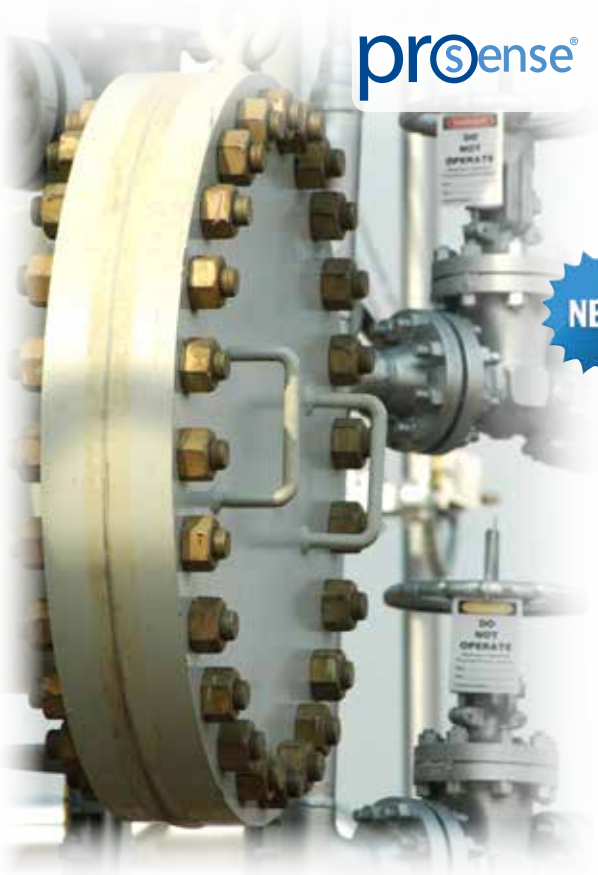
The system was turned on, and, to achieve stable flow through the system, the Do-more Designer software was used to adjust the PID instruction's proportional and integral coefficients. The flow setpoint was adjusted by simply changing a floating-point variable in the PLC's data table using the software. The Do-more software was used to provide real-time monitoring of system performance using self-scaling plots of both the process and the control variables.

Reneker notes in the Control Design

continued p. 24 >>

KNOW Pressure

Our low-cost pressure sensors/gauges make it easy



prosense®

Proven Pressure Sensors/Gauges

Get great prices on our vast selection of accurate, dependable pressure sensors and gauges! Choose from electronic and mechanical switches, transmitters and vacuum transducers, digital switches and transmitters, digital and dial pressure gauges and differential pressure transmitters.

NEW!

Digital Pressure Switches/Transmitters

EPS Series starting at $234.00

- Stainless steel housing with IP67 rating
- Ranges from vacuum to 5800 psig
- Selectable display units include: psig, bar, mbar, kPa, MPa, inH2O, and inHg
- Two discrete outputs: NO or NC
- Analog output on select models
- Large 2 color, 4 digit display
- Simple pushbutton setup

QPS Series starting at $69.00

- Two digital outputs (NPN or PNP) and a 4-20 mA analog output
- Two vacuum to pressure ranges (-14.5 to 14.5 psi and -14.5 to 145 psi)
- Tri-color digital LCD display

Air Differential Pressure Transmitters

DPTA Series starting at $105.00

- Highly stable capacitive sensing element
- Positive, negative, and bi-directional pressure measurement
- Pressure ranges from 0.1 to 25 inches of water column

NEW!

Digital Pressure Gauges

starting at $100.00

- ±0.5% accuracy
- Simple 2-button operation with backlight
- Option to show peak pressure
- Wide variety of pressure unit selections

Pressure Transmitters and Vacuum Transducers

SPTD25 Series starting at $99.00

- 4-20 mA or 0-10V outputs
- Sensing ranges from vacuum to 5000 psi
- Ceramic or stainless steel sensing elements
- M12, DIN connectorized, and cabled models

Dial Pressure Gauges

starting at $6.50

- 1.5", 2.0" and 2.5" diameter dials
- Steel (IP52) or stainless steel (IP65) cases
- Dry or liquid filled models
- Sensing ranges from vacuum to 6000 psi

Mechanical Pressure Switches

MPS25 Series starting at $82.00

- Sensing ranges from -15 psi to 7500 psi
- Tamper resistant field adjustment
- 1/4 inch NPT male process connection
- Snap-acting SPDT, 3 Amp, mechanical switch output

Electronic Pressure Switches

PSD25 Series starting at $89.00

- Sensing ranges up to 5800 psi (400 bar)
- Long Life - over 50 million switching cycles
- Mechanical adjustment dials rotate quickly to establish the setpoint and reset point
- No calibration required

Research, price, buy at:
www.go2adc.com/pressure

Order Today, Ships Today!

VOTED Best in SERVICE 15 YEARS

AUTOMATIONDIRECT.com
1-800-633-0405 the #1 value in automation

continued from p. 22

cover story, "Beyond the basic, core level of operation, the PLC offers a wide variety of the common support functions often needed in an industrial application such as limit detection, reporting and data recording. Compared to our Arduino demo, where each function must be written from scratch, this PLC allows the system designer to focus on the application and how it fits into a larger production system, instead of the details of controller hardware and software."

The Choice is Easy

"So, which is better, the Arduino or the PLC," asks Reneker in the cover story? "If only bare hardware cost for the controller and I/O are considered, the Arduino wins. But when all the ancillary components necessary to make the Arduino useful in this relatively simple application are added, the hardware cost gap will narrow or disappear. The time necessary to assemble and program the Arduino is also considerable. When this time is calculated at anything near normal engineering man-hour rates, the PLC is the clear winner in terms of overall cost."

Regarding function and performance, the Control Design cover story shows the Arduino and the PLC got the job done. However, it also notes that this is just a simple flow control loop. Typical industrial applications include many other discrete and analog functions. This is a strong point of a PLC as many functions are built in, and I/O expansion capabilities are extensive. This functionality and expandability is not included with the Arduino, unless you do the work to create the hardware and software.

The best programming method often depends on the user's background. An experienced C language programmer will likely find the Arduino a quick study. However, all functions, even the most basic, will need to be custom coded from scratch. Ladder logic programming may take some time as well, depending on the user.

The cover story notes, however, that the number of online and other tutorials available for PLC certainly weighs in its favor. The AutomationDirect website has many videos and tutorials aimed specifically at industrial users. "There are many function libraries available for downloading to perform common operations," notes Reneker. "For example, the PLC has loop-tuning software available, which would be very complex to write for the Arduino."

It's clear, from an equipment durability standpoint, that the PLC is much more suited for industrial applications than the Arduino or Raspberry Pi. The BRX PLC is also part of AutomationDirect's product line, providing long-term support along with scalability, built-in capabilities and ease of expansion. Additionally, a quick look at the expansion I/O modules, operator interfaces and other made-to-integrate hardware makes the BRX PLC an off-the-shelf and time-efficient solution.

Reneker sums it up well at the end of the Control Design August 2017 cover story. "For someone learning the basics of code writing and concepts of control, the Arduino and its ilk provide interesting teaching tools. Having to write control algorithms from scratch causes a user to consider the intricacies of how automation is performed. The availability of devices with this level of sophistication at such low costs is quite remarkable and is a boon to those with more time than money."

But for an actual industrial application where production and revenue are at stake, says Reneker in the cover story, "a PLC with equivalent or better capabilities can be had for a few hundred dollars, and it will come with extensive online training videos and other information, and with function block libraries designed specifically for industrial applications."

IMAGES COURTESY OF PETER WELANDER AND DOUG RENEKER ■

Keep it Cool...

it's easy and affordable with Enclosure Air Conditioners, Fans and Vortex Coolers from AutomationDirect!

Enclosure Climate Control

It's easy to keep cool when you buy from our wide selection of low-cost industrial strength enclosure cooling products. We have the enclosure climate control solution for your specific needs, from economical filter fans, to compact vortex compressed air coolers, to robust A/C units, all with the best customer care and support in the industry. Shop at AutomationDirect for all your enclosure cooling needs, where saving money is no sweat!

Enclosure Air Conditioners

- For NEMA 12, 4, 4X type electrical enclosures
- 1,000 to 8,000 BTUH
- Available in 120V, 230V and 480V supply voltages
- High unit efficiency
- Closed loop air circulation for a contaminant free environment

Enclosure Vortex Coolers

- Exceptionally reliable - no moving parts and virtually no maintenance
- Creates cool air without refrigerants (no CFCs, HCFCs)
- 400 to 2,500 BTUH

NEW! STEGO Enclosure Filter Fans Plus

STEGO filter fans are reliable and affordable fans that provide optimum climate in enclosures. And now they're even better with the release of the NEW Filter Fan Plus line which offers more options, efficiency, and simplified installation, all for the same low cost.

- High-performance enclosure cooling fan motors and finger guards
- FPI (airflow in) or FPO (airflow out) models
- Easy filter change via hinged cover
- 115 and 230 VAC or 12, 24, and 48 VDC models
- (4) six-position ratchet lever mount mechanisms allow quick and easy install

30-day Money-Back Guarantee 30 day

FREE Technical Support

FREE shipping - orders over $49 2-day Shipping

Research, price, buy at:
go2adc.com/climate-control

VOTED Best in SERVICE 15 YEARS

Order Today, Ships Today!

AUTOMATIONDIRECT.com
1-800-633-0405 the #1 value in automation

EFFICIENT PLC PROGRAMMING DRIVEN BY PROGRAMMING SOFTWARE

By Joan Welty, AutomationDirect

Top-down configuration and device-centric concepts lead the way during PLC program development.

Programmable logic controllers (PLCs) are available in a variety of sizes for applications big and small. While the application's hardware requirements often drive the PLC selection, the programming software's capabilities should also be considered as it has a significant effect on program development.

Some programmers may open the PLC programming software, create a new project and start creating ladder logic immediately-but this can lead to configuration-on-the-fly, not the most efficient technique. Instead, depending on the controller selected, the programming software may have built-in features allowing configuration based on menu-driven selections, which is often the better path (Figure 1).

An Efficient PLC Family

Figure 1: The AutomationDirect Do-more BRX Micro PLC family of PLCs enables efficient programming by providing top-down configuration and a device-centric approach.

In his July 2017 Control Engineering "Controller Embeds Programming Efficiency" article, Bill Dehner explains how top-down configuration and device-centric methods help lead a programmer down a quick and productive path. Bill Dehner, a Technical Marketing Engineer at AutomationDirect, explains how built-in, menu-driven choices configure devices, which then handle common functions behind the scenes with little programming required.

An example of this efficient programming can be found in AutomationDirect's Do-more Designer PLC programming and documentation software, available via CD or free download. This article discusses top-down configuration and device-centric programming, possible with software such as Do-more Designer. The article also includes examples of how these concepts can be used to improve programming efficiency in Do-more controllers like the BRX micro PLC.

Step to Top-Down Configuration
1. CPU configuration
2. I/O configuration
3. Module configuration
4. Device configuration
5. I/O mappings
6. Memory configuration

What is Top-Down Configuration?

In the Control Engineering article, Bill Dehner explains top-down configuration. "For some controllers, configuration is simplified using a top-down method (Table)," he says. "The order of the tasks listed in the Table is by precedence, with each item in the list depending on the item or items above it. For example, everything below CPU configuration depends on how the CPU is configured. Serial port, port type, Ethernet I/O Master options and server options such as Modbus/TCP and EtherNet/IP Explicit messaging are all configuration selections typically available during CPU configuration. These selections add necessary parameters to some or all the items below CPU configuration."

Setting up a controller in the proper order can simplify a software development project by automating certain steps, and by helping below tasks fall into place. For example, when configuring an EtherNet/IP Server, only the appropriate parameters are exposed in subsequent configuration dashboards.

Device-Centric Concepts

Following a methodical top-down configuration leads to device-centric concepts. With device-centric, the device is in the middle, so the ladder diagram program talks to the device, not directly to the hardware (Figure 2). These device drivers take care of low-level details, freeing the programmer to concentrate on the application.

"What is a device," asks Dehner in the article? "A programmer likely thinks of a device as a sensor, encoder, I/O module, variable frequency drive (VFD), EtherNet/IP module, remote rack, or a similar piece of hardware," he says. "In a device-centric controller, the devices are instead pieces of code

The Device is in the Middle

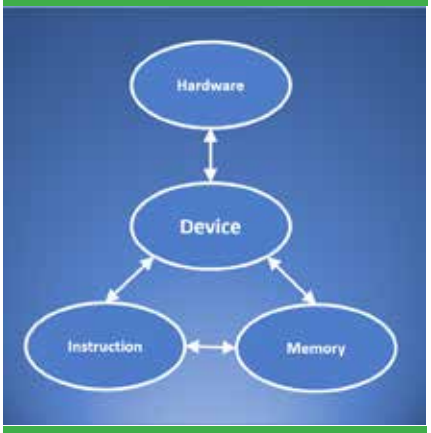


Figure 2: AutomationDirect's Do-more Designer uses a device-centric approach which places the device in the middle to handle the low-level interface between hardware components and the PLC's program instructions and memory.

between the program and the hardware.

Using this concept, the device is configured, and it handles the details for control of the hardware by the controller such as establishing communication protocols, handshaking and defining memory requirements. Much of the hardware details are handled via configuration of each device, not with controller programming."

A program instruction talks to a configured device, not to the hardware directly. Configuring a device defines memory and creates related variables, handshaking bits and memory flags.

A comm port device sends data to and from memory. As data is transmitted and received, buffering and status flags in memory are handled by the device. With device-centric programming, everything passes through the device which handles the details, behind the scenes.

A server is a device as well. Again, it talks directly with hardware. It runs in the background managing the data moving between memory and the hardware. An example is a Modbus/TCP device. It is configured, then functions mostly outside of the program, but the program accesses it to send and receive data.

Using Devices Efficiently

"Regardless of the complexity of the hardware selected, the device provides a clean, uniform interface between the hardware and controller program," says Dehner in the Control Engineering article. "Each device is set up the same way, for example a Modbus/RTU or a general-purpose serial port, by following top-down configuration steps which require selecting features and filling in a few blanks."

A typical application was discussed in the article-a box diverter. It contains a variety of hardware that is often controlled by a PLC. This includes encoders synchronizing a conveyor to a diverter gate dependent on box length, a VFD controlling a motor, and barcode scanning of a box on the conveyor to divert it to the proper destination. There are also inputs and outputs used to connect sensors and pneumatic actuators to detect a box and control a lift.

"As this box diverter application demonstrates, it's not unusual to have several different pieces of automation hardware connected to a PLC, with each hardware component and its required connections defining the devices," says Dehner in the article. "However, in this instance, a controller utilizing top-down configuration and device-centric concepts is quickly configured, with much of this effort performed automatically."

"If the controller lacks on-board high-speed inputs, a high-speed counter module can be used to count the quadrature pulses from the encoder", continues Dehner. "This module is not a part of the CPU configuration, but it is automatically discovered in the second step, I/O configuration" he says. "The third step, module configuration, will then autofill the needed parameters with default values for the discovered module. Any edits to the configuration required can be made here during this step. The PLC will automatically handle the I/O mapping for the added module, and create the needed image register addresses."

Configuration and use of the built-in Ethernet port "device" in a controller such as the BRX begins at the top of the configuration list. During the CPU configuration step, the Ethernet I/O master is selected to enable it. When enabled, IP configuration and other communication options are created in the I/O configuration. At this point, the device is available for use in the program, since the I/O mapping is completed automatically.

In the article Dehner also discusses how the controller's serial port uses simple ASCII text strings to communicate with the barcode scanner. "The port is recognized during the CPU configuration step, where a general-purpose serial port is configured including settings such as baud rate, and hardware protocols such as RS-232," he says. "I/O and module configuration is not needed, and the device configuration is created automatically, providing a pre-configured interface with access to system resources. The memory configuration step automatically allocates memory for the device."

In this diverter example, multi-point discrete input and output modules are used, which is typical in many automation applications. Similar methods are used to configure these modules. While some devices are more complicated to set up than others, they all use the same configuration methodology. Each is configured starting at the top of the Table, and then working down. By following this methodology, only parameters that need to be configured are accessible, and much of the configuration is automatically defined.

Effective Instructions

The diverter example above shows how a top-down and device-centric controller programming speeds configuration. The BRX controller using Do-more Designer programming software offers efficient PID loop and motion control instructions as well.

Many different control loops require the use of PID instructions, and Do-more Designer provides additional PID instruction features and functionality including run-time configuration, modularity and interchangeability.

"Part of this improved efficiency is the result of breaking down the PID loop into smaller pieces," says Dehner in the article. "Instead of embedding all the PID parameters such as filters, scaling, ramp-soak tables and alarm handlers in one PID instruction, separate instructions are used to access the parameters individually to simplify customization of these control algorithms. These instructions can also include trend views for display to help with understanding of the control loop response, and to assist with initial tuning and troubleshooting."

Motion control instructions can follow a similar path, broken down into different levels

continued p. 30 >>

PLCS IMPROVE CONTROL OF RADIO BROADCASTS

By Dennis Sloatman, Vice President of Engineering and Information Technology at iHeartMedia, Los Angeles

PLCs are slowly replacing the outdated hardware and software used at many remote transmitter sites in radio and TV broadcasting applications.

Broadcasting is a high tech industry and much of it is cutting edge, such as Ethernet-based audio over IP. Our industry employs the latest technology in many areas, such as the use of coding algorithms for bit rate reduction and remote broadcasting. But when it comes to controlling the radio signals sent out by the transmitter, most stations are still doing things the same way they have for a long time.

Controlling the broadcast hardware connected to the antenna—and the related transmission power, source and facilities—is still low tech. Typically, the broadcast engineer gets in his or her car and drives to the unattended transmitter, translator or repeater site (Figure 1) to flip switches and make other manual adjustments.

In radio and TV broadcasting, it's easy to get distracted by the acoustics, microphones and audio processing. But it's also important to focus on the transmission system because this is where all of the hard work in the studio is disseminated to listeners.

I love the broadcast industry and have been working in it for 46 years. I've been using programmable logic controllers (PLCs) to automate broadcasting functions that have been traditionally very manual, or custom and semi-automatic at best. This article shows how I automated the switching and backup functions of an antenna and transmitter system to improve operations, cut costs and improve reliability. It also provides a path for others in the industry to automate their broadcast and other facilities with PLCs, just as I've done.

Serving Southern California

iHeartMedia oversees 10 radio stations in a geographical area the size of South Carolina. The LA metro area is enormous in terms of population, which presents opportunities and challenges. In addition to radio stations, iHeartMedia owns outdoor advertising and also has a large online radio presence in the form of the iHeartRADIO app. The station broadcasts in digital, HD radio and old-fashioned FM.

The iHeartMedia website (**www.iheartmedia.com**) claims over a quarter of a billion monthly listeners in the U.S. and has the largest reach of any radio or television outlet in America. It owns and operates 858 broadcast radio stations serving more than 150 markets throughout the U.S., so there are many transmitter sites controlling AM and FM radio signal transmission.

In the old days, controlling the audio, antenna and transmitter was strictly a manual process. In more recent times, broadcast-specific remote control systems have been deployed to provide rudimentary control via dialup modem. With these systems, alarms can be setup to notify personnel by phone or email if there is an issue. The systems can also have macros programmed to handle automatic functions. The problem is that the cost, reliability and simplicity of these systems don't come close to what the PLC can deliver.

Interfacing and Control with PLCs

The use of PLCs in broadcasting to control transmitter functions is a topic broadcast engineers don't know much about. Discussing a common piece of broadcast equipment, such as audio mixers and audio distribution amplifiers, is easily understood in the broadcast industry. The use of PLCs to perform broadcast functions is not. Ladder logic and tag databases are not well understood, so the learning curve is steep.

Although many broadcast engineers don't realize it, the hardware commonly used in industrial automation works well for control and monitoring of transmission facilities. 50,000 Watt transmitter sites consume about 150 kW of power and contain air, power distribution and backup power systems.

Over the years, broadcast engineers have upgraded manual monitoring of trans-

Figure 1: KLAC transmitter building. Many transmitter sites, such as this KLAC radio station facility in Los Angeles, are remote and unattended.

Figure 2: KLAC P2000 transmitter automation system. An AutomationDirect Productivity2000 PLC was used to automate transmitter pattern and backup switching at a remote facility.

mission facilities by applying custom electrical cabinets filled with relays, timers, diodes and capacitors. Some are even taking a Raspberry Pi and interfacing it to a motor or blower fan using contactors and relays, which is not the simplest, most cost-effective, or the most robust design. By contrast, a PLC is designed to reliably control contactors, relays and other components in an industrial setting.

Many broadcast engineers spend a lot of time developing interfaces among different components and items of audio equipment. They take a transmitter manufactured by one company, an audio processor made by someone else, and a remote control system by yet another manufacturer and connect them together along with air conditioners, electrical distribution panels and exhaust blowers. They then figure out a way to integrate it all into a system, but the control hardware they use is often not suited to the task.

Automating Broadcast Functions

Automatic failure switchover and remote access are sorely needed in broadcast because many of the remote transmitter sites aren't readily accessible, particularly during periods of inclement weather. The discrete manufacturing and process control industries have been automating with PLCs for years to provide remote access and other advanced functionality, and we're now adapting this technology to broadcasting.

An application that highlights the use of PLCs in the broadcast industry is at our Dodgers Flagship station in Los Angeles, KLAC AM 570. In this application, we're using the AutomationDirect Productivity2000 controller (Figure 2) as an antenna/transmitter controller, and we chose this PLC for a number of reasons.

We've used the AutomationDirect CLICK controller in the past for transmitter control and it worked well. However, for the KLAC antenna/transmitter controller, we wanted to add more features. This included email notifications anytime the system did a transmitter pattern change or an error occurred, which is a built-in function of the Productivity2000 PLC. It also has PID built-in, which will be needed for building environmental control when added in a future project.

KLAC is a directional, amplitude-modulated (AM) radio station. In the daytime, it operates using a single tower (antenna) in non-directional mode, which is common in broadcasting at AM stations. At night, it uses two towers to produce a more directional signal to avoid interference with other stations on the same frequency, which is needed because AM signals travel farther at night. This pattern change is required and defined in the station's license from the FCC.

The PLC automates the switching between daytime and nighttime patterns. Using the real-time clock in the controller, we built a table to control the switching time in compliance with FCC regulations. The PLC performs the automated pattern change and sends an email to confirm.

Reliable Broadcasting

The Productivity2000 PLC and an AutomationDirect C-more touch panel display are the main components of the automation system also used to control and monitor the status of the station's main and backup transmitters. When we are broadcasting a Dodgers game, the station absolutely has to be on the air, and the reliability of the PLC ensures a continuous transmission signal

The PLC monitors the status of the main transmitter and will try to restart it if it fails. If unsuccessful, it automatically switches to the backup transmitter. If the backup fails, it switches to a third level transmitter and lowers power if necessary to keep at least a weak signal on the air.

The automation system duplicates what a human would do at the site, automatically handling antenna switching, pattern change, parameter monitoring and other functions. It also performs data logging per FCC guidelines, with this information available remotely. The PLC has a built-in webserver, so we can access logged data remotely via any browser. In our case, this is done through a Cisco firewall at the site.

PLCs have been very reliable compared to the custom control systems used previously. The PLC controls a wide variety of off-the-shelf audio switchers made by various companies. For the radio antenna switching, the PLC is controlling large RF contactors. We control these devices by mixing and matching the PLC's input and output modules including discrete, analog, relay contact and serial I/O. Using these I/O points, we can interface the PLC to all of our broadcast industry equipment.

We also installed a C-more touch panel display (Figure 3, next page), and created a main screen with buttons to change modes of operation or select a transmitter. The main screen also displays current time and transfer times for the month, along with a wide variety of analog parameters such as transmitter output, current to the antenna and system status. And if needed, a calibration screen can be accessed to scale the analog values to actual engineering units.

Test, Installation and Startup

Installation and startup of the antenna/transmitter automation system took significant planning to minimize the impact on broadcasts. Several test jigs were built to verify

continued p. 30 >>

continued from p.29

Figure 3: KLAC facility after new automation system installation. An AutomationDirect C-more touch panel display provides functional information about the transmitter site, as well as manual control and calibration functions.

operation of the automation system prior to installation, with simulated transmitters built to our specifications to make the test as close to the actual installation as possible.

For testing, we plugged in three simulated transmitters and connected RF contactors. We simulated the complete KLAC setup that the PLC would be controlling, and performed weeks of testing. After some tweaking and optimizing of the PLC and C-more programs, the resulting automation system worked far better than anything that had been installed at KLAC.

The installation went as planned. There were over 30 cables to install, and we used AutomationDirect ZIPLink modules to greatly reduce wiring time. To reduce off-air time to the absolute minimum, signals were bypassed with jumpers until tested so the station could continue transmitting while we installed the new automation system.

There were a few minor tweaks required to the program during onsite startup. When switching transmitter patterns from day to night, the RF signal from the transmitter must be muted to avoid putting 50,000 W through a contactor and damaging it. Tweaking was required to minimize the time that the station was off the air when switching. Actuation times of contactors and RF power-off delay of transmitters needed to be fine-tuned, and when this was completed the pattern switching was barely audible.

Working with AutomationDirect was straightforward and simple. They were chosen based on cost, quick delivery and ease of use. Shipping is free, and they provide emailed status updates. We have called for technical support a few times and were always provided with quick and comprehensive answers.

The AutomationDirect automation system is operating flawlessly at a high-power facility in a remote location. In the future, we plan to use AutomationDirect hardware to automate many more broadcast systems including automatic FM antenna switching, power control, and transmission line pressurization and fault detection.

This article reprinted from Nasa Tech Briefs, 2017.

continued from p.27

of instruction complexity, continues Dehner in the article. "Simple motion instructions allow quick application of basic move commands with minimal required configuration," he says. "Intermediate-level motion instructions provide more user-defined parameters. Advanced instructions enable selection or creation of custom move profiles, often through a simple configuration process."

New, advanced controllers provide a top-down approach and use device-centric methods. If the configuration is performed in the proper sequence, much of the hardware-to-software device configuration happens automatically. These efficient methods lead to quick development of program logic, and an enhanced variety of available instructions and programming further increases efficiency.

Power & Ethernet
combined to save you even more

Stride®

Unmanaged Industrial Grade Power Over Ethernet (PoE) Switches

STRIDE PoE Unmanaged Ethernet switches provide 10/100Mbps or 1000Mbps (GbE) Ethernet communication along with up to 30W of DC power (on each port) to your PoE enabled devices. These switches feature PD (Powered Device) Detection which allows the switch to detect the presence of a PoE enabled device before sending power. If a non-PoE device is detected, power will not be sourced on that port but Ethernet communication will be permitted.

With STRIDE PoE switches, no power supply is needed for your end device and no electrical power cable runs are required. By combining DC power and Ethernet communication in one device, these low-cost industrial-strength switches will save you even more!

FEATURES:

- Full PoE+ on four ports (30W on each port)
- PD (Powered Device) Detection
- Broadcast storm protection
- Power input requirements: 54-58 VDC for PoE+; 48-58 VDC for PoE
- Wide temperature range: -40 to +75°C (-40 to +167°F)
- Redundant power input
- GbE model available
- UL(cUL) listed, CE certified, and Haz Loc rated (C1D2)
- IP30 metal cases
- 5-year warranty

30-day Money-Back Guarantee 30 day

FREE Technical Support

FREE shipping - orders over $49 2-day shipping

5 YEAR WARRANTY

Research, price, buy at:
www.go2adc.com/poe

Order Today, Ships Today!

VOTED Best in SERVICE 15 YEARS

AUTOMATIONDIRECT.com
1-800-633-0405 the #1 value in automation

COPLEY HIGH SCHOOL'S AUTOMATION SUCCESS

By Hiba EL Rassi, 2017 Team Leader of Copley Innovators at Copley High School

With assistance from AutomationDirect, the Copley Innovators designed, built and programmed an award-winning automated cap assembly machine.

The Innovator team at Copley High School in Akron, Ohio needed to design a piece of equipment to snap caps together for Weaver Industries ProPak, a company that has been employing people with disabilities for about 40 years. With the existing assembly method, Weaver was struggling to meet production and contract requirements for component assembly.

As part of the SourceAmerica 2017 Design Challenge, the Copley Innovators from Copley High School, in Ohio, partnered with Weaver Industries ProPak to design a machine, called the Delta Snap, to easily and efficiently assemble a grinding capsule and top into a salt and pepper grinder cap for the food industry. The Copley Innovators won 2nd place in this national competition (Figure 1).

Figure 1, (Copley innovators 2nd place): The 2017 Copley High School Innovators team included, left to right, Colton Murray, Aaron Lampner, Assistant Coach Fiona Casida, Hiba EL Rassi, Coach Kirby Harder, Madeline Wiley, Georgia Shay, Kevin Du.

According to its website (**www.sourceamerica.org**), the SourceAmerica Design Challenge is a national engineering competition in which participants create innovative workplace technologies for people with disabilities.

The Problem

The original process required snapping together a top cap to a grinder capsule portion of the cap, and gently dropping the completed assembly into a box. The process looked easy, but when snapping the parts together, they would make an audible click as if they were assembled, but another click was often required to fully seat the parts. Also, dropping the part into the box, was causing some of the parts to come unsnapped.

The Copley Innovators visited Weaver Industries ProPak and talked to employee subject matter experts—and to the operation manager in charge of assembling, packaging and quality control of the grinder caps. After this visit, the team got together to brainstorm ideas on how to design and build a semi-automated process to solve Weaver's production and quality problems. The team decided to split up the work into different jobs such as specifying parts, programming the automation systems, and building the machine.

The Copley team considered fixturing the parts on a pallet and rolling a large drum over the parts to seat the caps, but this prototype roller/press tooling still did not close the caps properly. A prototype press was then designed and built, consisting of an air cylinder mounted to a block to snap the caps together.

The Solution

Although the prototype press worked, it was not safe for operators. Taking what was learned from prototype testing,

Figure 2, (Delta Snap Machine): The Copley Innovators solution to the design challenge was to design a manually loaded, six-station, semi-automatic machine they named the Delta Snap.

the team got together and designed a larger, safer and more sophisticated final prototype machine to help Weaver Industries assemble grinder caps. The design of the machine eliminated the need for operator strength or dexterity.

The final prototype machine assembles six caps at a time (Figure 2). The operator preloads the top and bottom caps together into six nests, and presses dual anti-tie-down buttons to start the cycle, assuring that the operators hands are clear of the machine. The machine then extends the part nests under six press cylinders. Once the nests are positioned, the press cylinders extend and press the top and bottom caps together.

The press cylinders then retract, and two additional cylinders open a door below the press. This opens the bottom of the nests, dropping the assembled caps into a box. The door then closes and the empty nests return to the load position, completing one assemble cycle of six parts. The operator then repeats the cycle.

Control Hardware, Programming and Pneumatics

Much of the control and pneumatic systems used were supplied by AutomationDirect. They have worked with Copley in the past, and were a near single-source supplier for all the controls hardware. Their technical support was also a tremendous help when designing, assembling and programming the machine.

An AutomationDirect CLICK Basic programmable logic controller (PLC) was used because it's well suited to a machine of this size and complexity. A mating CLICK power supply provided the needed 24 Vdc control power. A 16-point, 24 Vdc discrete input and a 16-point, 24 Vdc discrete output module were connected to the PLC to monitor and control the I/O.

The free CLICK Programming Software was downloaded from AutomationDirect's online store to program the machine sequence. All team members were involved with the PLC programming, providing a great learning experience. Team members made some mistakes along the way, but in the end, the machine sequence worked as designed.

AutomationDirect supplied most of the pneumatic hardware including cylinders, solenoids, valves, fittings and tubing. Single-solenoid, 4-way, 2-position, spring-return NITRA solenoid valves with ¼" FNPT inlets and outlets are used to control the nine air cylinders on the machine. These valves are operated by 24 Vdc outputs from the PLC, wired through an 11 mm DIN style wiring plug, and the valves operate the NITRA pneumatic air cylinders.

Most cylinders are ¾-inch bore with a 3-inch stroke. These are double-acting cylinders, requiring air to extend and retract, with a magnetic piston. NITRA solid state cylinder position switches detect the position of the magnetic piston within the cylinder to assure a complete press cycle to error-proof cap assembly.

The magnetic sensors are set to the specific cap height (Figure 3). The full stroke of the press cylinders can only be reached if the cap and grinder capsule are both right-side up

continued p. 34 >>

continued from p.31

Figure 3: (Caps Height Difference): If the cap and grinder capsule were not placed properly in the parts nest, the full-stroke sensors on the press, positioned at the green line, would not sense NITRA cylinders' magnetic piston.

and correctly positioned in the part nest. All other part positions limit the stroke of the press cylinders, so the sensors don't detect the piston, triggering an error sequence, and causing the red light mounted on the part nest to turn on.

Operation

The machine is simple to operate, with only minimal training required. It is wheelchair accessible, with both cap parts within reach of the machine operator.

An operator interface panel displays the status of the machine. There is a four-digit display to count parts assembled, along with how many minutes it has taken to fill a box. Red and green lights are embedded in the machine's part nests. A red light at a nest indicates the cap was improperly placed in the machine, and a green light at a nest indicates the cap was placed properly. When the maximum box part count of 834 is reached, the green lights flash, indicating the full box should be removed and a new box put in its place.

The original process could cause fatigue and there were possible pinch points, but the design of the new Delta Snap machine is safer and much more ergonomic. The machine can only be turned on by a supervisor via a key switch. The machine's dual palm buttons protect operator's hands by ensuring both buttons are pressed before the fixture can extend under the press cylinders. There is also an emergency stop button and an air dump valve to stop machine movement.

Impact in the Workplace

The operators really like the machine. It is like playing a game; drop a set of capsules and caps and go. The operators said their hands didn't get tired, which was an issue when it was necessary to manually snap the parts together.

The machine exceeded every need of Weaver Industries ProPak, and helped ensure the contract to assemble grinder caps remained in place. It solved Weaver's quality control problem of not properly seating the cap to the grinding capsule. The machine also reduced the defect rate and quality control checks. A supervisor no longer needed to provide a second check of the assembled cap, and the assembly defect rate was reduced from 16% to near zero.

Efficiency was also greatly improved. One operator improved her productivity by 80% the first time she used the new Delta Snap machine, and she had been assembling grinder caps for two years, saving 78 operator hours per order.

The SourceAmerica Design Challenge was a great experience for everyone on the team. They started from ground zero with no knowledge of machine automation, and ended up building build a useful machine for Weaver Industries ProPak and their employees. The team learned how to order parts, program PLCs and work with pneumatics. They also learned how to use tools such as bandsaws and drill presses, and to tap holes and solder wires. Most importantly, the team completed a real-life engineering project where they had to define a problem, brainstorm ideas, and build a machine to provide a solution. See more about the team as well as links and additional images at **http://bit.ly/SourceAm** and **https://www.youtube.com/watch?v=tBdNICGyTfo**.

The big winners were the employees of Weaver Industries ProPak. Instead of bruising and fatiguing the operators with time-consuming manual assembly, each employee now enjoys working with the efficient and semi-automatic Delta Snap machine. ■

BRAINTEASERS

By Chip McDaniel

1.) Budget Fudget

In his first visit to the AutomationDirect website, a purchasing agent spent half his meager budget on a STRIDE industrial Ethernet switch, and then $5 on some cable ties*. On his second visit, he spent half the remaining budget on a Photoelectric Sensor and $10 on a Cat5E Patch Cable. On his third visit, he spent half the remaining budget on an Inductive Proximity Sensor, and $15 on a SureMotion Timing Pulley. After the three purchases, he had $5 left in that particular budget. What was the original budget amount?

*New SapiSelco cable ties now available in multiple colors and at even lower prices (as low as 1¢/tie, that's right - just $1/100pk!)

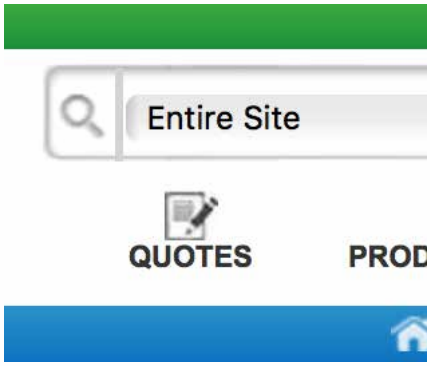
www.go2adc.com/sapiselco

2.) DIY Quotes!

A customer called two automation suppliers for pricing on a pushbutton and a safety switch. She was amazed when both distributors quoted the exact same prices for the two items over the phone. She asked them to fax over formal quotes for both parts, but both distributors made mistakes at this point - one subtracted the cost of the push-button from the safety switch, and quoted $44. The other multiplied the two prices and quoted $1280. What were the original, verbally-quoted prices for the two items?

Did you know you can generate your own Formal 30-day Quotes right on the AutomationDirect website? Just click the Quotes button at the top of any webstore page OR visit

www.go2adc.com/quotes



3.) Old Records / Pneu Records:

Engineer Bob placed an order for a large quantity of pneumatic cylinders from AutomationDirect last year, but he promptly forgot what he bought, AND the unit price AND the quantity of the item he purchased. He did remember that the total price for the parts was $47,867, excluding tax and shipping*. His summer intern did some quick figuring, and a price check on the AutomationDirect.com website and announced that she knew exactly which item had been purchased, the quantity, and the price paid. How did she do it? Bonus: what was the price and quantity of the item?

*Remember that AutomationDirect.com offers free two-day shipping on all orders over $49 - and customers outside of Georgia don't (currently) pay any sales tax.

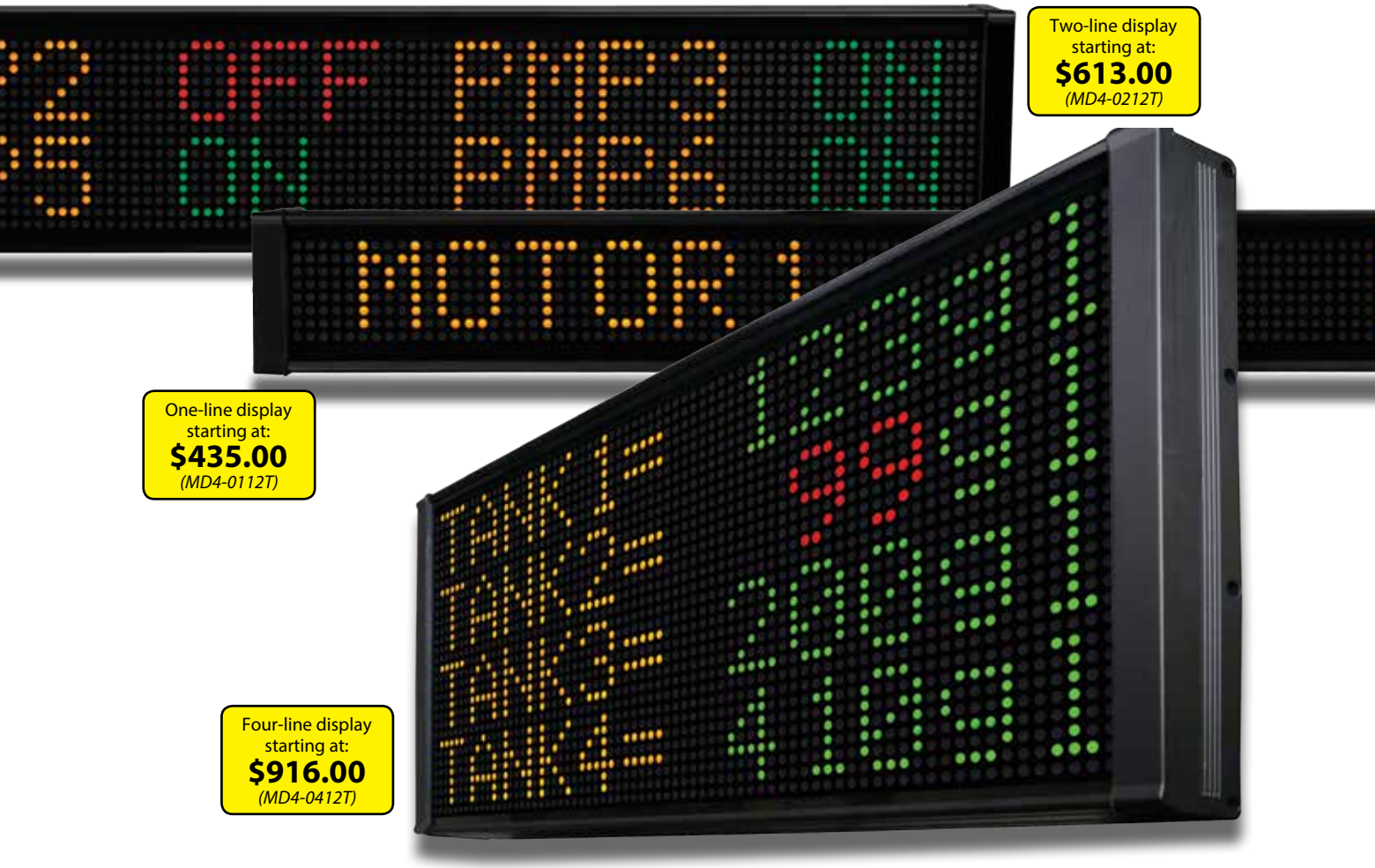
** Also note that you can review all your past purchases online also - but that's NOT how the intern solved this problem!

Credit to Henry Ernest Dudeney (1857 - 1930) for inspiration on this month's puzzles. He was a very interesting fellow. Learn more:
https://en.wikipedia.org/wiki/Henry_Dudeney

Visit **www.automationnotebook.com** for answers.

Low-cost message displays

Say it for less with ViewMarq



VIEWMARQ®
LED MESSAGE DISPLAY

Get the word out without spending a fortune with industry-tough LED message displays from AutomationDirect. ViewMarq LED message displays can display preformatted and real-time factory floor data messages controlled by a PLC, PC, or other master device.

Each display includes multiple options for communicating vital information:

- ASCII strings through the RS232 or RS485 port
- Modbus RTU messages through the RS232 or RS485 port
- Modbus TCP messages through the Ethernet port

The affordable ViewMarq line also offers:

- One-, two-, and four-line displays
- Right, left, up and down message scrolling options
- Viewing distances up to 400 feet and 140 degree viewing angle
- (1) RS232, (1) RS485 and (1) Ethernet port standard on all models
- FREE ViewMarq configuration software (online download) used to configure the display; create, preview and send messages from a PC; or create ASCII strings for PLC control
- NEMA 4 / NEMA 12 extruded aluminum housings suitable for harsh environments
- Mounting hardware, cable glands and Ethernet cable included

Research, price, buy at: www.automationdirect.com/viewmarq

Order Today, Ships Today!

VOTED Best in SERVICE 15 YEARS

AUTOMATIONDIRECT.com
1-800-633-0405 the #1 value in automation