

CONTROL ENGINEERING

JANUARY
2018

Covering control, instrumentation, and automation systems worldwide

Factory automation controllers

18, 22, 24, 27

At AutomationDirect.com we have the PLCs you need at the prices you want.

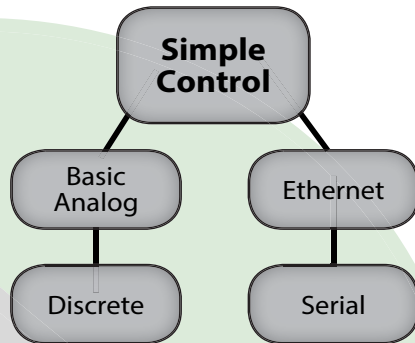
Regardless of your project or system needs, AutomationDirect has a PLC to match your specs and your budget. So whether you're building a simple process or a complex machine, you can count on us for affordable PLCs you can rely on.



CLICK PLCs
Basic PLC Unit starting at **\$69**

Free Programming Software & Tech Support for Life!

The CLICK PLC family offers extreme value for everyday applications. The compact size and easy programming make CLICK great for small applications and beginner projects.



Research, price, buy at:
www.CLICKPLCs.com

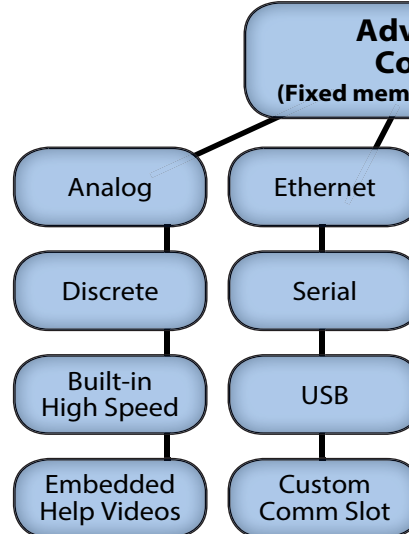


Do



Do-more PLCs start at
Free Programming Software

The Do-more PLC family is a programming powerhouse. With its extensive instruction sets in the market, it allows it to stand strong against



Research, price, buy at:
www.Do-more.com

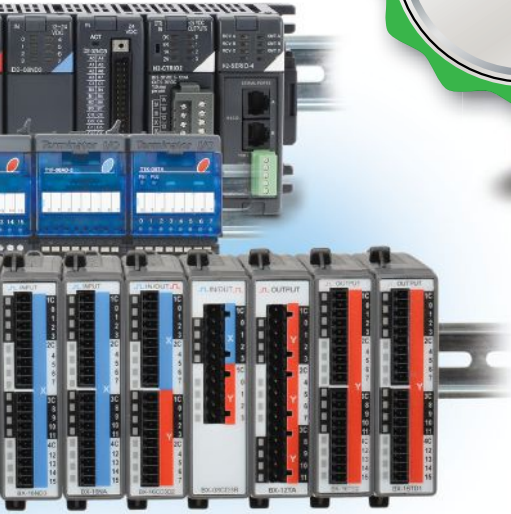
AUTOMATIONDIRECT.com
1-800-633-0405 www.AutomationDirect.com



input #22 at www.controleng.com/information

OU

more!



Productivity[®]Series.....



Productivity Series CPU starting at **\$169**

Free Programming Software & Tech Support for Life!

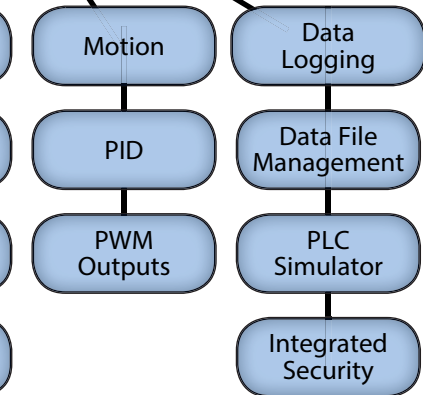
starting at **\$199**

Free Programming Software & Tech Support for Life!

determined to get it done. This has one of the most advanced set and many other features that t any challenge.

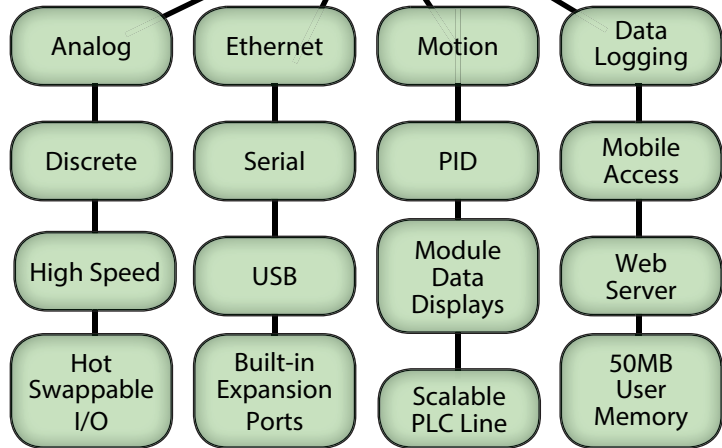
Are you still paying the price for your Allen-Bradley controller? Are you tired of the never-ending software and support expense? Has the unbearable cost of ownership taken you by surprise? Well now you can break FREE with Productivity. The Productivity Series PLCs are high-performance tag name based controllers with expansive built-in communication options and other features you'll love at an awesome price. And with Productivity you'll never get hit with extra fees since our software, manuals, tech support, and access to online resources are all completely FREE!

Advanced Control (Memory addressing)



price, buy at: www.morePLCs.com

Advanced Control (Tag name based)



Research, price, buy at: www.ProductivityPLCs.com

PLCs with a purpose...

...to exceed your needs while saving you money!

Do more

Do-more PLCs
starting at:
\$199.00
(BX-DM1-10AR-D)

Productivity Series

Productivity PLCs
CPU
starting at:
\$169.00
(P1-540)

CLICK

CLICK PLC Units
starting at:
\$69.00
(CO-00DD1-D)



We have the PLC for you...

Your industrial automation needs can vary from the smallest simplest machine to a complex plant-wide operation, and we want the opportunity to serve each and every one.

To meet the unique challenges of each application while at the same time guaranteeing the utmost satisfaction, we've partnered with three well-respected companies (Host Engineering, FACTS Engineering and Koyo Electronics) to develop three distinct, quality PLC product lines. Each PLC family comes with FREE software and life-long support, with new features added continually to not only meet ever-changing industry demands but also exceed your expectations.

So, if you've never considered AutomationDirect for your controller needs, let us show you how price and performance can work hand-in-hand for a better overall experience.

FIRST TEAM
LEADERSHIP
IN AUTOMATION

2016

Presented by AutomationWorld



GET MORE THAN YOU PAID FOR...



Order Today, Ships Today!
input #1 at www.controleng.com/information

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

*See our Web site for details and restrictions. © Copyright 2017 AutomationDirect, Cumming, GA USA. All rights reserved.

When things just work, work gets done.

Kepware's industrial connectivity software provides secure and reliable data from the shop floor to the top floor, so you can focus on productivity.

Learn more at kepware.com/CE



Bring Remote Devices to Your SCADA System



We help you connect remote devices to your existing SCADA system.



Got remote devices out there that you want to monitor with your current SCADA system? Automation engineers have relied on Moxa's technology to connect devices and equipment to control centers for over 30 years in different sectors including manufacturing, oil and gas, water/wastewater, and energy. We can help you connect to Modbus PLCs, CNCs and RTD sensors with high communications reliability and security.

Visit Moxa.com to learn more.

EZ Touch[®]

Gives Them a Run for Their Money!

Fully Loaded, Fully American, Fully Reliable HMI

\$583 Value at **\$349** Limited Time Offer*

30-day Money Back Guarantee



Starter Kit Includes:
EZPPS DIN-Mount Digital Power Supply
+ 7" Fully Loaded Widescreen HMI
+ Cable + Programming Software
with Patented Online-Edit

Fully Loaded, No Add-on Costs!



Watch Amazing Video Order Here!
Scan QR Code to Watch



*One Per Company, No Substitutions, No Other Discounts Applied

EZAutomation.net
Innovative Low Cost Automation Products Made in *America*

1-877-774-EASY

EZ PPS

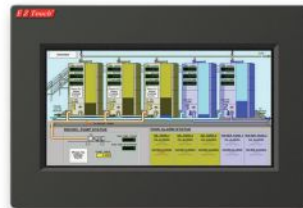
Power Supply Features



- Load Current Read-out LED display
- Output Voltage Read-out LED display
- Compact size on DIN rail mount (240W only 1.8" wide)
- Short circuit, over voltage and over temperature protection
- Displays remaining life in hours with built-in maintenance alert
- Programmable Current Limit
- Adjustable Voltage Setting
- NEC Class II for up to 90W Models
- Cost effective and still 100% Made in the USA

EZ Touch[®] Features...

- **Universal Connectivity to all Major PLC Manufacturers**
Allen-Bradley (EtherNet/IP, DF1, CIP Protocol, DH+), Siemens (ISO over TCP/IP, Profibus), Automation Direct (K-Sequence, Do-More, DirectNet, Productivity, Click), GE (SNPX, SRTP), Mitsubishi and more!
- **Dual Communication Drivers & Protocol Conversion**
Communicate to two different drivers simultaneously and convert data from one PLC manufacturer to another (i.e. AB EtherNet/IP and Siemens Ethernet)
- **Data Logging and USB Programming**
Store up to 8GB of valuable PLC data on Micro SD card. Convenient USB programming.
- **Incredible Graphics, Colors, and Resolution**
Advanced AVG Symbol Library (4000+ objects), 65K Colors, 800 x 480 Resolution
- **2 Serial and Ethernet Communications Built In**
Fully Loaded, no Add-on costs for Ethernet!
- **Patented Online-Editing**
No Machine Down-time when making any edits to HMI while in RUN mode!
- **WiFi Ready**
Connect your PC to wirelessly over EZ-WiFi



18

COVER IMAGE, TOP: A compounding control center houses an extrusion system's electrical and control infrastructure, including a programmable logic controller (PLC), ac drives, and solid-state relays. Courtesy: Rockwell Automation



RIGHT: Controllers may use tight integration and open IEC 61131 programming. Courtesy: B&R Automation

24

5 | **INSIGHTS**

- 6 | **2017 VSD/VFD survey findings**
- 8 | **Using software to provide IIoT value**

NEWS

- 12 | **Automation sales achieve highest levels of growth in 2017; Manufacturing index closes 2017 with strong surge**
 - 13 | **Digital technologies, connected enterprises at industry forum; Online articles**
- 16 | **Think Again: Hot topics in 2017**

Get credit for your learning

CFE Edu: <https://cfeedu.cfemedia.com/catalog>
(PLCs, IIoT, arc flash and more)

Webcasts: www.controleng.com/webcasts
(HMIs, sensors, IIoT, and more)



17 | **ANSWERS**

- 18 | **Modular control system design approach**
- 22 | **How to select the correct factory automation controller for your application**
- 24 | **Selecting an automation controller**
- 27 | **CNCs and PLCs in the future factory**
- 29 | **Make an interconnected enterprise**
- 31 | **Understand Ethernet cabling**
- 32 | **System integrators, customers, skills gap**
- 33 | **Drives get smarter**
- 35 | **Four trends in VFD management**

INSIDE PROCESS

- P1 | **Bluetooth connectivity makes VFDs safer, easier to use**
- P3 | **Three Major VFD trends**

40 | **INNOVATIONS**

PRODUCT EXCLUSIVE

- 41 | **Multi-connectivity IIoT gateway**

NEW PRODUCTS FOR ENGINEERS

- 42-45 | **Sensors, HMI, data management, industrial computers, networking, electrical protection, and more**

BACK TO BASICS

- 64 | **Ten control system programming tips**

CONTROL ENGINEERING (ISSN 0010-8049, Vol. 65, No. 1, GST #123397457) is published 12x per year, Monthly by CFE Media, LLC, 3010 Highland Parkway, Suite #325 Downers Grove, IL 60515. Jim Langhenry, Group Publisher/Co-Founder; Steve Rourke CEO/COO/Co-Founder. CONTROL ENGINEERING copyright 2018 by CFE Media, LLC. All rights reserved. CONTROL ENGINEERING is a registered trademark of CFE Media, LLC used under license. Periodicals postage paid at Downers Grove, IL 60515 and additional mailing offices. Circulation records are maintained at 3010 Highland Parkway, Suite #325 Downers Grove, IL 60515. Telephone: 630/571-4070. E-mail: customerservice@cfemedia.com. **Postmaster: send address changes to CONTROL ENGINEERING, 3010 Highland Parkway, Suite #325 Downers Grove, IL 60515. Publications Mail Agreement No. 40685520.** **Return undeliverable Canadian addresses to: 3010 Highland Parkway, Suite #325 Downers Grove, IL 60515. Email: customerservice@cfemedia.com.** Rates for nonqualified subscriptions, including all issues: USA, \$150/yr; Canada/Mexico, \$180/yr (includes 7% GST, GST#123397457); International air delivery \$325/yr. Except for special issues where price changes are indicated, single copies are available for \$30 US and \$35 foreign. Please address all subscription mail to CONTROL ENGINEERING, 3010 Highland Parkway, Suite #325 Downers Grove, IL 60515. Printed in the USA. CFE Media, LLC does not assume and hereby disclaims any liability to any person for any loss or damage caused by errors or omissions in the material contained herein, regardless of whether such errors result from negligence, accident or any other cause whatsoever.



Instrumentation that Keeps Danger at Bay



NEW

**SFY Functional Safety
Frequency-to-DC
Transmitter**

Put a fortress of protection around your process with FS Functional Safety Series instrumentation from Moore Industries. You can be confident that it will safeguard your processes when you need it the most. Our STA, SSX, SST, SRM, STZ and the NEW SFY Functional Safety Frequency-to-DC Transmitter have been designed and built to strict IEC 61508 standards, ensuring safe and reliable function – particularly in environments where hazardous or emergency situations are likely to occur.



MOORE INDUSTRIES WORLDWIDE

Demand Moore Reliability
input #3 at www.controleng.com/information



To learn more about our Functional Safety Series,
call (800) 999-2900, or go to:

www.miinet.com/safetyseries

CONTROL ENGINEERING

RESEARCH

6 Five VSD/VFD findings

Respondents to the Motor Drives study identified five key findings related to drives.

M More INSIGHTS

More research details, other topics
www.controleng.com/ce-research

CONTROL ENGINEERING CHINA

8 Using software to provide IIoT value

Schneider Electric is expanding its industrial software platform offerings to provide value for the Industrial Internet of Things (IIoT) to companies.

NEWS

12

Automation sales growth; Digital technologies, connected enterprises at forum; Manufacturing index closes 2017 with surge; Online

Weekly Top 5 articles recap the most-read articles at www.controleng.com posted during the prior two months.

THINK AGAIN

16

Hot topics in Control Engineering for 2017

Control Engineering readers choose hot topics of 2017 based on online traffic at the automation industry website. What can you learn from these top *Control Engineering* articles of 2017? Online, see the top three covers of 2017.

Simplify Machine IP Integration



EIPR IP Router

Maintain your factory-set IP addresses when integrating with the customer's IP network by using the EIPR IP Router.

- Reduce installation time
- Eliminate IP conflicts
- Easily comply with your customer's IP requirements

CONTEMPORARY CONTROLS

Learn more at www.ccontrols.com/machine

2017 MOTOR DRIVES STUDY

Five VSD/VFD survey findings

Eighty-seven percent of respondents to the *Control Engineering* 2017 Motor Drives Study buy, specify, use, or expect to use variable-speed drives (VSDs) over the next 12 months. Among those who do, below are five survey findings as they relate to VSDs and variable-frequency drives (VFDs) that control the speed and torque of ac or dc motors, among other functions:

1. Applications: VSDs are popularly specified for new ac/dc motor applications (90%), along with some retrofit (76%) and replacement (73%) applications.

2. Purchasing: Thirty-six percent of end users prefer to purchase motors and related VSDs, ac/dc controller products separately, while 24% order them as matched units and 40% have no preference.

3. Important factors: The top functions evaluated when comparing VSDs are frequent start/stop tolerance (78%), ability to continuously operate at a low

speed (76%), and low harmonics operation (70%).

4. Expenditures: End users estimated an average expenditure of \$148,000 for VSDs over the past 12 months, with 45% reporting \$50,000 or less and 12% spending more than \$250,000.

5. Control types: Seventy-eight percent of engineers are using a V/Hz control (open-loop) for their VSDs. One-fifth of users are planning to use encoderless, flux vector, or direct torque controls in the near future. **ce**

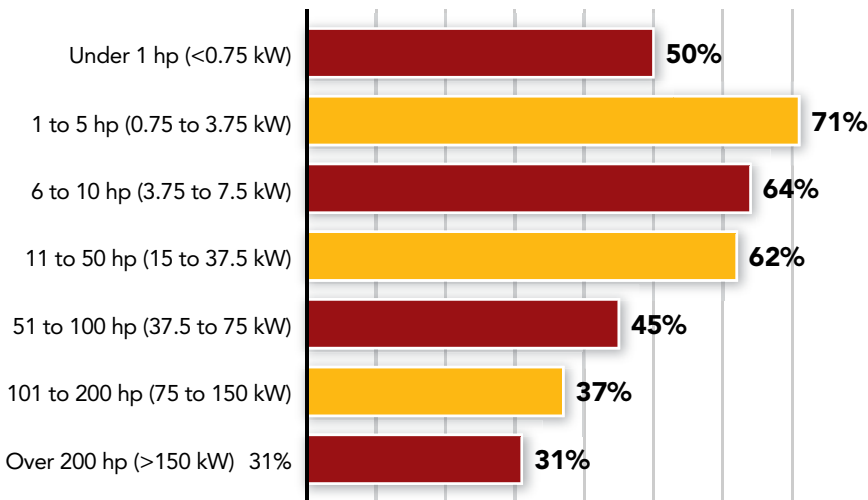
View more information at www.controleng.com/2017MotorDrives. **Amanda Pelliccione** is the research director at CFE Media, apelliccione@cfemedia.com.



Control Engineering covers several research topics each year.

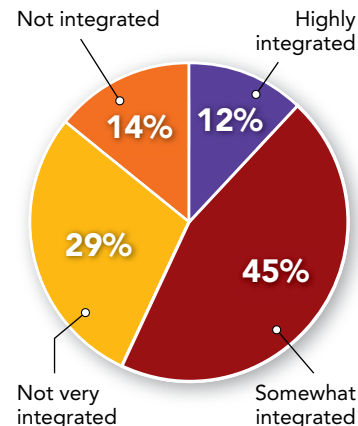
All reports are available at www.controleng.com/ce-research

Sizes of VSDs currently in use



The majority of engineers are currently using 1- to 50-hp (0.75- to 37.5-kW) VSDs; 31% are using drives with over 200-hp (150-kW) capacity. Source: *Control Engineering*

Wireless technology integration



Only 12% of facilities have fully integrated their wireless technologies with their controls, automation, and instrumentation systems. Source: *Control Engineering* 2016 Mobility, Ethernet, and Wireless Study

43% of companies award bonus compensation based on an employee's personal performance for the year. Source: *Control Engineering* 2017 Career & Salary Survey

1/2 of end users' HMI software is capable of displaying on multiple desktop monitors at one time. Source: *Control Engineering* 2017 HMI Software & Hardware Study

63% of end users specify servo and/or stepper drives for retrofit applications. Source: *Control Engineering* 2017 Motor Drives Study

More research

Control Engineering covers several research topics each year. All reports are available at www.controleng.com/ce-research.



ALLIED
ELECTRONICS & AUTOMATION



Allied Delivers Innovative, and Industry-Proven Control Solutions

Reliable, easy-to-install
products for both inside and
outside the cabinet.



AUTHORIZED DISTRIBUTOR

input #5 at www.controleng.com/information

Using software to provide IIoT value

Schneider Electric is expanding its industrial software platform offerings to provide value for the Industrial Internet of Things (IIoT) to companies.

Software defines the future manufacturing industry. As hardware becomes increasingly convergent, this assertion becomes more realistic. Schneider Electric, a global industrial automation provider, began acquiring industrial software companies a few years ago to expand its software offerings.

During the Schneider Electric industrial software user convention, *Control Engineering China* interviewed Cui Jingyi, who is in charge of software business of Schneider Electric China region, and Geok Kee Tay, chief technical officer of software business in the Asia-Pacific Region to better understand Schneider Electric's software strategy.

Software, which is seen as the future core of competitiveness for manufacturing, also provides value for the Industrial Internet of Things (IIoT).

Lifecycle software foundation

Schneider Electric, while regarded as a hardware provider, expanded its software offerings with the 2014 acquisition of Invensys. The company has become one of the few industrial software product and solution suppliers that cover process, hybrid, and discrete manufacturing.

“**EcoStruxure** from Schneider Electric provides interconnected hardware, edge point control, and applications, analytics, and services.”

Jingyi said the existing software product lines of Schneider Electric includes six parts: process engineering, operation control, information management, asset management, operation management, and supply chain management. Each stage covers the full lifecycle including design, planning, operation, analysis, and optimization.

At this point, software offerings already covered the breadth of the industrial supply chain and each market niche.



Cui Jingyi is in charge of software business of Schneider Electric China Region. Courtesy: Control Engineering China

Jingyi said Schneider Electric began to engage in mergers and acquisitions five or six years ago and continued to invest in its original software offerings. In 2014, Schneider Electric established a software department to integrate related assets, technologies, and personnel. The number of global software business personnel numbers 3,000.

In addition, Schneider Electric has 10 R&D centers and more than 1,000 R&D personnel. Schneider Electric has 2 million software authorizations, serves more than 100,000 factories, and has 4,000 partners globally.

Core of the platform strategy

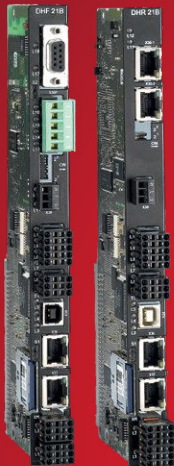
Facing an upsurge in global intelligent manufacturing, Schneider Electric released EcoStruxure IoT architecture at the beginning of 2017. However, EcoStruxure, as a three-layer architecture, is neither an IIoT platform nor an industrial cloud platform. The bottom layer includes various hardware products with interconnectivity capacity. The intermediate layer is edge point control. The uppermost layer comprises various applications, analytics, and services. These three layers are not mutually independent. IIoT only can be realized through intercommunication of these three layers regarding

ENGINEER NEEDED

Immediate opening. Consulting firm seeks an experienced drive engineer. Must be

Running Lean?

Then, lean on us! Our MOVIDRIVE® inverter requires **zero** programming. So, you don't need an engineer who speaks IEC 61131, C#, or C++. Simply enter your parameters and go. MOVIDRIVE also substantially reduces the load from your main PLC and dramatically improves the PLC's performance. Plus, you can even use your existing control system because MOVIDRIVE speaks your fieldbus language! So, keep your bus and leave the driving to us.





Geok Kee Tay is CTO of software business of Schneider Electric in the Asia-Pacific Region. Courtesy: Control Engineering China

Application software helps with data generation, transmission, collection, analysis, and decision-making.

information, data, communications, and applications. In this case, a software platform at operating system level is needed to support and connect this three-layer architecture.

At the convention, Schneider Electric released its Wonderware System Platform 2017 software to assume this responsibility.

Tay said System Platform 2017 was a responsive, expandable, and open software platform designed for application development personnel in industrial fields. The platform serves as a connecting link between the second layer and the third layer and is capable of realizing integration between information technology (IT) and operations technology (OT). It is the core of the EcoStruxure and plays a decisive role.

Three core values of System Platform 2017 are it is easy to build, easy to use, and easy to own. By using the platform, users may import functional models needed through component construction and application, such as monitoring, supervisory control and data acquisition (SCADA), manufacturing execution system (MES), data analysis, and asset management applications. System Platform 2017 can realize seamless connection with system platform and realize data sharing and interaction. It also is backward compatible with Wonderware products.

Openness also is important for a platform. Tay said the system platform was open even though it integrated basic functions like human-machine interface (HMI) monitoring and construction of data architecture.

Users or third-party software partners may develop their own industrial applications in the system platform, or ask Schneider Electric to develop application programs based on individual requirements.

IIoT value through software

At the start of 2017, Schneider Electric released two key transformational strategies to become a

digitalization leader and industrial application expert. To realize these two transformation strategies, software business plays a crucial role by “reflecting the value of Industrial IoT by software,” a theme emphasized at the software convention.

1. Data management: Jingyi said the three-layer architecture of EcoStruxure corresponded to four stages (connection, collection, analysis, and operation) if analyzed from the perspective of IIoT. Data generation, transmission, collection, analysis, and decision-making could not be realized without application software in each stage. Jingyi said data acquisition was the only first step.

Data alone cannot bring value. Enterprises must upgrade original data acquired to information, conduct knowledge mining from information, refine knowledge to wisdom, and feedback to decision-making and execution layers to realize a closed loop of personnel, assets, and operations designed to bring value to enterprises. The powerful software strength of Schneider Electric from operation control to operation management helps enterprises realize the IIoT’s potential.

2. Software as a service (SaaS): Schneider Electric also has launched a cloud-based software consumption model for its software business, a subscription-based model. Users may purchase the software based on functional models and points needed. Software is upgraded free during the subscription.

Jingyi said this authorization model can lower users’ costs and provide more flexible and convenient product portfolios and even bring more financial flexibility to users or partners to help realize the IIoT’s business value. **ce**

Stone Shi is executive editor-in-chief, Control Engineering China. Edited by Mark T. Hoske, content manager, Control Engineering, CFE Media, mhoske@cfemedia.com.



KEYWORDS

Automation software, IIoT
Schneider Electric expands, outlines software strategy
Industrial automation software lifecycle is considered
A subscription model includes updates.

CONSIDER THIS

When considering manufacturing software, is a platform view taken? If not, why not?

ONLINE

If reading from the digital edition, click on the headline for more resources.

See the IIoT webcast series at www.controleng.com/webcasts and international coverage at www.controleng.com/international.

SIEMENS

Ingenuity for life

PC-System
IPC427D PN/IE

CPU
1507S

S7-1500

PM 70W 120/230V...
CPU

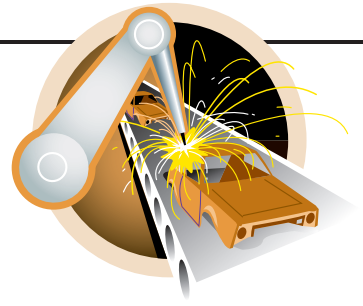
Totally Integrated A
DI 32x24VDC BA_1
DI 32x24VDC BA_2
DQ 32x24VDCIO

Engineered with TIA Portal

SIMATIC Controllers

The intelligent choice for your automation tasks

Siemens offers the right standard and fail-safe controller for the full range of automation requirements – Basic, Advanced, Distributed, Software and Motion. Innovative features like scalability and integrated safety, security, simulation and diagnostics allow you to significantly reduce your engineering time. Combined with our single engineering framework TIA Portal, we offer exceptional value in a controller and position you for the future – today!



Automation sales achieve highest levels of growth in 2017

The North American automation market set new records through the first nine months of 2017, according to the Association for Advancing Automation (A3). Records were set in the areas of robotics, machine vision, motion control, and motor technology.

Robotics

For the first nine months of 2017, 27,294 orders of robots valued at \$1.47 billion were sold in North America, which is the highest level ever recorded in any other year during the same time period. These figures represent growth of 14% in units and 10% in dollars compared to the first nine months of 2016. Automotive-related

orders were up 11% in units and 10% in dollars, while non-automotive orders were up 20% in units and 11% in dollars.

For shipments, 25,936 robots valued at \$1.49 billion were shipped in North America during the first nine months. These record high quantities represent growth of 18% in units and 13% in dollars over what sold in 2016. Automotive-related shipments also grew 12% in units and 9% in dollars during that time, with non-automotive shipments increasing by 32% and 22% for units and dollars, respectively. The industries with the highest levels of growth were metals (54%), automotive components (42%), and food and consumer goods (21%).

Motion control and motors

Total motion control shipments increased by 10% to \$2.6 billion, marking the industry's best nine month mark to date. The largest product category was motors (38% of shipments), followed by actuators and mechanical systems (18% of shipments), and electronic drives (17% of shipments).

The fastest growing categories in the first nine months of 2017 were motion controllers (24% to \$147 million), sensors and feedback devices (20% to \$116 million), ac drives (15% to \$295 million), actuators and mechanical systems (13% to \$479 million), and motors (11% to \$1 billion).

The majority of suppliers believe that order and shipment volumes will increase in the next six months, with most distributors feeling that orders and shipments will be flat during the same time period.

Vision and imaging

The North American machine vision market recorded growth of 14% overall to \$1.937 billion, 14% in systems to \$1.657 billion, and 14% in components to \$271 million. Each of those three categories set new records in the first nine months of 2017, and every individual product category experienced positive year-over-year growth for the same period in 2016.

Notable growth rates were smart cameras (21% to \$295 million), lighting (20% to \$54 million), software (16% to \$15 million), and component cameras (14% to \$143 million). It is projected that lighting, optics, imaging boards, and software will trend up, while camera sales will remain flat.

Additionally, expectations are for application-specific machine vision systems to increase and smart cameras to remain flat over the same time period. The U.S. manufacturing sector expanded in the second quarter of 2017 and is projected to remain strong in the future.

Edited from an A3 press release by CFE Media.

Manufacturing index closes 2017 with a strong surge

Manufacturing ended 2017 with a surge that matched the increase in retail spending at Christmas. The monthly purchasing manufacturers' index (PMI) from the Institute for Supply Management (ISM) jumped 1.5 percentage points to 59.7% in December, reversing a small decline in the previous two months and tickling the 60.0% mark that would indicate growth 20% above the baseline average.

The New Orders Index jumped 5.4 percentage points in December to 69.4%, leading a series of indicators that pointed toward continued strength in the manufacturing sector.

"Comments from the panel reflect expanding business conditions, with new orders and production leading gains; employment expanding at a slower rate; order backlogs expanding at a faster rate; and export orders and imports continuing to grow in December," said Timothy Fiore, chairman of the ISM's Manufacturing Business Survey Committee. "Supplier deliveries continued to slow (improving) at a faster rate, and inventories continued to contract at a slower rate during the period. Price increases continued at a faster rate."

The comments from committee members reflected a general confidence about the health of the sector, and pointed toward a strong start to 2018. Among the comments:

The PMI's December reading what the 16th straight month the index finished above the 50% threshold for growth, and was the seventh straight month the index topped 55%, indicating 10% growth for manufacturing. For the year, the PMI averaged more than 15% growth, with the average PMI coming in at 57.6%.

Bob Vavra is content manager, CFE Media, bvavra@cfemedia.com.

Digital technologies, connected enterprises are focus of industry forum

Digitally enabled technologies, approaches, and business processes are disrupting the way industry, infrastructure, and municipalities operate and serve their customers. These are topics of focus at the 22nd annual ARC Industry Forum in Orlando, Fla., Feb. 12-15. This digital transformation impacts every aspect of business, industry, and infrastructure, organizers said.

"We're seeing signs of positive disruption via digital transformation everywhere we look," said Andy Chatha, president and founder of ARC Advisory Group. "Today's smart, connected, information-driven industrial enterprises are making better use of their assets and data to improve business and regulatory performance. We're seeing a similar transformation across infrastructure and within municipalities."

Chatha said, "Without robust cyber-

security, connected enterprises are more vulnerable to hackers and other cyber-criminals. Also, today's shortage of the skilled knowledge workers needed for successful digital transformation will become an increasing constraint." ARC has helped organize an end user-driven Digital Transformation Council, which will convene for the first time at this year's forum.

Experts are asked to explore these and related topics. Keynote speakers will include Kenny Warren, vice president of engineering at ExxonMobil Research & Engineering, who will speak on the business goals of the company's Open Process Automation initiative; and Jason Handley, director of smart grid emerging technology and operations at Duke Energy, who will speak on new technologies that are impacting the emerging smart grid.

Edited from an ARC Advisory Group press release by CFE Media.

Headlines online

Learn more about the ARC Industry Forum at: www.arcweb.com/events/arc-industry-forum-orlando

Top five Control Engineering articles

Dec. 18-24: The most visited articles included Engineers' Choice finalists, the 2018 System Integrators of the Year, robot implementation, data collection, and PLC software.

Engineering company acquisition

IMI Precision Engineering agreed to acquire Bimba and combine air-related products.

Report: Small business owners not concerned about cybersecurity threats

Small business owners, said a Paychex report, fear cyber attacks less than do larger companies and have fewer protections.

Industrial Internet, robotics liaison

The Industrial Internet Consortium (IIC) and the Robot Revolution Initiative (RRI) have agreed to a liaison to maximize interoperability, portability, security, and privacy for the industrial internet.



ADVERTISEMENT

White Paper Connection

Advantages of a Mobile App Based HART Communicator

The HART Communicator has been around for many years, but until recently it has not been a true "hand held" HART communicator. Existing HART Communicators are large, power hungry, and expensive. The mobile device App revolution solves those problems. Now is a good time to see if a mobile App based HART Communicator is right for you.

The paper describes the advantages of a mobile App based HART Communicator over traditional HART Communicators. For example, a big advantage of a mobile App solution is that you can use the mobile device you already own. Since mobile hardware is upgraded frequently, you are continuously getting more features and more processing power for very little cost.

The paper also examines key features you should look for when selecting a mobile App based HART Communicator. For example, a key feature is that it must be "DD based". This means the mobile App uses the HART Device's DD binary file to present device menus, variables, and methods. Unless you have full DD access to the HART device, you may be stuck in the field without the ability to change a necessary parameter or perform a calibration on the HART device.



Download the paper: <http://bit.ly/2zaoYFA>

sales@procomsol.com • www.procomsol.com

White Paper Connection

Physical Infrastructure for a Resilient Converged Plantwide Ethernet Architecture

Learn how a successful deployment of CPwE logical architecture depends on a robust physical infrastructure network design that addresses environmental, performance, reliability, and security challenges with best practices from Operational Technology (OT) and Information Technology (IT).

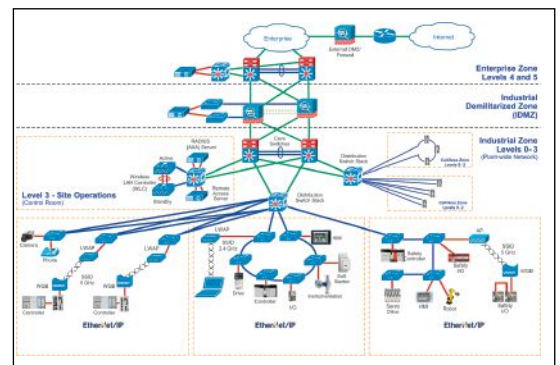
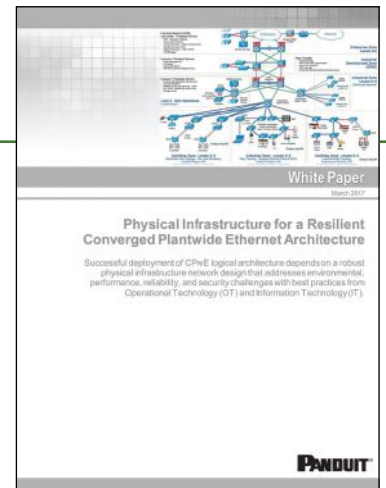
Industrial Ethernet networking is advancing technology applications throughout the plant. These applications are rapidly being deployed from the plant floor to the enterprise. The integration of IT and Industrial Automation and Control System (IACS) Operational Technology (OT) introduces the need for increased security, ease of use, rapid deployment, and network management support. Panduit is collaborating with industry leaders, including Rockwell Automation and Cisco, to provide industry-leading solutions, architectures, and services that help companies reduce risk, enhance operational performance, improve reliability, and successfully implement EtherNet/IP™ solutions and architectures through:

- Optimized physical network infrastructure solutions from Panduit® that have been developed to align with the Cisco and Rockwell Automation "Deploying a Resilient Converged Plantwide Ethernet Architecture" Cisco Validated Design (CVD)
- Design guidance for aligning logical and physical industrial network architectures that utilize industry best practices. Strategic design guidance facilitates effective collaboration between OT and IT
- Integrated solutions, tools, and services to simplify design and implementation for better equipment optimization and broader risk management

Resilient plant-wide network architectures serve a crucial role in achieving overall plant uptime and productivity. The CPwE architecture provides standard network services to the applications, devices, and equipment in modern IACS applications, and integrates them into the wider enterprise network. It also provides design and implementation guidance to achieve the real-time communication and requirements of the IACS as well as the scalability, reliability and resiliency required by those IACS applications. The CPwE Resiliency Panduit solution can help provide manufacturers the guidance needed to meet the challenges of a fully integrated IACS and realize the business benefits offered by standard networking.

This paper specifically focuses on the physical infrastructure deployment for CPwE using best practices and a building block approach from Panduit. The methodology is reflected in the physical infrastructure details that complement Deploying A Resilient Converged Plantwide Ethernet Architecture, white paper and Design and Implementation Guide, a collaboration between Panduit, Cisco and Rockwell Automation.

Register to download the paper at: <http://bit.ly/2kxMdRF>



PANDUIT®

www.panduit.com

White Paper Connection

How to Modernize Your Factory on Your Terms

Jim Wilmot | Controls Product Manager, Siemens

Underperforming automation systems can compromise productivity and profits

Downtime is a plant's #1 enemy. Thus, many manufacturers are contending with outdated or insufficient automation systems and components that are compromising productivity. The time to modernize is now! But manufacturers may still hesitate to invest in their automation systems because they fear downtime during changeover, the need for more staff training, having to convert existing code or taking a hit to their budgets.



To avoid these challenges, manufacturers should seek automation solutions that have integrated functionality and are engineered to migrate seamlessly into future technologies to lower their total cost of ownership. These solutions should be based on a single engineering framework that seamlessly integrates controllers, distributed I/O, HMI, drives, motion control and motor management using a common database as well as integrated security, safety and diagnostics.

Is staying with your current vendor the best choice?

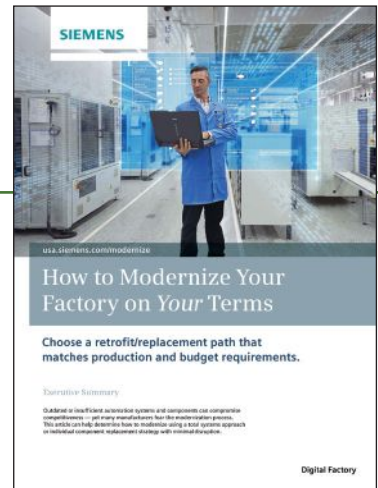
While it may seem like the least painful route is to upgrade components from a current vendor, it may not be the best option for manufacturers. Many vendors have dead-ended or are phasing out legacy hardware, and no spare parts are available.

Some vendors may offer more advanced versions of obsolete parts, but manufacturers may still need to convert their code to new programming software.

A total systems approach or individual component replacement?

Manufacturers have two options when deciding to modernize their production: a total systems approach or individual component replacement. A total systems approach is best for manufacturers that want the full benefits of totally integrated automation — a necessary step to integrating your entire value chain, from design and engineering, to sales, production and service. When total replacement is not feasible, manufacturers should seek advanced automation components that can easily integrate with existing systems while providing additional functionality.

Doing nothing can compromise your competitiveness. When it comes to modernizing, manufacturers have installation options to match their production and budget requirements – enabling more informed decisions for greater flexibility and competitiveness.



SIEMENS

James.Wilmot@Siemens.com
www.usa.siemens.com/modernize

Register to download the paper at:

www.industry.usa.siemens.com/topics/us/en/modernization/resources/Pages/Modernize-White-Paper.aspx

Hot topics in *Control Engineering* for 2017

Control Engineering readers choose hot topics of 2017 based on online traffic at the automation industry website. What can you learn from these top *Control Engineering* articles of 2017?

Control theory tutorials took three of the top 10 hot topics in *Control Engineering* for 2017, with articles on proportional-integral-derivative (PID) learning, salary and career survey, and automation project management, supervisory control and data acquisition (SCADA), motor selection, and industrial communications, among leading topics.

Because measuring performance using the calendar year gives a numerical advantage to articles posted earlier in the year, see this article online for links to top articles in August, October, and December, for better coverage of topics posted later in the year.

Hottest 2017 topics

Below are the hot control engineering topics of 2017, based on traffic at www.controleng.com, January through December. Traffic ranking based on website analytics from Chris Vavra, senior production coordinator/editor, *Control Engineering*.

1. The PID learning process, March 6: Knowing how proportional-integral-derivative (PID) components interact can help with learning proper tuning theory and methods.

2. *Control Engineering* 2017 Salary and Career Survey, May 16: *Control Engineering* salary and career survey research

M More INSIGHTS

With the longer version of this online, see the 11th article, top 10 posted prior to 2017, and the top three 2017 covers as chosen by Mike Smith, *Control Engineering* art director.

Top 10 *Control Engineering* topics for 2018 are at www.controleng.com/magazine under December 2017; help write future history at www.controleng.com/2018articles.

shows an average salary of \$96,045 in 2017, up slightly from the 2016 results; job satisfaction continues among respondents. Life-long learning remains critically important.

3. Hot topics in *Control Engineering* for 2016, 2017, Jan. 11: Think Again: Readers choose hot topics of 2016, and that online traffic points to key trends in *Control Engineering* in 2017.

4. Eight things to avoid in control system automation projects, June 14: Identify missteps to help ensure a control system automation project is successful.

5. What the oil and gas industry needs from SCADA, Feb. 11: Supervisory control systems aggregate data at key points in the supply chain. A list of industry suppliers is included.

6. How to select a motor for an industrial application, Feb.

8: Understanding the main types of loads, motors, and applications can help simplify motor and accessory selection.

7. What does time-sensitive networking and real-time Ethernet data mean for the future of industrial systems? Jan. 14: Avnu Alliance members explain how real-time communications strengthen industrial systems.

8. Four aspects of good control panel design, Jan. 2: Good designs have strong layout and component placement, labeling, panel sizing and component spacing, and wireway design.

9. Exploring the basic concepts of multivariable control, Feb. 7: Multivariable controllers can balance competing objectives.

10. To PID or not to PID, Sept. 1: The venerable proportional-integral-derivative (PID) algorithm can solve a variety of feedback control problems, but not all. **ce**



Mark T. Hoske,
Content Manager

Content Specialists/Editorial

Mark T. Hoske, Content Manager
847-830-3215, MHoske@CFEMedia.com

Jack Smith, Content Manager
630-907-1622, JSmith@CFEMedia.com

Kevin Parker, Senior Contributing Editor, IloT, OGE
630-890-9682, KParker@CFEMedia.com

Emily Guenther, Associate Content Manager
EGuenther@CFEMedia.com

Amanda Pelliccione, Director of Research
978-302-3463, APelliccione@CFEMedia.com

Joy Chang, Digital Project Manager

Chris Vavra, Production Editor
CVavra@CFEMedia.com

Contributing Content Specialists

Suzanne Gill, *Control Engineering Europe*
suzanne.gill@imlgroup.co.uk

Ekaterina Kosareva, *Control Engineering Russia*
ekaterina.kosareva@fsmedia.ru

Wojciech Stasiak, *Control Engineering Poland*
wojciech.stasiak@trademedia.us

Lukáš Smelik, *Control Engineering Czech Republic*
lukas.smelik@trademedia.us

Aileen Jin, *Control Engineering China*
aileenjin@cechina.cn

Editorial Advisory Board

www.controleng.com/EAB

Doug Bell, president, InterConnecting Automation,
www.interconnectingautomation.com

David Bishop, president and a founder
Matrix Technologies, www.matrixti.com

Daniel E. Capano, president, Diversified Technical Services Inc.
of Stamford, CT, www.linkedin.com/in/daniel-capano-7b886bb0

Frank Lamb, founder and owner
Automation Consulting LLC, www.automationllc.com

Joe Martin, president and founder
Martin Control Systems, www.martincsi.com

Rick Pierro, president and co-founder
Superior Controls, www.superiorcontrols.com

Mark Voigtmann, partner, automation practice lead
Faegre Baker Daniels, www.FaegreBD.com

CFE Media Contributor Guidelines Overview

Content For Engineers. That's what CFE Media stands for, and what CFE Media is all about – engineers sharing with their peers. We welcome content submissions for all interested parties in engineering. We will use those materials online, on our website, in print and in newsletters to keep engineers informed about the products, solutions and industry trends.

www.controleng.com/contribute explains how to submit press releases, products, images and graphics, bylined feature articles, case studies, white papers, and other media.

* Content should focus on helping engineers solve problems. Articles that are commercial or are critical of other products or organizations will be rejected. (Technology discussions and comparative tables may be accepted if non-promotional and if contributor corroborates information with sources cited.)

* If the content meets criteria noted in guidelines, expect to see it first on our Websites. Content for our e-newsletters comes from content already available on our Websites. All content for print also will be online. All content that appears in our print magazines will appear as space permits, and we will indicate in print if more content from that article is available online.

* Deadlines for feature articles intended for the print magazines are at least two months in advance of the publication date. Again, it is best to discuss all feature articles with the appropriate content manager prior to submission.

Learn more at: www.controleng.com/contribute

CONTROL ENGINEERING



COVER STORIES: FACTORY CONTROLLERS

18 The benefits of a modular control system design

Mitsubishi Chemical Performance Polymers (MCP) used a modular controller design to reduce startup challenges and optimize plant operations for a new automotive production facility.

22 How to select factory automation controllers for an application

Picking the right hardware is critical, but users also need to make sure they include controller programming software in the evaluation process.

24 Select an automation controller

Criteria help when selecting an automation controller for motion, robotics, machines, and other applications.

27 Role of CNCs and PLCs in the factory of the future

As automation in manufacturing increases, industrial controllers and control systems are changing the role of computer numerical controls (CNCs) and programmable logic controllers (PLCs).

29 Architecting an interconnected enterprise

Automation, the conventional pinnacle of productivity, increasingly requires multi-platform connectivity to stakeholders across the enterprise. Learn how.

31 Understanding industrial Ethernet cable requirements

Ethernet users should be aware of the effects of conductor size, cable selection, and Power over Ethernet (PoE).

32 System integrators, customer relations, and the skills gap

CFE Media's interviews of representatives from the 2018 System Integrators of the Year share tips on customers and dealing with the skills gap.

33 Drives are getting smarter in the Industrie 4.0 era

Intelligent drive systems play a large role in optimizing machine configuration and performance and aiding the adoption of Industrie 4.0.

35 Four trends in VFD management

Variable frequency drive (VFD) advances enable users to do more with less.

INSIDE PROCESS

P1 Bluetooth connectivity makes VFDs safer, easier to use

Variable frequency drive (VFD) product advances improve performance, simplify installation and operation, and increase safety.

P3 Three trends dominating the VFD industry

Variable frequency drive (VFD) development is shifting focus away from general-purpose motor controls toward reduced installation costs.

M More
ANSWERS

Check out the PLC digital report and the **Control systems** navigation bar at www.controleng.com

Online learning on PLCs cfeedu.cfemedia.com

The benefits of a modular control system design approach

Mitsubishi Chemical Performance Polymers (MCP) used a modular controller design to reduce startup challenges and optimize plant operations for a new automotive production facility.

Automation hardware and software was integrated into a new manufacturing plant in Brazil to add visibility and flexibility. A programmable logic controller (PLC), drives, and human-machine interface (HMI) software were expected to help with the new plant's operations and remote diagnostic capabilities to reduce potential downtime from days to hours. The overall design approach to this project enabled the plant to launch quickly so the company could help auto suppliers meet the impending airbag requirement.

New mandate for Brazil's auto industry

Consumers in places like the U.S., Japan, and most of Europe assume new vehicles will come equipped with an airbag. The safety feature became prevalent in vehicles in many developed countries

during the 1990s. By the turn of the century, it was either required by law or considered an essential component for automakers to include in vehicles to achieve desired safety ratings.

In many developing and emerging countries around the world, airbags still either aren't required or aren't commonly found. In Brazil, a new law took effect in 2014 requiring airbags and other safety technologies be installed for all new vehicles sold in the country.

Brazil's new airbag requirement was the driving force that led Mitsubishi Chemical Performance Polymers (MCP) – a group specializing in polymer design and compounding production facilities – to establish a greenfield production facility in Brazil, the world's seventh-largest car market. The new facility would primarily support the automotive market and supply resins to airbag manufacturers for safety-critical airbag covers.

Prior to expanding to Brazil, MCP had operations in 16 countries around the world and provided custom automotive solutions for fuel management, interior, exterior, wiring, and other automotive applications for more than 30 years.

MCP production facility in Sao Paulo

MCP selected an industrial site north of Sao Paulo as the location for its new production facility in Brazil. The company wanted to get production up and running quickly to help local auto suppliers meet the airbag requirement.

"We wanted the start of production to coincide as closely as possible with the timing of the new airbag requirement," said Lee Wilson, plant manager for MCP. "The harsh rain season pushed our site work behind schedule somewhat. When that happened, it became all the more important to look for ways to be efficient in launching this new location."

For the production infrastructure, the new facility required a feeder and extrusion system that could produce up to about 10 million pounds of resin per



Figure 1: Rockwell Automation FactoryTalk Historian, FactoryTalk View and FactoryTalk VantagePoint EMI software provide access to manufacturing intelligence. All graphics courtesy: Rockwell Automation



Figure 2: A compounding control center houses the extrusion system's electrical and control infrastructure, including an Allen-Bradley CompactLogix programmable logic controller (PLC), Allen-Bradley PowerFlex 755 ac drives, and solid-state relays from Rockwell Automation. A separate utility control center houses the system's utilities and information server.

year at maximum production capacity. Wilson and his team wanted the Brazilian plant to mimic what MCPP already did in other regions in terms of production speed and quality management.

“Quality was our first priority,” said Wilson. “We needed to make sure we could maintain tolerances with the feed systems that were feeding the extruder, as well as achieve proper distribution and dispersion of the various ingredients inside the extruder. Aesthetically, we needed to be able to maintain a consistent product look as material is compounded and pelletized.”

Accessing the system remotely would be essential to help operators monitor quality and quickly take action in the event of potential production issues. This would allow U.S.-based MCPP employees and other outside experts to troubleshoot or diagnose technical challenges and help compensate for a lack of local technical support in Brazil.

A modular approach

MCPP chose Indiana-based Apex Engineering and its subsidiary, Apex Controls Specialists, a Rockwell Automation-recognized system integrator, to develop the extrusion system for its Brazilian production facility.

Apex Engineering proposed a solution based on its proprietary modular extrusion system. The material-handling system receives raw materials

including various rubbers, oils, heat stabilizers, impact modifiers, and pigments. Those materials are then distributed through a feeder deck down to the extrusion system, where they are heated and blended. Then they are sent to an underwater pelletizing system that produces the final bead-like product, which is packaged into large bags and boxes before being shipped to the airbag manufacturers.

A compounding control center housed the extrusion system's electrical and control infrastructure, which included a PLC, ac drives, and solid-state relays. A separate utility control center housed the system's utilities and information server.

The information-enabled system allowed workers and outside experts to see the critical manufacturing intelligence, temperatures, feed-rate pressures, and feeder motor speeds. Historian software collected thousands of these data points throughout the production process while HMI software and enterprise manufacturing intelligence (EMI) software allow workers to manage recipes, monitor processes, and identify and resolve production issues.

Communications over EtherNet/IP, an Ethernet protocol by ODVA, allowed information to be shared throughout the plant and with outside experts via remote access. This also reduced the amount of wiring in the facility.



KEYWORDS:

PLC, HMI, Ethernet

How to save time with a modular system design approach

How remote support benefits facility operations

Optimizing plant operations with a modular system design.

CONSIDER THIS

Can your controllers accommodate new components within 10 minutes?

The Global System Integrator Database helps sort system integrators by various engineering specialties, such as programmable logic controllers (PLCs) and/or human-machine interfaces (HMIs) and other parameters.

www.controleng.com/Global-SI-Database



Figure 3: The facility's integrated approach has been vital to helping workers optimize quality management and identify production issues.

MCPP's modular design

The extrusion system's modular design helped MCPP speed up the launch of its new facility. During the construction of the plant in Brazil, Apex was simultaneously designing and building the system in Evansville, Ind. Wilson and his team at MCPP communicated weekly with Apex engineers throughout the process. Once the extrusion system was complete and operational, they were on-site with Apex personnel for a week of testing.

"We crawled all over the equipment," said Wilson. "It was great being able to see the equipment running and test it firsthand. We only made small changes, but it was nice being able to make them before shipping the equipment to Brazil. It helped us avoid production delays and saved us some long flights to Brazil."

Once the equipment arrived in Brazil, an on-site contractor easily assembled the system. The system's power and electrical components, for example, were set up on connectors. Workers only needed to pull cables from cable trays and plug them in. The system's mechanical components also had an accompanying drawing with easy-to-follow instructions to build the system.

“The facility’s integrated control and information has been vital in helping workers optimize quality management and identify production issues.”

The system took about one month to install at the new facility. This saved MCPP as much as four months in deployment time and allowed the company to finish the extrusion system right around the time it finished construction of the facility.

The facility's integrated control and information has been vital in helping workers optimize quality management and identify production issues.

"Operators can see trending information on the screen to make sure all the equipment and feeders are running right where they should be," said Wilson. "Any processes that run outside their minimum or maximum setpoints will generate alarms on the operator screen so they can quickly address the issue."

MCPP and Apex team members can remotely access the system to monitor systems and help workers without traveling on-site. This was especially valuable early on as workers were getting the system up and running and had limited access to local technical support.

"I can look at any of the data points from right here in my office," said Wilson. "We've looked at alarms and helped them diagnose issues, such as when they had trouble getting the proper feed rate or were encountering some initial mechanical issues with the feeder. It's safe to say remote support helped us reduce some of those early downtime incidents from days into hours."

By using add-on instructions in the extrusion system's development, Apex Control Specialists created plug-and-play functionality for any future changes or additions at the facility. For example, MCPP can add a new feeder to the system in as little as 10 minutes.

Wilson said MCPP might seek to replicate some of the modular extrusion system's benefits at other facilities.

"The next project we do, we're going to consider replicating some of the benefits we've seen with the modular system," said Wilson. "It made the project a lot more manageable than a conventional build. I could even foresee using the approach closer to home here in the U.S." **ce**

John Hamilton is an account manager at Rockwell Automation. Edited by Emily Guenther, associate content manager, Control Engineering, CFE Media, eguenther@cfemedia.com.

BALLUFF

B innovating automation

YOUR INDUSTRIAL AUTOMATION IS SMARTER & EASIER WITH IO-Link

With your preferred control architecture, we enable visibility into your production process. Our market leading portfolio of IO-Link products prove the value of smart manufacturing and make your life easier.

Learn more at www.balluff.us/io-link

www.balluff.com

input #11 at www.controleng.com/information



sponsored by: **EZAutomation**

2017 Programmable Controller Software & Hardware Study

Turning research into insights makes for better business decisions

This study was conducted by *Control Engineering* to acquire information related to the buying and specifying habits of automation engineering professionals for programmable controller software and hardware. Respondents to the *Control Engineering* 2017 Programmable Controller Software & Hardware Study unveiled several key findings regarding what end users expect and how they purchase or specify industrial controller software and hardware.

According to the study, the top uses for programmable controller software or hardware are discrete and continuous manufacturing (22% primary, 22% secondary), and continuous manufacturing (22% primary, 17% secondary). In addition; in the past 12 months, respondents spent an average of \$157,678 on industrial controller hardware and software—with 21% having spent \$200,000 or more. Eighty-two percent of respondents expect to buy industrial controller software or hardware in the next 12 months. On average, respondents plan to use nine controllers over this period.

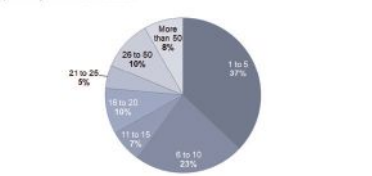
Uses for programmable controller software or hardware

The top uses for programmable controller software or hardware were discrete and continuous manufacturing (22% primary, 22% secondary) and continuous manufacturing (22% primary, 17% secondary).



Expecting to purchase over the next 12 months

Eighty-two percent of respondents expect to buy industrial controller software or hardware in the next 12 months. On average, respondents plan to use nine controllers over this period. Nearly one-fifth (18%) expect to buy more than 25 controllers.



Access the 2017 Programmable Controller Software & Hardware report with additional findings and insights. www.controleng.com/2017ControllersReport

CONTROL ENGINEERING

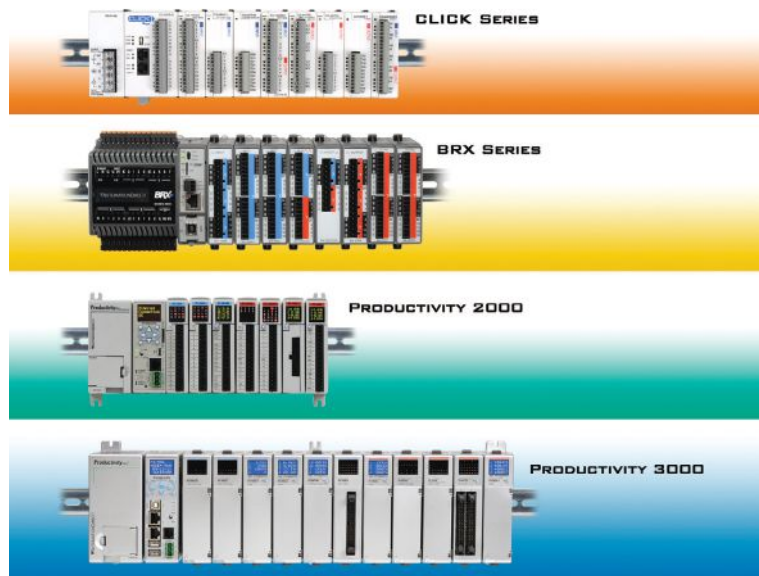
Jeff Payne, AutomationDirect

How to select the correct factory automation controller for your application

Picking the right hardware is critical, but users also need to make sure they include controller programming software in the evaluation process.

When selecting a controller for factory automation, it's not just about if a programmable logic controller (PLC), programmable automation controller (PAC), or industrial personal computer (IPC) should be used. It's also about defining application requirements including control basics and scalability for the future.

However, the programming software platform can be just as important as selecting the right hardware and needs to play a big part in the decision-making process.



AutomationDirect programmable controller products range from micro PLCs with fixed I/O (top), to mid-range PLCs (middle), to modular PLC systems capable of handling thousands of I/Os (bottom). Shown, top to bottom, are AutomationDirect Click, Do-more, and Productivity controllers. Courtesy: AutomationDirect

Whether it's machine or process control, typical families of controllers include PLCs, PACs, and IPCs. There are many differences among these controller types, but their features and functionality are merging.

While the PLC was first to the game as a relay replacer, it remains the best choice for small- to medium-sized applications. PLC capabilities are growing as new technologies are adapted. Many lower-end models use ladder logic programming, which is sufficient for most applications. More expensive PLCs are able to use function block and other IEC 61131-3 programming languages.

The PAC adds capabilities to the PLC including improved motion, safety, and vision capabilities. PLC-based PACs also are available as a subset of this class of controllers, providing PAC power with easy functionality of a PLC. IPCs are ideal for more complex applications because of their more advanced features and the ability to work with additional languages, such as variants of C.

Regardless of which controller family is chosen, vendors offer a wide variety of controller form factors within each family, from small, medium, or large (see Figure).

Within each family of controllers, there are many configuration options and different combinations of built-in and remote input/output (I/O). There are also communication options from simple serial to Ethernet. Hardware configurations also may include stand-alone controllers with built-in I/O, often called bricks, which can be expanded with stackable I/O and rack-based options.

Controller selection considerations

While understanding and evaluating the controllers' specifications is critical—application requirements, plant personnel capabilities, and future connections are also important factors in the decision process.

Key controller selection considerations include:

- Automation experience of plant personnel
- Number and type of I/O
- Required control functions such as closed-loop proportional-integral-derivative (PID), motion, and speed
- Communication options
- Data collection requirements
- Special function requirements.

Some facilities are automation-savvy and can handle a wide range of controllers and equipment while others have limited familiarity with newer technologies. PLCs are the primary automation tool for many industries and applications because they provide accurate, reliable, and modifiable control while being easy to work with due to their widespread use and familiarity.

If plant personnel are new to using PLCs, consider using a PLC that is small and simple. These controllers are designed for easy expansion while having many of the features present on larger PLCs.

PLC selection, applications

The next step is examining application requirements. A good starting point is to estimate the number of discrete and analog I/Os. A list of major components—along with position and presence sensors—will help determine an accurate count.

In addition to discrete machine and analog process functions, some PLCs have evolved to perform complex tasks, such as motion and PID control. This type of controller can handle complex applications such as a high-speed packaging line using registration alignment.

Servo and variable speed drives used for some motion control functions don't always require coordination, but they still can be quite complex in terms of communication and other requirements. Many controllers can communicate to multiple drives at one time to command position, speed, or torque. RS-232, RS-485, Ethernet, and other options are all valid choices to communicate to drives. Choosing a digital communication protocol is a better choice compared to a discrete I/O because they simplify wiring, allow more parameters to be monitored and commanded, and is more flexible when changes are needed.

Data collection requirements should also be considered. Fortunately, many controllers, even the new small PLCs, have built-in communications, data logging, web server access, and email capabilities. The ability to write data to micro SD cards is another feature worth having along with web server functionality and remote access.

Some applications require safety ratings to meet regulatory requirements. While the application

may suggest using a safety-rated PLC, using a non-safety rated PLC along with one or more programmable safety relays can reduce costs while providing the functionality that is required.

Evaluating software programming

Software programming is about half the effort on a typical automation project, but the time required to program the controller and the required level of expertise can vary widely depending on the controller programming software. Controller programming software considerations include:

- Ease of programming
- Preferences and comfort zone
- Time and money investment
- Available training resources
- Data logging and remote access.

Simple—and sometimes free—software with limited programming instructions covers most applications suitable to use with these small controllers. As machine size and complexity increases, most midsize and larger PLCs provide software platforms, which take longer to learn than their simpler counterparts.

Controller programming software choices often relate to a user's preferences and comfort zone. While the hardware required is driven and determined by the application requirements, software selection is usually a subjective decision. Most companies should enforce a standard controller programming software platform along with consistent programming methods.

Users should consider training resources that are available when selecting programming software. There are huge libraries of technical information and user manuals exist online.

Once the software program is developed, it needs to be tested. The programming software should include the ability to view a PID loop response and motion profiles and to simulate other software functionality. Built-in project simulators can be a huge timesaver by allowing code to be tested without the hardware present or before being downloaded to an existing system.

While there are many considerations for selecting the right hardware and programming software for a controller, it's unlikely there's a "one size fits all" approach to selecting a controller. It's better to pick a family of controllers capable of handling a company's range of requirements. **ce**

Jeff Payne is an automation controls group product manager at AutomationDirect. Edited by Emily Guenther, associate content manager, Control Engineering, CFE Media, eguenther@cfemedia.com.

In addition to discrete machine and analog process functions, some PLCs have evolved to perform complex tasks, such as motion and PID control.



KEYWORDS

Programmable logic controllers (PLC), programmable automation controllers (PAC), industrial personal computer (IPC)

How to choose a controller for particular applications

Developing the controller's software programming

Proper testing methods for software programs.

Research: see controller research results at www.controleng.com/ce-research.

CONSIDER THIS:

What is the most cost-effective way to properly test and simulate the controller's software program?

John Kowal, B&R Industrial Automation Corp.

Selecting an automation controller

Consider these criteria when selecting an automation controller for motion, robotics, machines, and other applications.

An automation controller does more than replace relays as the programmable logic controller (PLC) was originally envisioned. Now a controller is capable of integrating logic, motion, robotics, and communicating with other machines and management systems. Performance can range from simple devices to multicore processors.

The distinctions between a traditional PLC, programmable automation controller (PAC) and industrial personal computer (IPC) are largely irrelevant—the processing power is still available. Due to the acceptance of the International Electrotechnical Commission (IEC) 61131-3 programming, control software has gained a degree of standardization. Robust real-time operating systems running in the background obviate the need for Microsoft Windows-based operating systems, so the term “IPC-based control” would more accurately be termed “Intel-based” or “AMD-based” to reflect using powerful mainstream processors.

Since today’s automation controllers do more than logic, “PLC” is probably an obsolete term. Because all automation controllers are programmable, the “P” in

PAC also seems to be redundant. Controllers are fundamentally computers, and may run multiple operating systems (real-time, Microsoft Windows, and Linux) on the same processor. An IPC may be used for control, data acquisition, and emerging tasks such as edge computing.

Controller functionalities

It’s become popular to coordinate all of the machine’s functionalities in the same software environment, in the same program, running on the same processor. This allows the machine functions to be synchronized and the modular code structure makes for an organized, cohesive approach. Still,

there is a place for less integrated control, such as straightforward applications, that are not intended to scale up.

The application’s complexity and performance requirements dictate the controller’s specifications. The following are criteria from platforms that may or may not need to be checked off depending on the application.

✓ Logic

There is a fundamental need for logic control, which is why we continue to call automation controllers “PLCs.” PLCopen is an organization that maintains and expands the scope of the IEC 61131-3 programming standard and manages a large base of knowledge, training, and libraries. The group’s activities extend far beyond logic to include motion, safety, OPC Unified Architecture (UA), XML, and more.

✓ Multi-axis motion

Depending on the required complexity and synchronization of the motions, dozens or even hundreds of axes of motion can be controlled by an automation controller. A separate motion or robot controller with a dedicated motion network is no longer required due to Moore’s Law and industry standards.

✓ Network safety

Hardwired network safety is still preferred in North America. Network safety running on the same network controlling the machine has become a proven and useful control functionality.

Network safety can be implemented from a redundant core on the control processor, to a separate safety controller, and then to a safe input/output (I/O) in small systems. Network safety also extends to motion safety and robotics functionalities that allow machines to run in safe mode rather than shutting down—providing exceptional operational efficiencies.



KEYWORD: programmable logic controller (PLC)

The three most common form factors for automation controllers

Possible application requirements for automation controllers

CONSIDER THIS:

What boxes need to be checked off to meet your application’s automation controller requirements?

ONLINE:

See the PLC Digital Report at www.controleng.com/DigitalReports.

✓ Multiple robots

It is possible for the same automation controller to integrate multiple delta, selective compliance assembly robot arms, articulated and/or gantry robots along with all the other machine functions. In addition, it's also possible to perform the kinematics in an IEC 61131-3-compliant environment. Dedicated robot controllers continue to serve valuable functions because of what is built into the robot's system—ranging from palletization algorithms to assembly patterns.

✓ Machine monitoring

Monitoring a machine's health is key to a predictive maintenance plan and reducing unplanned downtime. A controller can be combined with various off-the-shelf transducers such as temperature probes and accelerometers to monitor actual conditions. Machine monitoring can also help detect anomalies before catastrophic failures occur. Energy monitoring also can be applied to compressed air usage, fluctuations, natural gas use in heaters and dryers, and water usage for process and cleaning.

✓ Data handling

An automation controller can be a web and OPC UA server and client. They have functions to collect Industrial Internet of Things (IIoT) data, and to receive instructions back from the cloud or edge to optimize the process. Automation controllers typically send data to the manufacturing execution system (MES), enterprise resource planning (ERP), overall equipment effectiveness (OEE), trusted platform module (TPM), and product lifecycle management (PLM) software. In an IIoT environment, it's equally important also to receive useful analytics.

✓ Automatic configuration

Before, when a new component (such as a drive) was replaced, it was necessary to manually determine and load the correct firmware version for the device. Today, automation controllers may automatically read the device and alert a technician to make the necessary adjustments without intervention.

✓ Communications capabilities

Today, even low-cost controllers have one or more Ethernet communications ports to communicate with human-machine interface (HMI) panels, management systems, programming, and other non-time-critical tasks. It also is common for controllers to support a type of industrial Ethernet for a deterministic machine network such as EtherNet/IP, EtherCAT, Powerlink, Profinet, and others. Unfortunately, there is still not one, universally recognized industrial Ethernet

standard to provide the high-speed, deterministic communications suitable for machine control.

There is great anticipation, however, in the development of Time-Sensitive Networking (TSN), which along with OPC UA and OPC UA publish-subscribe (Pub-Sub), will bring a certain level of determinism to the Institute of Electrical and Electronics Engineering (IEEE) 802 family of Ethernet standards. A testbed has been established in the Industrial Internet Consortium, with multiple

“The application's complexity and performance requirements dictate the controller's specifications.”

industrial automation suppliers participating in “plugfests” demonstrating the viability of TSN in machine-to-machine communications.

TSN is important because for IIoT to work, there will need to be communications interoperability among different control platforms in use at a facility or enterprise-wide and the cloud. If serial interfaces are required, they should be specified due to the decrease in popularity.

✓ Form factors

The following are the three most common automation controller form factors.

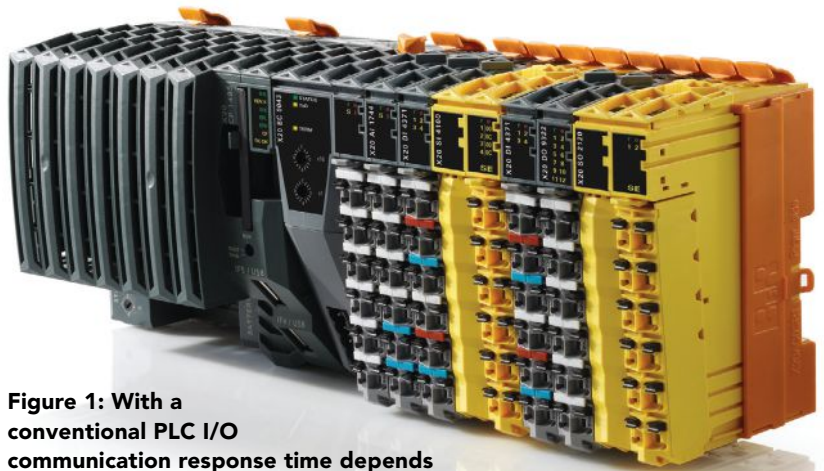


Figure 1: With a conventional PLC I/O communication response time depends on network performance, number of nodes, traffic, CPU performance, and CPU load; a design using tighter integration and open IEC 61131 technology with centralized software management and decentralized program execution can improve performance. All graphics courtesy: B&R Automation

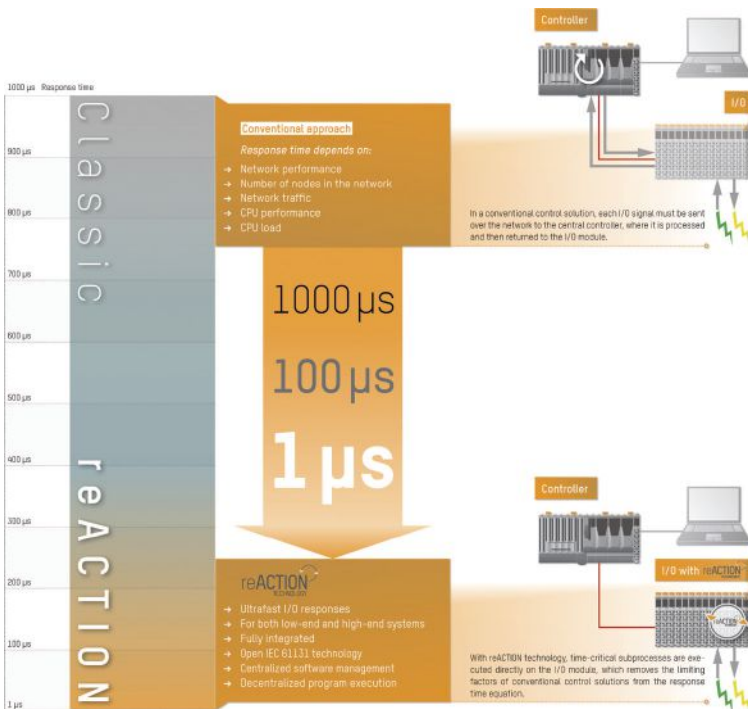


Figure 2: Controller, I/O, communication: B&R Automation X20 System provide remote I/O, control, and easy networking configuration and flexibility for each application.

- **IP20, cabinet mounted:** This is the traditional PLC form factor that has a separate HMI, and typically uses integral and/or backplane/rail mounted I/O, and/or remotely mounted I/O modules.
- **IP65/67/69K sealed, pedestal or panel-front mounted:** This format integrates the HMI and controller and is increasingly popular with swing-arm mounting for its ergonomic advantages.

This format can also incorporate PC functions to run various Microsoft Windows applications in addition to control, such as HMI, although there is an increasing trend for a web-based HMI.

There are sealing requirements that correspond to environmental conditions and cleaning practices.

Pedestal mounting tends to be more expensive than panel mounting, stainless steel bezels, and higher levels of sealing protection for comparable controllers.

Some prefer separate panel-mounted PLCs and HMIs to avoid having to replace both components if one or the other is damaged. However, this is no longer a concern, as integrated units are available in which the controller is mounted to, but removable, from the HMI. This makes it easier to switch to a larger screen, or swap in more powerful control hardware without changing the screen.

- **IP20, cabinet-mounted industrial PC, with separate HMI:** Just like the integrated form factor, this form is capable of serving as a controller with real-time operating systems, various computer operating systems, and web services. The controller may be sep-

arate, and the industrial computer is dedicated to non-control tasks such as edge, fog, or cloud computing. Historian, serialization, and vision inspection are also common applications.

✓ Scalability

While software development environments are often tied to hardware (nano, micro, mid-range, and large PLCs), it also is possible to work in development environments that are independent from the hardware. This means that a project is coded, and then the control hardware can be selected or changed. This flexibility extends to motor and drive types. A low-end stepper or variable frequency drive (VFD)-based machine can share the same program as a high-end servo machine. The need for scalability is most valuable when a family of machines is being designed and allows key software elements to be reused.

✓ CPUs

There are a lot of choices from low-end to multi-core processors, often with overlapping performance characteristics. Therefore, it is recommended to work with the technology provider's technical support and sales engineering team to select the optimum price/performance for the anticipated application's requirements because of their product knowledge.

Ideally, the processors should be scalable so the control software is compatible across the controller product line. Automation technology providers invest in significant stockpiles of critical components to ensure product availability, and migration for drop-in replacements.

Also, determine whether fanless operation will be required, and the expected ambient temperatures where the controller will be mounted. Other heat dissipation options include fans, air conditioning, heat sinks, and water cooling.

✓ Memory

Solid-state memory has become very popular in automation controllers, removable media like C-Fast cards, and permanently installed memory devices in the more cost-sensitive applications. The advantages to removable memory are that it can easily be replaced, it is easy to make and store backups, and it is easy to expand memory capacity.

However, be careful using industrial memory cards and ensure that the media meets the necessary specifications for the application. Different memory types have different service lives, which are dependent on read and write cycles. This is also a topic to discuss with an automation supplier. **ce**

John Kowal is the director of business development at B&R Industrial Automation Corp. Edited by Emily Guenther, associate content manager, Control Engineering, CFE Media, eguenther@cfemedia.com.

Role of CNCs and PLCs in the factory of the future

As automation in manufacturing increases, industrial controllers and control systems are becoming more complex and efficient, which will change the role of computer numerical controls (CNCs) and programmable logic controllers (PLCs) in the factory of the future.

The concept of automation is changing as Industrie 4.0 and the Industrial Internet of Things (IIoT) become more prevalent. Automation encompasses concepts such as zero downtime, increased precision, high speeds, efficiency, and proactive maintenance. This is powered by digital, programmable systems that have been developed and perfected over several decades.

Computer numerical controls (CNCs), for example, facilitate the automation of machine tools through computers that execute pre-programmed sequences. “CNC was developed during the 1950s and ‘60s as a logical progression from computer-aided manufacturing (CAM) and tracer-based automation,” said Ian Baird, CNC applications manager for Fanuc’s Factory Automation Division. “Established alongside computer and servo system developments, it helped manufacturers to meet their increasing requirements for repeatable, high-precision production. Today, five main parts form the CNC—a sequencer, interpolator, servo controllers, logic controller, and operator control interface—and it is synonymous with precision and control.”

Twenty years after the CNC was introduced, a cheaper and simpler form of computer-aided control was developed: the programmable logic controller (PLC).

“The PLC was developed in the 1980s to supersede relay logic control systems, which were often less cost-effective, flexible, and easy to use because they relied on hardware to perform their key functions. PLC has input and output functionality and can be programmed to perform sequential operations, data processing, or simple axes control.”

However, the PLC was never intended to replace the CNC. “Both serve very different purposes and marketplaces, with their own advantages and disadvantages. Therefore, it would be limiting for anyone in industry to say, ‘I’ve invested in CNC—there’s no room for PLC here,’ because they are two entirely



Computer numerical controls (CNCs) and programmable logic controllers (PLCs) will have different roles to play in the factory of the future, which is becoming more automated and focused on minimizing downtime. Courtesy: Fanuc/Control Engineering Europe

different controls,” continued Baird.

CNC is associated more with automation because its use extends beyond a simple input/output (I/O) algorithm. The modern CNC is a flexible, digitally controlled system designed to suit a manufacturer’s needs without having to reprogram the entire system.

“Most modern CNCs also include user interfaces with built-in operation, maintenance, and diagnostic screens. For this reason, CNC is popular with people who want full control over their machines, because its functionality does allow you to fly solo after a bit of training,” said Baird.

CNC flexibility lends it to complex, multi-axis machining in almost any industry. “A CNC’s applications are limited only by imagination. Any application that requires precision motion control needs CNC, whether that be the manufacture of watch parts and medical devices, or reactive atomic plasma etching.”

Simple control tasks

The PLC, Baird said, is useful for simple control tasks. “If you’ve got an application that doesn’t need a high level of accuracy or flexible motion control, such as an ac motor conveyor, then PLC is often the best choice. It is cheaper than CNC, which would arguably be better invested in more complex applications.”

However, Baird said there are some disadvantages to the PLC's simplicity. "PLC does not have the flexibility of CNC. If you need to change the program even slightly, you have to reprogram it entirely. It also doesn't offer the precision of CNC and is therefore best used as a low-cost solution for basic tasks." According to Baird, despite the low cost of PLCs many manufacturers are choosing CNC, due in part

this as a collision and respond in one of two ways. If it's moving slowly, it will stop, and if it's moving quickly, it will perform a 'vectored back-off' where it will retract any moving machinery to avoid damage. For high-end machines, you can also incorporate 3-D technology, which stops five-axis machinery from moving outside of its pre-determined work envelope."

Zero downtime also is an important consideration for manufacturers looking to automate their processes. Unplanned downtime is expensive and can halt production for days, weeks, or even months. An undetected fault could cause irreversible damage to machinery and could even be hazardous to workers.

Minimizing downtime

"Although it's unrealistic to expect factories to work seamlessly 24/7, we can aim to minimize downtime caused by minor faults or errors," Baird said. This is where the concept of predictive maintenance comes in, which, as Baird explained, is facilitated by CNC technology. "Predictive maintenance allows us to spot potential problems before they occur, and act accordingly before they become serious. We do this by employing the automation technology that controls the machine as a kind of watchman."

Does this mean the CNC is destined to become the sole tool of the factory of the future? Baird doesn't think so; the PLC still has a critical role to play. "The best example of this is a production line. CNC may be controlling the robot arms, the tooling, milling, and grinding, but PLC is powering the belt that takes a product or material from one part of the line to the next. The complexity of CNC does not lend it well to such tasks and would be wasted. As part of a factory floor, where simple and complex tasks are done simultaneously, CNC and PLC work perfectly together."

With CNC and PLC both maintaining a place in manufacturing's toolkit, it is now important to look at how they can be developed. "Industrial control systems (ICSs) will continue to evolve, and this will largely come in the form of specializations suited to specific industries," Baird said. "Third-parties will also exploit the concept of an open interface to integrate the factory with the Internet of Things (IoT). With this will come intelligent machines and data collection and analysis on a vast scale, which will help us to identify further process improvements."

While it isn't clear what role CNCs and PLCs will play in the factory of the future, they will both form a part of it, even if they aren't always working in collaboration. **ce**

Suzanne Gill, editor, Control Engineering Europe. Fanuc provided additional information for this article, which originally appeared in an Oct. 15 Control Engineering Europe article online. Edited by Chris Vavra, production editor, Control Engineering, CFE Media, cvavra@cfemedia.com.

A CNC's advanced user-programmable features can minimize downtime and control the energy usage or output of the machine.

to its lower total cost of ownership. "It is interesting to see many designers turning to CNC after investing in PLC, largely for reasons of flexibility, reliability, and cost. The initial cost of CNC is higher than that of PLC, but the return on investment can be higher in the long term because of the CNC's higher reliability and control. It also gives system designers the flexibility to dictate how much control they want users to have over their machines."

The long-term cost-effectiveness of CNC can be attributed to its advanced user-programmable features, which can minimize downtime and control the energy usage or output of the machine.

Many CNCs are equipped with artificial intelligence contour control. This means the machine can be controlled to operate within a certain workload, or adaptively control the machine for working overnight. For example, it can be programmed so it only works at 80% load, allowing the company to be more economical with their energy usage. CNCs also come equipped with energy efficiency functions such as energy charge modules.

CNCs also have safety functions, which lend themselves well for collaborative operations with humans. "CNCs come equipped with a digital algorithm that looks after the motion control," Baird said. "This digital system is formed of two parts—a real digital data system and an observer digital system. The observer acts like the 'ideal,' providing the machine with the parameters in which it should be working. The real and the observer are both driven by the same command, so they should be working in exactly the same way."

"If the real system encounters a disruption, such as an unexpected load, then this causes the real data to deviate from the observer data. The machine will translate

More ANSWERS

KEYWORDS PLC, CNC

Computer numerical controls (CNCs), which have been around since the 1950s, facilitate the automation of machine tools through computers.

Programmable logic controllers (PLCs) are designed for simpler control tasks than CNCs, are useful on the production line, and may provide less accuracy.

PLCs and CNCs will have different roles in the factory of the future and will remain useful.

GO ONLINE

Read this story online at www.controleng.com for more information about CNCs and PLCs and see a link for the PLC digital report.

CONSIDER THIS

What new roles will PLCs and CNCs play in the factory of the future and what new benefits might they provide to companies?

Architecting an interconnected enterprise

Automation, the conventional pinnacle of productivity, increasingly requires multi-platform connectivity to stakeholders across the enterprise to realize the advantages of smart manufacturing in the Industrie 4.0 era. How? Look at platforms, people, processes, and products.

The pinnacle of productivity has conventionally been touted as automation. With the advent of Industrie 4.0, it is becoming clearer that a fundamental building block for smart manufacturing is connectivity.

Some organizations are quick to jump on the trend bandwagon, and others adopt a wait-and-watch approach. With trends like interconnected enterprises, the modus operandi might lie somewhere between these two extremes. For example, in a recent interaction with a beer manufacturer, the customer revealed interest in augmented reality (AR) smart glasses (Microsoft HoloLens) that will help identify faulty, leaking valves in the facility.

Things are moving fast. In fact, the industry mindset itself has shifted a little. From connected devices, leaders are talking about connected enterprises with flipped architectures that are dynamic and integrated rather than siloed. Those with an interconnection-first strategy can connect their customers, partners, and other key stakeholders to anything, anywhere, on any platform.

In view of these benefits, Equinix's Jeremy Deutsch said last year that the number of interconnected enterprises would double from 38% to 84% by 2017. The prediction comes with the expectation of a booming digital universe, forecasted to reach 44 zettabytes by 2020.

The concept of connected enterprises questions the notion that organizational productivity peaks with automation. It offers new avenues to increase output, establish differentiation, and boost growth by releasing real-time information across departments. For instance, these enterprises can accelerate new product development, facilitate supply chain collaboration, streamline operations, and improve machine reliability, which currently averages 78.3%, much below the ideal 100%.

While real-time data typically emanates from

operational technologies (OT), transactional information on logistics, inventory, quality, and financial health come from information technologies (IT). In connected enterprises, IT and OT converge to form the basis of competitive advantage and productivity.

Digital infonomics (assigning economic value to digital information) is a crucial part of this process. It is slated to serve as the framework for data-driven decision making on a massive scale. Although the concept appeals to many enterprises, it has not been

“An interconnection-first strategy can connect customers, partners, and other key stakeholders to anything, anywhere, on any platform.”

exploited fully yet due to the absence of a foolproof implementation plan, an enterprise-wide approach that rests on four operational pillars: platform, people, process, and product.

Building connected enterprises

A good connected-enterprise starting point is to embrace digital engineering. This involves the use of advanced technologies that collect real-time intelligence related to product variations, defects, and overall productivity. While it supports safe, compliant, and dependable operations, digital engineering also introduces new connection points. As a result, risk exposure for the manufacturing environment increases, creating the need for secure networking infrastructure that leverages the Ethernet.

With the average consolidated cost of a data breach

IloT BLUEPRINT



The connected enterprise combines Industrial Internet of Things networks with operational and information technology frameworks to increase output, establish differentiation, and boost growth by releasing real-time information across departments. Courtesy: L&T Technology Services Ltd.

standing at \$4 million, security issues must be preempted and addressed upfront. Blockchain and security-as-a-service are some options to protect connected enterprises at the people, process, device, and data levels. In public cloud environments, data security governance programs are another possibility, which approximately 20% of organizations are likely to resort to, in 2018.

Interconnections: 4 layers

Eventually, implementing an interconnection-oriented architecture (IOA) approach will become the preferred path to building connected enterprises. Not only does this ensure the secure interconnection of employees, partners, clouds, locations, and devices, but also it lays the groundwork for data exchange and digital commerce.

To graduate to IOA, enterprises will have to create four layers: network, security, data, and application. Once the topology of the network is streamlined, it should be followed up with the development of security guard rails. Finally, applications will need to be integrated with various touch points like supervisory control and data acquisition (SCADA) and manufacturing execution systems (MES).

Digital edge operations

IOA is all about preparing technology for the digital edge, where the virtual and physical worlds converge. Moreover, it calls for the adoption of the edge model by migrating applications, data and data centers to the edge with the support of colocation data centers. This model shortens the distance between enterprises, users, and partners, creating one marketplace.

With such a clear roadmap in place, 76% of com-

Interconnection-oriented architecture requires attention to networks, security, data, and applications.

panies in Hong Kong are looking to pursue interconnection by 2017, while 84% will implement multi-cloud interconnection over the next few years. In Singapore, 84% of organizations will embark on the interconnection journey in 2017, partly because the strategy has yielded more than \$10 million in revenues and cost savings.

But, nowhere has interconnection been better received than in the Americas. From less than 50% adoption in 2015, uptake in the U.S., Canada, and Brazil is estimated to hit 92% this year.

It is not all rosy, and the concerns around return on investment on interconnected ecosystems often crop up in technology summits and board meetings across the globe. What remains is a resonating hope that this wave of technology will take us a few steps ahead of where the last wave promised us. **ce**

Amit Chadha is president, sales and business development, and member of the board, L&T Technology Services Ltd., a CFE Media content partner. Edited by Mark T. Hoske, content manager, Control Engineering, CFE Media, mhoske@cfemedia.com.



KEYWORDS:

Industrie 4.0, smart manufacturing

Using an interconnection-oriented architecture (IOA) will build connected enterprises.

Connections increase output, establish differentiation, and boost growth by releasing real-time information across departments.

IOA will ensure the secure interconnection of employees, partners, clouds, locations, and devices, and lay the groundwork for data exchange and digital commerce.

ONLINE

References for statistics, more info, and links are included in the online version of this article.

CONSIDER THIS

Are you using these strategies to increase interconnections, information flow, and make smarter decisions?

BACK TO BASICS

A zettabyte (larger than a petabyte and exabyte, but smaller than a yottabyte) is the seventh power of 1,000, 10^{21} , one followed by 21 zeros, 1 sextillion bytes, or 1 trillion gigabytes.

Suzanne Gill, Control Engineering Europe

Understanding industrial Ethernet cable requirements

Ethernet's performance in passing data through an automation system at high rates is subject to active devices such as switches and controllers. Users should be aware of aspects such as conductor size, cable selection, and Power over Ethernet (PoE).

Ethernet plays a major role in passing data through an automation system at high rates. The digital performance of a network is subject to active devices such as switches and controllers. However, passive devices such as cable and connectors ultimately can determine a network's performance.

A component's frequency dictates its performance. Cat 5 cables, for example, are specified for operating frequencies up to 100 MHz. This cable also is suitable for 100 Mbit applications using a two-pair cable and for gigabit (1,000Mbit) applications when using a four-pair cable with the correct connector.

It is easy to confuse MHz performance with the Mbit.

Table: Industrial Ethernet cable, frequency requirements

Class	Frequency range	Data rate	Capability
Cat 5/5e	100 MHz	2-Pair	4-Pair
Cat 6	350 MHz	Yes	Yes
Cat 6A	500 MHz	Yes	Yes

Cables of a higher category (class) meet all transmission characteristics of the lower classes and provide an additional performance margin in a given application.

Conductor size

A stranded Ethernet cable does not have the same performance characteristics as a solid conductor. This is important to remember when distance is a factor. Ethernet conductors are typically 26 and 24AWG. It is always best to use the largest size when requiring high data rates over long distance.

The Profinet standard introduced 22AWG cables, which provide significant transmission performance advantage over 26 and 24AWG cables. A full 100 m segment length can be achieved with stranded or solid cable types.

Three types have been defined within the Profinet standard—stationary, flexible, and special application. When using 22AWG cables, selecting the correct RJ45 connector should be done carefully as many are not compatible with the increased wire size and a Profinet cables' larger outside diameter.

Power over Ethernet (PoE)

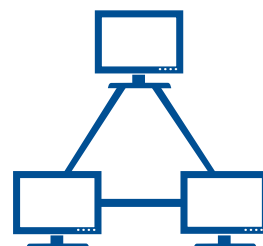
Spare conductors in an Ethernet cable can be used to provide power to Ethernet devices. Wire size is important in calculating voltage drop in PoE applications. It is also important to consider cable selection.

Cable selection

The industrial environment requires suitable cables that have far more robust constructions than those used in office environments. Materials such as polyurethane (PUR) are often used to provide mineral oil resistance and high abrasion resistance. They are also halogen-free.

Ethernet cables are available with solid conductors, which only are suitable for static applications. Stranded conductors—typically seven strand—are suitable for flexible applications. Highly stranded connectors—typically 19 strands—are suitable for continuous movement applications. **ce**

Suzanne Gill, editor, Control Engineering Europe. Lutze Limited provided additional information for this article, which originally appeared in a Nov. 6 Control Engineering Europe article online. Edited by Chris Vavra, production editor, Control Engineering, CFE Media, cvavra@cfemedia.com.



M More ANSWERS

KEYWORD: Ethernet

KEY CONCEPTS

Ethernet plays a major role in passing data through an automation system at high rates.

Passive devices such as cable and connectors can ultimately determine a network's performance.

Selecting the correct RJ45 connector when using 22AWG cables should be done carefully; many are not compatible with Profinet cables' larger outside diameter.

GO ONLINE

Read this story online at www.controleng.com for additional links and information.

CONSIDER THIS

What cable considerations are most critical for your industrial Ethernet cable application?



System integrators on customers, skills gap

Representatives from the 2018 System Integrators of the Year focus on what makes a good customer, how to address the skills gap, and what customers want.

CFE Media interviewed representatives from the 2018 System Integrators of the Year—Burrow Global, Automation Plus, and ECN Automation.

What makes a good customer for a system integrator? What should manufacturers do to prepare for an integration project for it to be more successful?

Grant Mitchell, CEO, Automation Plus: One that's really strategic and is absolutely important so they're really out there planning. And of course that's really essential so really beginning with that in mind. So if we can actually paint that vision, boy, that's really just a knockout customer and what we're looking for.

Jason Savoie, EVP, automation, Burrow Global: We are most successful when we're able to fully collaborate and to fully integrate with a customer base so customers don't look at automation as a commodity but understand there is a real value to what we do and

invite us to the table. So when we can participate with them in the very beginning we can help them forecast their spend plan for five years and help them integrate projects into turnaround schedules and into everything else they're doing.

Arturo Freydig, director general, ECN Automation: It's very important to understand what the customer's needs are and what kind of technology they feel will fulfill all necessities.

How do you recruit, train, and retain skilled engineers? Has the process changed?

Nigel James, president of automation, Burrow Global: We believe in hiring and developing young talent. Unfortunately, many young people do not find system integration as exciting as working in high tech. It is critical that we reach out to this population and get them excited about automation. Having a vibrant mentoring program is a key element of this, and we are working to build processes that engage entry-level new hires and give them access to industry veterans.



The 2018 System Integrators of the Year met at the Digital Manufacturing and Design Institute (DMDII) in Chicago. From left: John Glenski of Automation Plus, Jason Savoie of Burrow Global, and Arturo Freydig of ECN Automation. Courtesy: Katie Spain, CFE Media

Mitchell: There is a war on talent. We know that. So what we have really been doing and focusing on is employee engagement; it's one of our strategic priorities. We just went through strategic planning this past year and employee engagement is absolutely essential. We monitor training, we look at the dollars that we spend, and we get very specific and very strategic about that as well. We have co-op programs, and we're bringing those folks in, and we have found that now employees are seeking us out.

Freydig: What is amazing in the last few years is that new engineers learn this job very fast. I remember years ago we needed more than one year to have a fully developed engineer, but now in six months they are ready for our process and are very enthusiastic.

What are your customers telling you they need?

John Glenski, president, Automation Plus: I think a lot of what we hear from our clients is they hear about Internet of Things (IoT), they hear about Industrie 4.0, and they're really looking at how we can turn data into value. There's a lot of data acquisition (DAQ), but how do they turn that into true business metrics? How can we use it to really improve our plant operations and processes?

Are you starting to see people being more comfortable with the idea of investing in manufacturing?

Freydig: We are focused on the process industry such as food and beer, chemical, mining, and so on, and what I saw is with prices increasing, they have more money to invest in processes. Return on investment (ROI) is very important even more in manufacturing, and it is part of the process you are tasked with. It's not just bringing in equipment anymore.

Savoie: Beyond integrating hardware, we're providing an integrated team to the customer, bringing knowledge to the table to help fully forecast costs. **ce**

M More ANSWERS

KEYWORDS: System integration, skills gap, IoT

Collaboration and a clear vision are priorities from system integrators as they start a project with a customer.

There is a demand for young engineers to narrow the skills gap, and integrators are making it a strategic priority.

Customers are becoming more comfortable with investing in manufacturing and processes and improving their return on investment (ROI).

GO ONLINE

Read more about each System Integrator of the Year. www.controleng.com/SIY

CONSIDER THIS

How can your next project have a sharper focus?

Mike Lomax, Bosch Rexroth

Drives are getting smarter in the Industrie 4.0 era

Intelligent drive systems play a large role in optimizing machine configuration and performance and aiding the adoption of Industrie 4.0.

Machine manufacturers are under pressure to provide shorter development times for highly advanced machines with fewer personnel as Industrie 4.0 adoption gains momentum. The requirement for real-time data to inform operational decision-making is growing. The keyword with Industrie 4.0 is connectivity—between all participants in the production process—even in facilities where Industrie 4.0 adoption may not have happened yet. It is important that components or systems are at least compatible with Industrie 4.0 requirements and have the ability to connect and communicate with internal and external networks.

While this is easy to achieve with new components, replacing all existing systems to ensure compatibility is unrealistic. This has led to the development of a variety of devices that offer at least basic connectivity to Industrie 4.0 systems without impacting the automation logic.

Enhanced functionality is a particular requirement with drives. Modern drive systems now have sufficient intelligence to perform position movements and velocity control. These functions are expected in the same way as is accessing email via a mobile phone. Another expectation with Industrie 4.0 is drive systems will be able to acquire data on machine functionality and performance and then configure and present this data externally.

Advances in drives allow manufacturers to allocate functions to the drive via in-built technologies that remove the need for an external programmable logic controller (PLC). The latest servo drives, for example, now include the International Electrotechnical Commission (IEC) 61131-3 programmable controller operating system. This represents a change from the minimal functionality offered by previous drives.

It will take time for the implications of these advances in drives to be understood fully, but drives now have the ability to solve control challenges in real time—a key facet of Industrie 4.0. Removing the PLC and going straight to the drive eradicates any



Advances in drives allow manufacturers to allocate functions to the drive via in-built technologies that remove the need for an external programmable logic controller (PLC), which represents a change from the minimal functionality offered by previous drives. Courtesy: Bosch Rexroth

time lapse, and so optimizes cycle time and production consistency.

Staying in sync

Even if a drive system does contain the appropriate problem-solving tools or function blocks, the challenge of synchronizing multiple movements on the machine remains. Where the bus system in use is not deterministic, the solution is for the drives to communicate between themselves, without having to refer back to a central control system. This is where technologies such as SERCOS III—one of the first deterministic bus systems—come into their own. A deterministic system is not necessarily a prerequisite for Industrie 4.0 adoption. Drives can store real-time data and send it in a non-deterministic way to upward systems.

With such a range of function tools available within the drive, it is important to select the right tool. The goal should be that a machine builder programmer with no previous experience of the particular challenge can access and use these functions.

The solution lies in employing tried and tested PLC function blocks that can be used in PLCs under IEC 61131-3 and even incorporated within ladder logic programming.

‘**When a critical issue requires the machine to cease operating, this decision can be made inside the drive, which minimizes lost production and the risk of machine damage.**’

A variety of function blocks now are available and can be selected depending on the individual application requirements. Their capabilities range from correcting the positions of products on conveyor belts, and the control of winders, to closed loop register control and even the creation of a complete motion profile for cross-cutters and cross sealers.

Creating a machine HMI

Creating an interface between the machine and operator—another vital component of Industrie 4.0—previously required central PLC involvement along with a bus system to convey key machine set-up information and variables to the drives. Diagnostics and machine status information is redirected to the PLC before being displayed on the human-machine interface (HMI).

Although modern bus systems can achieve this, it can require a great deal of programming effort and may be unnecessary when all the required information is contained within the drive system. To address this, many drive systems contain all the tools needed to create an HMI. In some instances, a central PLC may not even be required as the drives are capable of using a full range of inputs and outputs, which would normally be connected to the PLC.

A key factor that must be kept under control is the time taken to set up and commission the machine. Intelligent drives now offer a number of tools to reduce start-up time through optimized axis movements and process synchronization.

These rapid start-up tools have been designed to enable the drives to be moved at an early stage of the machine commissioning, even before the machine control software is installed on the system. This results in rapid and easy testing of

machine mechanics with only basic IT tools, such as mobile phones or tablets, needed to gather information.

Help with maintenance

Modern drives now can play a part in a proactive maintenance regime as they can be supplied with a fully integrated series of software tools capable of performing key predictive maintenance functions, with minimal additional programming effort. This software can be set up to continuously monitor the condition of the machine mechanics and process conditions in real time. This includes waveform analysis through analyzing the rate of temperature change, as well as checking for backlash, increased friction, or process overload.

If a fault condition arises, a code is generated and passed to the machine HMI. If a critical issue is identified that requires the machine to cease operating, this decision can be made inside the drive, which minimizes lost production and the risk of machine damage.

Industrie 4.0 provides enhanced processing power and improved functionality for intelligent drives. This presents many opportunities for companies to optimize programming, production, and maintenance. With the need for central PLCs eliminated or reduced in many situations, more advanced machines can be created in much shorter timeframes. **ce**

Mike Lomax is electrification manager at Bosch Rexroth. This appeared Oct. 22 on the Control Engineering Europe website. Edited by Chris Vavra, production editor, Control Engineering, CFE Media, cvavra@cfemedia.com.



KEYWORD: Industrie 4.0

Machine manufacturers are turning to Industrie 4.0 to improve connectivity and provide real-time data.

Another expectation with Industrie 4.0 is that drive systems are able to acquire data on machine functionality and performance and then configure and present this data externally.

Industrie 4.0 provides enhanced processing power and improved functionality for intelligent drives and the opportunity to optimize programming, production, and maintenance.

GO ONLINE

Read this story online at www.controleng.com for more information about Industrie 4.0 and its impact on machines and drives and see a link to the original *Control Engineering Europe* story.

CONSIDER THIS

What other benefits can Industrie 4.0 provide for machine manufacturers?

Four trends in VFD management

Variable frequency drives (VFDs) do more with less.

The demand for efficient motor controls due to rising energy prices and a trend toward energy efficiency has resulted in a growing demand for variable frequency drives (VFDs). The market for VFDs is expected to increase at a rate of 5.94% (CAGR) in the next three years, so it's not surprising manufacturers are investing in state-of-the-art VFD technology. The latest advances in VFD software and hardware tackle common problems original equipment manufacturers (OEMs), system integrators, and manufacturers have been wrestling with for years: enabling teams to do more—faster and easier—with fewer resources.

1. Wireless diagnostics

Wireless diagnostics represent the future of VFDs whether it's Wi-Fi, Bluetooth, or something else entirely. In a typical plant where access to a drive in a closed enclosure may be limited, engineers can connect directly to the system from a distance using the wireless signal built into the drive.

Online software enables engineers to view and diagnose problems without touching the drive or its enclosure.

2. Flexible integration

VFDs with flexible integration allow engineers to solve for the application challenge once and then interface to an upper-level programmable logic controller (PLC) of choice.

When an OEM is selling a given machine to customers domestically and abroad, regional trends in PLC preference are not an obstacle for machine integration. The OEM can take a drive with multiple communication options, solve the machine application once, and pick the option that matches the upper-level controller choice for each customer.

VFDs constructed specifically for flexible integration usually consist of a single basic inverter with control or networking modules that can be selected at will.

3. Modular memory

Gone are the days when technicians would have to go into the keypad to program a replacement VFD. Soon, having to use a PC or even just a USB stick to transfer the configuration to a replacement drive will be a thing of the past.



Scalable functionality and ease of use are design goals of Lenze's i500 inverter. Applications include pumps, fans, conveyors, formers, winders, traveling drives, winders, and tool and hoist drives. Courtesy: Lenze Americas

Today, drives with removable, modular, nonvolatile memory make maintenance quick and easy. They eliminate the need to connect additional hardware. If a piece goes bad, device replacement is as simple as taking the memory module out of the old drive and putting it into a new one.

4. Predictive maintenance

Manufacturers are gathering massive amounts of data from their machinery and manipulating it into business intelligence that drives predictive maintenance.

The Internet of Things (IoT), a global trend in every industry, has had an impact on VFDs by speeding and simplifying the flow of information from machine to technician and back again. As such, manufacturers are making changes to everything from their machines to their information technology (IT) departments to facilitate the collection, analysis, and application of drive data.

From a hardware perspective, teams are moving away from serial and toward Ethernet as the network of choice. Basic IT departments are familiar with Ethernet switches, hubs, and routers, resulting in a more seamless integration for data transfer.

Complex communication strategies are requiring modern VFDs to report lifetime counters, production rates, downtimes, power output, and more for better real-time decision making. **ce**

Joel Kahn is a product manager for inverters at Lenze Americas. Edited by Jack Smith, content manager, CFE Media, Control Engineering. jsmith@cfemedia.com.



KEYWORD: Variable frequency drives (VFDs)

Engineers can connect directly to VFDs from a distance using the wireless signal built into the drive.

VFDs constructed specifically for flexible integration usually consist of a basic inverter with control or networking modules that can be selected at will.

For hardware integration, teams are moving toward Ethernet.

CONSIDER THIS

How advanced are the VFDs in your plant?

GO ONLINE

Link to additional online resources, variable frequency drives (VFDs) and related content at www.controleng.com/archives, under January 2018.

William Nyback, ABB Inc.

Bluetooth connectivity makes VFDs safer, easier to use

Variable frequency drive (VFD) product advances improve performance, simplify installation and operation, and increase safety.



Figure 1: The ability to connect a smartphone to one or more variable frequency drives (VFDs) through Bluetooth is one of the recent developments that have made the operation of drives easier and safer. All images courtesy: ABB Inc.



KEYWORD: Variable frequency drives (VFDs)

The ability to connect a smartphone to one or more VFDs through Bluetooth is among drive advances.

In many industrial facilities, drives are installed in a control room cabinet, away from the motors they control.

CONSIDER THIS

Would Bluetooth connectivity make VFDs safer and easier to use in your plant?

GO ONLINE

Link to additional online resources, variable frequency drives (VFDs), Bluetooth, and related content at www.controleng.com/archives, under January 2018.

Motors consume approximately 66% of the electricity in an industrial facility. With industrial electricity usage expected to grow substantially over the next 10 years, facilities of all types are equipping motors with variable frequency drives (VFDs) to reduce consumption and gain other production efficiencies.

Though only 10 to 15% of industrial motors are controlled by a VFD, the number is increasing. Leading drives manufacturers are cultivating the growing market by introducing many product advances that improve performance, simplify installation and operation, and increase safety for those who operate the equipment.

Bluetooth connectivity

The ability to connect a smartphone to one or more VFDs through Bluetooth is a recent development that has made the operation of drives easier and safer (see Figure 1). With a smartphone app developed by the manufacturer—typically available for free from either Google Play or the Apple Store—it is possible to wirelessly connect to VFDs to execute any task an operator could accomplish by directly accessing the drive keypad. Depending on the layout and structure of the facility, Bluetooth is functional up to 250 ft. from the drive.

With the VFD app, an operator can pair the smartphone to multiple drives through a simple set of initiation instructions. Each drive must have a Bluetooth-enabled keypad, which is standard or available as an option on the newest generation of drives from participating



Figure 2: Each drive must have a Bluetooth-enabled keypad, which is standard or available as an option on the newest generation of drives from participating manufacturers.

manufacturers (see Figure 2). Descriptive names and passcodes dedicated to each drive assure parameters and loggers for each VFD are kept separate and are secure from unwanted access.

Once installed, Bluetooth provides the means to commission, tune, and maintain a VFD, often keeping users from having to enter hazardous or difficult-to-reach work areas.

Operator safety, parameter functions

In many industrial facilities, the full array of drives is installed in a control room cabinet, isolated from the motors they control. With each VFD charged with 480 V of power, the potential for an arc flash is high when an operator opens the door to access the drive keypads. Rather than requiring an operator to put on cumbersome arc flash personal protective equipment (PPE), it is easier and more efficient to access the VFDs through a smartphone Bluetooth connection.

The same convenience is applicable to drives mounted high on a wall, in a loud room, or behind a partition. Using a smartphone is safer and easier than climbing a ladder, entering a high decibel area, or walking to a distant location.

The Bluetooth interface from the most sophisticated manufacturers provides full parameter access. All important functions can be analyzed, adjusted, and backed up with a smartphone and all event loggers are fully captured and easily available. **ce**

William Nyback is a product specialist for high performance drives at ABB Inc. Edited by Jack Smith, content manager, CFE Media, Control Engineering, jsmith@cfemedia.com.

TAKING IT TO THE eXTREME

THE WAGO-I/O-SYSTEM FOR eXTREME APPLICATIONS



750 Series XTR:

- eXTREme Vibration: up to 5g acceleration
- eXTREme Temperature: from -40 °C to +70 °C
- eXTREme Isolation: up to 5 kV impulse voltage
- eXTREme Intrinsic Safety: signal acquisition and transmission in Zones 0 and 1



www.wago.us/xtr



input #12 at www.controleng.com/information

Jason Wellnitz, Yaskawa America Inc.

Three major VFD trends

Variable frequency drive (VFD) development is shifting focus away from general-purpose motor controls that are already meeting market demands toward reduced installation costs.

More than 40 years ago, transistor-based variable frequency drives (VFDs) quickly demonstrated their ability to save energy and improve process control. Successive VFD generations improved motor-control performance, became smaller, and minimized installation time. VFD development is shifting focus away from general-purpose motor controls that are already meeting market demands toward one remaining constant market driver: reduced installation costs.

1. Save time

To minimize commissioning time, VFDs are being designed and built for individual industries. Out-of-the-box VFDs are programmed with industry-specific

terminology, parameter defaults are customized, new functions created, and unneeded features are cut away. VFDs also are being programmed with industry-specific setup wizards to guide the installer through the typical steps needed to run a drive (see image).

These software features are designed to minimize the installer's time in front of a drive at the job site to reduce commissioning costs. A second benefit of creating industry-specific drive features is to minimize the time required to train drive installers by making drive setup intuitive and easier.

2. Save space

Open-type and NEMA 1 VFD enclosures are still the staple of VFDs manufactured in the

PROTECT PUMPS

DRY RUNNING • CAVITATION • BEARING FAILURE • OVERLOAD

MONITOR PUMP POWER

- Best Sensitivity
- Digital Display

TWO ADJUSTABLE SET POINTS

- Relay Outputs
- Adjustable Delay Timers

4-20 MILLIAMPER ANALOG OUTPUT

COMPACT EASY MOUNTING

Only 3.25" x 6.25" x 2"

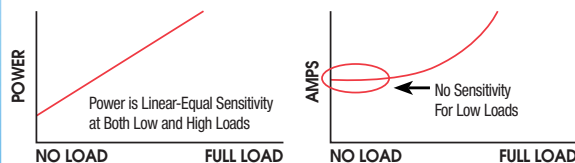
- Starter Door
- Panel
- Raceway
- Wall

UNIQUE RANGE FINDER SENSOR

- Works on Wide-range of Motors
- Simplifies Installation



WHY MONITOR POWER INSTEAD OF JUST AMPS?



PUMP POWER



ALL PRODUCTS
MADE IN USA

LOAD CONTROLS
INCORPORATED
WWW.LOADCONTROLS.COM

CALL NOW FOR YOUR FREE 30-DAY TRIAL 888-600-3247

Americas. They are commonly mounted to a machine, facility wall, or added to another enclosure with a higher environmental protection rating. However, NEMA 12 (IP54) and NEMA 4/4X (IP66) VFDs are rapidly gaining popularity, particularly in fan and pump applications where the application controls now reside in the VFD's software rather than external logic.

They are smaller and weigh less than VFDs mounted in another enclosure. They also minimize overall component count by minimizing wire, terminal blocks, and additional cooling. Engineered drive packages with branch circuit protection, power conditioning devices, and control input/output (I/O) still have a firm place in the industry, but enclosures will continue to become more specialized and cost effective.

3. Mitigate harmonics

Meeting IEEE 519-2014: IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems current harmonic requirements has become a focus in Pacific coast states and has been slowly moving eastward. Mitigating current harmonics increases installation costs from the



VFDs also are being programmed with industry-specific setup wizards that guide the installer through the typical steps needed to run a drive. Courtesy: Yaskawa America Inc.

equipment owner's perspective; the cost savings comes from the power utility's side. Reducing current harmonics has become so important to utilities that many offer rebates to help offset higher VFD costs. This is perhaps

the area of greatest change in the VFD marketplace over the past five years. Conventional low-harmonic topologies, such as 18-pulse rectifiers and harmonic filters, are being displaced by a wide array of active switching topologies that are more efficient, consume less space, and easier to install.

VFD manufacturers are evolving their products and adding a multitude of features, but the primary purpose of a VFD is to save the owner money. VFDs that continue to reduce total cost of ownership (TCO) will continue to dominate the markets. **ce**

Jason Wellnitz is a product manager at Yaskawa America Inc. Edited by Jack Smith, content manager, CFE Media, Control Engineering, jsmith@cfemedia.com.



KEYWORD: Variable frequency drive (VFD)

To minimize commissioning time, VFDs are being designed and built for individual industries.

Open-type and NEMA 1 VFD enclosures are still the staple VFD manufactured in the Americas.

Mitigating current harmonics increases installation costs from the equipment owner's perspective; the cost savings comes from the power utility's side.

CONSIDER THIS

Are reduced installation costs shifting your focus away from general-purpose motor controls in favor of VFDs?

GO ONLINE

Link to more online, and related content at www.controleng.com/archives, under January 2018.



NEMA 4X/IP66 Nonmetallic Enclosures for your Toughest Applications

- Fiberglass Reinforced Polyester (FRP) or Polycarbonate material
- Lightweight
- Non-corrosive
- Non-conductive
- UV resistant
- Custom modifications
- Premium accessories
- 3D model library for easy download

12" x 12" AM & AM-R Series

input #14 at www.controleng.com/information

Scan to learn more about Allied Moulded and the latest in nonmetallic enclosures & accessories.



Or connect with us online!



ALLIED MOULDED PRODUCTS, Inc.

222 North Union Street • Bryan, Ohio 43506
Ph: 800-722-2679 • Fx: 800-237-7269

© 2018 Allied Moulded Products, Inc.

www.alliedmoulded.com

CONTROL ENGINEERING

41

PRODUCT EXCLUSIVE

Multi-connectivity gateway for IoT applications

NEW PRODUCTS

44



42



45

64

BACK TO BASICS

Ten control system programming best practices

Best practices for programmers include defining their structure, knowing the system resources and tools, consistency, and keeping track of changes during a project.



Looking for new products by category?

Check out the New Products for Engineers Database and search hundreds of products, with new innovations added every day.

Look for this logo on the *Control Engineering* home page.

www.controleng.com/NP4E

Have a New Product for Engineers to submit for consideration?

Do so here: www.controleng.com/NP4E

Operator panels

X2 extreme

Rugged HMIs for tough environments



X2 extreme are certified by all major classification societies. Designed to perform in rugged environments with -30°C to +70°C, high vibrations and high-pressure wash-downs.

7, 12 and 15 inches. Standard versions. High performance and fully sealed high-performance versions with high brightness display and optional integrated CODESYS PLC.

X2 series. Strong. Stylish. Smart.

► Learn more at beijerelectronics.com/x2extreme

input #15 at www.controleng.com/information

Beijer
ELECTRONICS



Multi-connectivity gateway for IoT use

Advantech's UTX-3117 fanless and extended-temperature embedded gateway is ideal for industrial automation and other Internet of Things (IoT) applications.

Advantech's latest IoT gateway aimed at empowering industrial IoT solutions, the UTX-3117, is a fanless and extended-temp embedded box. It is designed to provide real-time IoT computing, and to be a power-efficient, plug and play gateway ideal for industrial automation, smart metering, HVAC, smart city street lighting, smart parking, smart agriculture, healthcare, and other applications.

The UTX-3117 is compatible with Microsoft Windows 10 IoT Enterprise, Yocto Linux, and Wind River Pulsar OS. The UTX-3117 also has Advantech intelligent software WISE-PaaS integrated and is certificated with AWS Greengrass IoT offerings to bridge connectivity from edge sensors to the cloud.

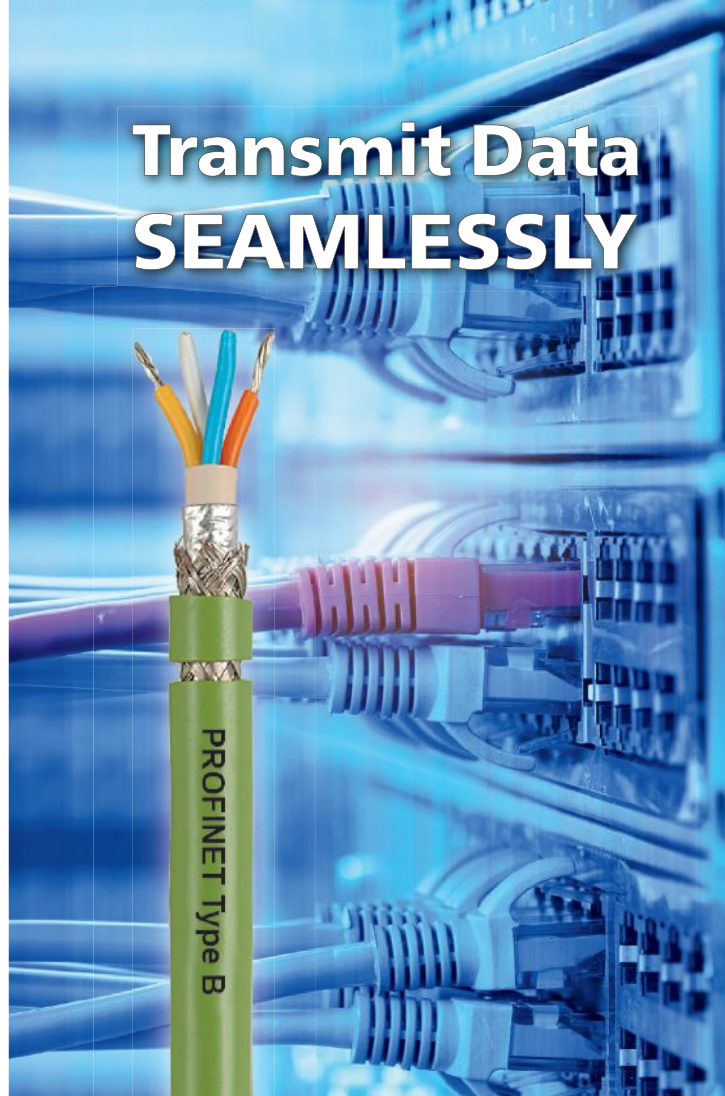
The UTX-3117 integrates three radio frequency (RF) modules in palm-sized dimensions, including one M.2 slot for Wi-Fi, one half-size MiniPCIe slot, and one full-size MiniPCIe slot for 3G/LTE, Zigbee, or LoRa connection. It has a special double-sided thermal solution and offers the independent RF modules to maintain maximum RF throughput in extended temperatures ranging from -20 to 60°C. The UTX-3117 offers five RF antennas. These antennas are designed in optimized locations to prevent RF signal conflicts.

The UTX-3117 is ideal for transportation, logistics, and industrial automation with wide range power input from 12 V to 24 V dc. It comes with rich connectivity and expansion options including two RS-232 and RS-422/RS-485 serial ports for device control and wire sensor data aggregation. It also offers two USB 3.0 ports, one audio jack, and dual gigabit LAN ports for general system control.

Advantech, www.advantech.com

Input #200 at www.controleng.com/information

Transmit Data SEAMLESSLY



Data, Network and Bus Technology

HELUKABEL® offers an entire range of data, network and bus technology. Our HELUKAT® and HELUCOM® brands are well-positioned to serve the global market.

PROFINET Type B

Cat 5e for use in cable carriers and automated equipment. PVC and FRNC versions available.

 **HELUKABEL®**
The Worry-Free Cable Experience

www.helukabel.com | cables@helukabel.com





Rotary position sensor for OEMs and control systems

Curtiss-Wright's NRH305DR is a non-contact rotary position sensor for original equipment manufacturers (OEMs) that design vehicles and control systems. The NRH305DR is designed to enhance system performance by incorporating two completely independent power supplies and output channels for full electrical redundancy, operating from a 5 V dc regulated supply. With a 8 mm low-profile sensor body and small footprint, this fully-encapsulated, IP68/IP69K-rated sensor offers protection against water, dust, shock, vibration, and temperature. The separate magnet assembly that activates the sensor can have a permissible air gap between 1.5 and 8 mm (depending on magnet style) and can accommodate up to ±2 mm radial offset to ease setup and installation.

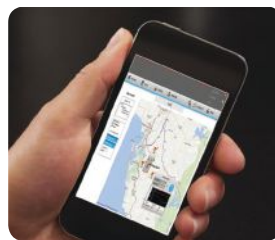
Curtiss-Wright, www.curtisswright.com

Input #201 at www.controleng.com/information

Chemical injection control and diagnostic module

DCiii's Mirador chemical injection control and diagnostic module is designed to provide greater remote control and diagnostic monitoring capabilities over the chemical injection process for reduced waste and production costs. Operating on an open-based platform with Modbus RTU communication protocol, the Mirador is designed to integrate with sensors, communications, and software to provide full operational visibility, tracking, control, and analysis over chemical injection processes from a remote control station. Through a simple retrofit to existing "tank and pump" only systems, this value-added subsystem addresses 95% of chemical injection systems that work by on/off control capacity to deliver chemical to the point of injection.

DCiii LLC, www.dc3control.com Input #202 at www.controleng.com/information



HMI/SCADA solution with contextual mobility

PcVue Inc.'s Contextual Mobility HMI/SCADA solution is designed to proactively and securely present the right contextual information, to the right person, at the right location, and at the right time. PcVue has developed a mobility infrastructure that takes advantage of an indoor position system (IPS) and a global positioning system (GPS) to provide proximity and location services. The mobile worker now is able to automatically get relevant information on his/her mobile device depending on location and role within the organization without the need to navigate. The United States Patent Office has granted a patent for Contextual Mobility to use PcVue HMI/SCADA solutions in location-based applications. Via a mobile device, location information of a user in or near a facility is detected using a position sensor.

PcVue Inc., www.pcvueinc.com Input #203 at www.controleng.com/information



Data management software suite

National Instruments' (NI) Data Management Software Suite provides a complete workflow to standardize measurement data across teams, mine that data for useful information, transform the data through automated analysis, and deliver reports. The Data Management Software Suite aims to simplify this workflow by introducing new server-based software features and the Analysis Server product, which helps engineers and scientists automate the search, standardization, analysis, and reporting of large amounts of measurement data. The full suite is flexible enough to integrate with customers' existing data formats and information technology (IT) infrastructures. Manage data using this, a Microsoft Windows machine, and a network.

National Instruments, www.ni.com

Input #204 at www.controleng.com/information

Linear drive motor with electric cylinder

The Spindasyn SEZ electric cylinder from AMK Automation is a ready-to-install linear drive motor system in which the rotor is pressed directly onto the screw. Featuring high and constant force, high precision, position accuracy, and high energy efficiency, closed-loop positioning and force control make it ideal for linear technologies such as pneumatic or hydraulic cylinders, rack and belt drives, and linear motors. With several options available for screw and strength length, motor type and acceleration, the SEZ provides high rigidity without additional wearing parts. With the ability to set multiple travel profiles, it easily can be integrated into machine automation processes and applications such as packaging, carton forming, palletizing, pick and place, cross-cutting, labeling, wrapping, strapping, filming, insertion, order picking, sealing plastics, printing, paper processing, textiles, food and beverage, machine tooling, and more.



AMK Automation, www.amk-group.com

Input #205 at www.controleng.com/information

Miniature circuit breaker with surface mount »»

Noark Electric's UL 489 BINQ miniature circuit breaker (MCB) is designed as a direct replacement for the common MCB when paired with the optional surface mount. This quick-connect breaker is available in three curves (B, C, and D), ranges from 0.5 to 63 A, and is compliant with UL/CSA/IEC standards for branch circuit protection in commercial and residential applications. This MCB is suitable for industrial applications and other component sub-assembly designs. The current-limiting BINQ is thermal-magnetic and protects against short circuit and overload conditions. The 1- and 2-pole breaker, offered at 120/240 Vac, provides optimum and efficient protection for branch and control circuits.

Noark Electric, www.noark-electric.com
Input #206 at www.controleng.com/information



» Industrial networking and Ethernet solutions

Mencom's range of industrial Ethernet switches include managed switches, unmanaged switches, gigabit switches, harsh environment switches, and EN50155-certified switches. They also include secure routers, media converters, serial device servers, Modbus gateways, and power supplies. The networking solutions provide prolonged mean time between failure (MTBF) so in an event of link or device failure, smart-redundancy features will detect the failure, relay the cause of the failure back to the control center, and recover to provide continuous operation. They also are designed with embedded isolation to withstand the harshest industrial-grade electromagnetic interference and susceptibility without suffering fatal damage or generating noise. In addition, Ethernet ring protection switching (ERPS), rapid spanning tree protocol (RSTP), or media redundancy protocol (MRP) ring settings can resume the operation and network connectivity immediately if a network switch fails or a communication link is broken.

Mencom Corp., www.mencom.com
Input #207 at www.controleng.com/information



ACS580

Operate with confidence

We realize that multiple things play into keeping your system running. With the ACS580, ABB leverages coated control boards, extensive testing, protection on all three phases, long-life fans, thermal sensors and more to ensure reliability.

new.abb.com/drives/us/acs580-campaign



Rackmount series for medical and industrial applications >>

Kontron's ZINC19 rackmount series is designed for industrial and medical applications and can be used for complex control and computing tasks. Demanding graphics and image processing applications are made possible by a number of optional high-performance graphic cards. The system is designed specifically for continuous operation in rough industrial environments and can withstand exposure to extended shock, vibration, and temperature levels. Available in 2U and 4U rackmount form factors, the ZINC19 series can be customized to meet individual customer needs thanks to their modular structure and numerous expansion slots. Up to five PCIe and two PCI slots allow for a wide variety of options, including a 10 GBit/s expansion card and a set of high-performing graphic cards. The ZINC19 rackmount series has an extended temperature range of 0 to 50°C and can be used for harsh environments. Its optimized thermal design allows for quiet operation in noise-sensitive areas where operators are present.



Kontron, www.kontron.com Input #208 at www.controleng.com/information

<< Modular terminal block series



Weidmuller's Klippon Connect A-Series Universal modular terminal blocks includes feed-through, multi-tier distribution, PE, fuse, test disconnect, and neutral conductor disconnect terminal blocks. They are designed specifically for use in recurring control panel applications that include voltage/current transformer wiring, control voltage distribution, motor wiring, signal wiring, and initiator/actuator wiring. Features include integrated push-button clamp actuator for safer wiring and simple handling. They also have a spring-loaded mounting foot to compensate for rail size fluctuations and have two integrated jumpering channels. The A-Series application range offers users custom-fit control panel solutions to help increase productivity for recurring applications.

Weidmuller, www.weidmuller.com Input #209 at www.controleng.com/information

Medical open frame power supplies.
Very compact and efficient 15 and 30 Watt models certified to ES 60601-1 3rd edition for 2 x MOPP.



TPP15 & TPP30 Series

- Low leakage current (<100 µA) within the limits for BF applications
- EMC compliance according IEC 60601-1-2 4rd edition
- Risk management process to ISO 14971 incl. risk management file
- Acceptability of electronic assemblies according IPC-A-610 Level 3
- Design and manufacturing according ISO 13485 management system
- 5-year product warranty

TRACO POWER

Reliable. Available. Now. www.tracopower.com

input #18 at www.controleng.com/information

Power and feedback cables for >> abrasive environments



Helukabel's Topserv and Topgeber product portfolio of servomotor power and feedback cables are receiving a heat-resistance upgrade from 80° to 90°C. Higher heat resistance has its advantages because conductor temperatures in motor applications and the surrounding environments, such as motor terminal boxes, often exceed 80°C. The polypropylene (PP) materials for the conductor insulation can withstand temperatures up to 110°C. For the servo and feedback cable jackets, polyvinyl chloride (PVC) and polyurethane (PUR) cables are used. PUR, in particular, has advantages in dynamic drag chain applications where continuous flexing and high abrasion resistance are paramount.

Helukabel, www.helukabel.com

Input #210 at www.controleng.com/information

Discrete PLC I/O modules

AutomationDirect's Productivity2000 programmable logic controller (PLC) system has 50 discrete and analog input/output (I/O) modules providing over 400 local I/O points. With remote expansion, over 4,000 total I/O points are available. DC discrete I/O modules include 8-, 16-, and 32-point, 12-24 V dc, sink/source modules with additional isolated commons. There are two isolated commons for the 8- and 16-point modules and four isolated commons for the 32-point module. The Productivity2000 is a modular, rack-based system with a full lineup of discrete, analog, and specialty I/O modules. The high-performance CPU has 50 MB memory, fast scan times, and five communication ports. Two 10/100 Mbps

Ethernet ports allow programming, expansion, and client/server connections such as Modbus TCP, EtherNet/IP scanner, and adapters.

AutomationDirect
www.automationdirect.com

Input #211 at www.controleng.com/information



Embedded PC has many cores

Beckhoff's CX20x2 Embedded PC devices integrate Intel Xeon D processors, each with 4, 8, or 12 CPU cores of the fifth generation Intel Core microarchitecture, and are manufactured using 14 nm process technology. The processor core options provide ample processing power and parallelism, even for extremely demanding automation tasks. Optimal multi-core support via TwinCAT 3 automation software makes it possible to distribute the individual tasks of a control process across the many available CPU cores. This means that the computing load can be planned in fine detail to achieve the best-possible processor efficiency. A cable-free plug-in connection facilitates easy fan replacement if required, and the regulated fan speed can be queried in the programmable logic controller (PLC) software.

Beckhoff Automation
www.beckhoffautomation.com

Input #212 at www.controleng.com/information

Meet the smallest Industrial PC from Beckhoff.

The ultra-compact C6015 IPC for automation and IoT.



www.beckhoff.us/C6015

With the ultra-compact C6015 Industrial PC, Beckhoff has again expanded the application possibilities of PC-based control. Wherever space or cost limitations previously prevented the use of a PC-based control solution, this new IPC generation offers an excellent price-to-performance ratio in an extremely compact housing. With up to 4 CPU cores, low weight and unprecedented installation flexibility, the C6015 is universally applicable in automation, visualization and communication tasks. It is also ideal for use as an IoT gateway.

- Processor: Intel® Atom™, 1, 2 or 4 cores
- Interfaces: 2 Ethernet, 1 DisplayPort, 2 USB
- Main memory: up to 4 GB DDR3L RAM
- Housing: Die-cast aluminum-zinc alloy
- Dimensions (W x H x D): 82 x 82 x 40 mm

New Automation Technology **BECKHOFF**

input #19 at www.controleng.com/information



Executive VOICE

CORPORATE PROFILES

The voice of the engineering community speaks loud and clear in the following pages featuring corporate profiles of those companies participating in the Executive Voice program presented by *Control Engineering* magazine.

Our thanks to the following participants:

ABB Drives and Controls
Allied Moulded Products
AutomationDirect
B&R Industrial Automation
Balluff
Beckhoff Automation
Beijer Electronics
Digi-Key Corporation
Emerson Automation Solutions
EZ Automation/AVG Automation
Kepware Technologies
Moxa Americas
Panduit
SEW Eurodrive
YRG Inc.

**CONTROL
ENGINEERING®**

Approximately 40% of the world's electricity is consumed by industrial applications. As overall consumption is expected to rise by 33% in the next 12 years, facilities of all types and sizes have the responsibility to reduce the correlation between economic growth and energy usage.

With motors consuming an average of two-thirds of the electricity in an industrial facility, equipping them with variable frequency drives to regulate their speed is an emerging part of the solution. Though only 10-15% of industrial motors are currently controlled by a drive, the number is rapidly increasing. ABB, the market leader in drives, is at the forefront of this energy efficiency trend.

“ABB drives can reduce energy consumption and the subsequent CO2 emissions by 30% to 50% in many applications”

By continually matching the speed of a motor to the actual demand of a process load in real time, ABB drives can reduce energy consumption and the subsequent CO2 emissions by 30% to 50% in many applications. ABB drives also bring about improvements in product quality through fast and accurate process control, while also boosting productivity and lowering motor maintenance costs.

ABB drives are installed in a variety of industries, including HVAC, food and beverage, water and wastewater, COG, energy, mining, material handling, plastics, metals and many more. The majority of the ABB drives installed in North America are manufactured at an ABB plant in New Berlin, Wisconsin.

ABB has introduced several new “all-compatible” drive models in the last several years, with all essential features built-in, greatly simplifying drive selection, commissioning, operation and maintenance.



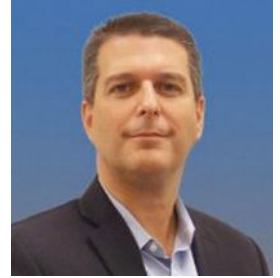
ABB manufacturing plant in New Berlin, Wisconsin.

Once users have learned one drive, they will be able to quickly integrate others, including larger drives, saving effort, training costs, energy and money with each installation.

Another recent development is Bluetooth connectivity, which makes it possible to connect wirelessly to an ABB drive with a smartphone, allowing users to set-up, tune and troubleshoot

Pedro Mendieta

Vice President and General Manager, ABB Drives and Controls, United States



a drive without having to enter a potentially hazardous or difficult-to-reach work area

ABB also has a vast network of technical experts that support end-users throughout the product lifecycle, helping to develop cost-effective and easy-to-maintain systems to meet specific project application requirements.

With a very short payback period based on the energy savings alone, ABB drives are a highly economical and effective means to increase industrial productivity and lower the stress on utilities and the environment in a sustainable way.



www.abb.us/drives • 800-752-0696
abb.mail@us.abb.com

Allied Moulded Products, Inc. is a leading manufacturer of nonmetallic electrical boxes and enclosures in today's residential, commercial and industrial markets. Leveraging more than half-a-century of experience, Allied Moulded has grown to become the benchmark of quality within the electrical industry. Its full-service molding operation includes expertise in compression and injection molding, using thermoset and thermoplastic materials, as well as a unique resin transfer molding process.

Utilizing a modern, automated assembly process, Allied Moulded provides customer with a superior product at a competitive price. Unrelenting focus on service, delivery, value, innovation and technology in everything Allied Moulded makes and does, has made it what it is today.



Allied Moulded manufacturing plant in Bryan, Ohio

Allied Moulded's industrial enclosures can be found all over the world in many different control applications such as industrial & manufacturing

plants, waste water treatment, wind turbines, security, SCADA, solar, marinas, data & telecommunications, mining, and more.

The extensive line of NEMA type 4X/IP66 fiberglass reinforced polyester (FRP) enclosures, made with its proprietary ULTRAGUARD® resin formulation, outperforms competitors in the areas of yellowing, gloss retention, discoloration and change in texture. With a wide range of sizes, accessories and customizations available, Allied Moulded offers a complete solution to your industrial enclosure needs.

In addition to fiberglass, Allied Moulded also offers the POLYLINE® series, a line of polycarbonate, injection-molded enclosures.

According to Matt McIntosh, Vice President of Global Sales and Marketing, "Allied Moulded's nonmetallic enclosures are found in many diverse industries around the world. The design features combined with their resistance to corrosion provide a solution to many application problems, such as exposure to UV rays and extreme weather conditions. Allied Moulded's enclosures are easy to customize and have a large variety of accessories available to suit any application need."



Matt McIntosh

Vice President of Global Sales and Marketing

"Allied Moulded's enclosures are easy to customize and have a large variety of accessories available to suit any application need."

Allied Moulded's products are marketed in the U.S. primarily through an extensive network of professional manufacturer's reps, all specialists and experts in electrical enclosures. Allied Moulded has expanded its global reach, with the addition of Allied Moulded Enclosure Products (India) Pvt Ltd., serving India and the Middle East markets.



ALLIED MOULDED PRODUCTS, Inc.

800-722-2679
sales@alliedmoulded.com
www.alliedmoulded.com

AutomationDirect takes the best ideas from the consumer world to serve the industrial market. As a direct seller of industrial automation products for more than 20 years, AutomationDirect is a leader in the industry that offers many customer services not typical with traditional distributors. The company created a print catalog, and later an online store that provides complete product information and pricing so customers can make informed decisions on their automation purchases quickly and independently.

AutomationDirect's products are practical, easy to use and offer a low cost of ownership. The company offers quality products at prices up to 50 percent lower than those of more traditional distributors. Most product programming software is free, requiring no initial or upgrade costs and no software maintenance contracts. Product offerings include programmable logic controllers (PLCs), alternating-current (AC) drives/motors, operator interface panels/human machine interface (HMI), power supplies, direct-current (DC) motors, sensors, push buttons, National Electrical Manufacturers Association (NEMA) enclosures, pneumatic supplies and more.

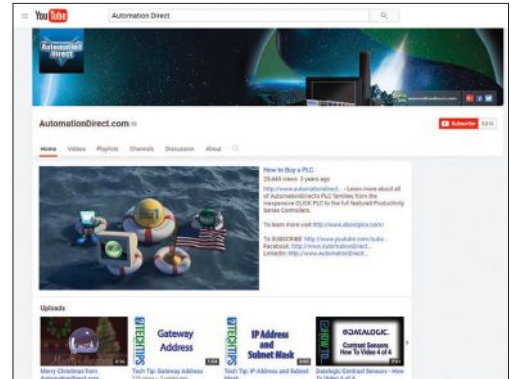


AutomationDirect's corporate headquarters near Atlanta, Georgia

Award-Winning Services Satisfy Customers

AutomationDirect has always maintained a huge inventory, allowing them to ship 99.7 percent of orders complete the same day. They were among the first to offer free two-day shipping, available for any order over \$49. Shipment confirmations and any backorder status and estimated delivery information are communicated electronically to keep you informed.

Their online store is one of the most exhaustive in the industry – all technical documentation can be downloaded free of charge, as well as software and firmware updates. Hundreds of instructional videos are available without registration. Online access to your account allows viewing and changing account information, viewing order history and making payments.



See videos on AutomationDirect's YouTube channel:
<https://www.youtube.com/user/automationdirect>

Customers can also obtain return authorizations online for quick and easy product returns or exchanges.

AutomationDirect's phone technical support staff has garnered top honors in service from industry magazine readers 15 years in a row. And, with tens of thousands of active customers, the company's online technical forum taps into that knowledge base by encouraging peers to help each other with applications and other questions. Other online help includes frequently asked questions, application examples and product selection guides.

They Guarantee It

AutomationDirect wants you to be pleased with every order. That is why they offer 30-day money-back guarantee on almost every product they sell, including software (see Terms and Conditions for certain exclusions).



sales@automationdirect.com
1-800-633-0405 • www.automationdirect.com

Are you ready for batch size one? The new generation of 'digital native' consumers expects no less.

The concept is for the consumer to order on line, to produce and package customized products inline, and ship direct from your smart factory to the consumer.

B&R Industrial Automation is singularly capable of providing the adaptive machine technologies to enable your mass customization strategy.

Dedicated machine designs are giving way to base machine modules that are configured to production requirements, reconfigured as needed and support 'batch of one' operations.

The result is a new category of machinery, *the adaptive machine*. Download B&R's white page on this topic at <http://bit.ly/2EOdPLu>.

At its core is track technology, with each product transported and processed on an independently controlled shuttle for unprecedented flexibility.

With the adaptive machine, 'changeover' is obsolete, as changes can take place with every cycle. Dedicated machine designs are giving way to the adaptive machine, enabling batch size one to compete for consumers who are 'digital natives.'

Along the way, tasks are performed with speed and precision by synchronized robot arms and devices. This performance is made possible by an advanced automation platform, characterized by a single controller, running a single integrated software application on a single powerful processor. It's definitely not your average PLC — but it has the same familiar look and feel to technicians and operators.



Marc Ostertag

*President, B&R Industrial Automation
North America*

B&R Industrial Automation is leading the trend, combining track technology with scores of complementary automation software functionalities.

*The world is changing,
and it is an exciting time
to be in automation.
Won't you join with us?*



Batch size one gives manufacturers a direct-to-consumer e-commerce strategy

Adaptive machinery is now entering the market and will have a profound impact on e-commerce, consumer goods processing and packaging, assembly, medical device and kit production, and much more.

Learn more by requesting our white paper, *The Adaptive Machine: Design Strategies & Attributes*, by emailing us at marketing.us@br-automation.com.

Stay informed with the latest automation trends and news by subscribing to our digital magazine, *Automation Strategies* at <http://bit.ly/2EOmaif>.

PERFECTION IN AUTOMATION
A MEMBER OF THE ABB GROUP



770-772-0400 • office.us@br-automation.com
www.br-automation.com

Beckhoff Automation is a global provider of open automation systems based on advanced PC Control technology. The “New Automation Technology” philosophy at Beckhoff represents universal and open automation solutions used in a wide spectrum of high-tech applications around the world. These applications range from control of machines and robots used in manufacturing, to Internet of Things (IoT) systems, intelligent building automation and much more.

The world headquarters of Beckhoff Automation is in Verl, Germany while the US headquarters is in Savage, Minn. (Minneapolis area).



US headquarters in Savage, Minnesota

System-Integrated Solutions for Automation and IoT

The comprehensive Beckhoff system architecture for machine and plant automation promotes control hardware consolidation by advancing powerful PC-based control technology. This approach takes the best from automation technology (AT) and IT, making the most powerful tools available to engineering teams in one universal environment.

All the benefits from the early days of this effort remain from the integration of PLC, motion control and HMI, while adding other high-value functions for robotics, safety, high-end measurement, condition monitoring, and of course, cloud connectivity and IoT.

Beckhoff has machine builders and manufacturers covered whether they need to gather and store process data in the cloud, integrate condition monitoring or implement track-and-trace functions in machinery. With TwinCAT IoT and TwinCAT Analytics software, machines directly benefit from Industrie 4.0 and IoT functionality.

Engineering efficiency is greatly increased because the software packages share the same universal platform as all other machine programming tools from Beckhoff.

Aurelio Banda

CEO and President,
Beckhoff Automation



The “New Automation Technology” philosophy at Beckhoff represents universal and open automation solutions used in a wide spectrum of high-tech applications around the world.

Another significant innovation from Beckhoff is EtherCAT P technology. With EtherCAT P, Beckhoff unites EtherCAT communication and power supply in a standard, 4-wire Ethernet cable. Innovative, space-saving One Cable Automation technology integrates the 24 V DC supply of the EtherCAT P slaves with the signals and data from connected sensors and actuators.

For more information:
www.beckhoffautomation.com

BECKHOFF

Emerson is, at heart, an engineering and technology company. We are innovators, problem-solvers, and industry leaders working to ensure human comfort and health, protect food quality and sustainability, advance energy efficiency and create sustainable infrastructure.

Our industry offerings in heating, ventilation, air conditioning and refrigeration (HVACR) and building automation bring quality, reliability and efficiency to building systems, making us a key partner to many leading OEMs.



The Helix Innovation Center on the campus of the University of Dayton

Leading in Human Comfort

Emerson has decades of experience in residential and commercial HVAC. We pioneered the Copeland Scroll compressor technology that today powers home and commercial AC systems around the world, efficiently and reliably. We have been at the forefront of enabling environmentally friendly refrigerant changes to protect our environment.

Today, we offer a broad portfolio of modulating compressors, including two-stage, variable speed and tandem/trio compressor configurations that enable the industry's most efficient and reliable systems.

Our focus on comfort extends to automated and remotely-monitored control

systems for commercial buildings, including the new Sensi Multiple Thermostat Manager, our latest innovation to leverage Internet of Things technology to help ensure human comfort and health.

Protecting Food Quality

At Emerson, we are a leader when it comes to managing the Cold Chain. We help safeguard food, reduce energy consumption, protect the environment and optimize business results for supermarkets, convenience stores, restaurants, retailers and transportation using compression technology, integrated controls, connectivity, monitoring, services and insight solutions.

Emerson's ProAct Services portfolio, includes technology, data, services, software and expertise that assures quality and integrity of conditions management wherever commercial goods are moved, stored or sold. Systematic measurement of cost drivers provides a powerful basis for everyday decision-making by allowing key participants in the cold chain to quickly identify opportunities for operational improvement.

Emerson's newest facility control platform, Site Supervisor, allows large and small format retailers to quickly and economically support monitoring, optimization and control over key store systems. Site Supervisor controls manage refrigeration systems, HVAC, lighting and more.

Advancing Energy Efficiency

Efficiency and energy savings are key design elements to many of our solutions to the HVACR industry.

Brent Schroeder

Group President of Heating and Air Conditioning



In addition to our compression and control solutions, our relationship with Transformative Wave allows us to provide innovative HVAC retrofit technology with the CATALYST. More than a controller and more than a variable frequency drive (VFD), this offering is a complete HVAC energy efficiency upgrade that radically lowers energy use and improves the overall performance of constant volume HVAC systems.

Emerson is where technology and engineering come together to create solutions for the benefit of our customers.

Driven by Innovation

Emerson is where technology and engineering come together to create solutions for the benefit of our customers. Our network of Helix Innovation Centers has hosted thousands of our partners and customers and we are working daily to address the biggest challenges our industry sees now and in the future.



www.emerson.com

Lately, every article or webinar we see with reference to consumer electronics or industrial automation, talk about IoT or IIoT. So what exactly is all the hype about? According to TechTarget, *The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction*¹. In short, it is a means of having two or more devices sharing information without any human interaction.

Specific to the Industrial Internet of Things (IIoT), it focuses on the interconnectivity and utilization of powerful data in a manufacturing environment. IIoT enables the acquisition and accessibility of important plant data at far greater speeds, security and reliability. IIoT incorporates machine learning and big data technology, harnessing the sensor data, machine-to-machine communication and automation technologies that have existed in industrial settings for years. The driving philosophy behind the IIoT is that smart machines are better than humans at accurately, consistently capturing and communicating data. The driving force behind IIoT's data communication is the industry accepted Messaging Queuing Telemetry Transport protocol or MQTT.

Manufacturing outfits around the world both small and large are quickly adopting the concept of IIoT to monitor productivity of their machines and furthermore perform preventative or predictive maintenance to reduce machine downtime and increase their revenues! By having machine data readily available at your fingertips, it allows plant personnel to act pro-actively on increasing productivity or conducting predictive maintenance. Equipment performance is monitored permanently to anticipate failure. Maintenance is initiated, if certain values are exceeded or if certain (wear-out) patterns are recognized. I have had the pleasure of working with Arlen Nipper, co-inventor of MQTT, and learning first-hand the benefits and power of MQTT sharing real-time data within the manufacturing environment. Hence, it only makes sense why EZAutomation is extremely proud to have the very first American Manufactured PLC that Meets IIoT!

“Program a PLC and then data just ‘appears’ in your HMI / MES / OEE / Cloud/Historian... How cool is that?”

The EZRackPLC with built-in MQTT Protocol, can be used to control a machine and/or act as a “bridge” between existing operational technologies within a plant, for example factory machines, and plant database networks, so valuable data can be shared reliably and securely. With built-in communication protocols such as Allen-Bradley's Ethernet I/P, Modbus RTU & TCP/IP, Ignition's Sparkplug B, and ASCII In/Out protocols, the CPU for just \$149, can not only act as a PLC, but also as an edge-gateway device to existing PLCs. It's because of this technology companies like Ford Motor Company, which uses primarily Rockwell Automation PLCs, is using our devices as “machine health monitoring systems.”

EZAutomation
Division of **AVG**

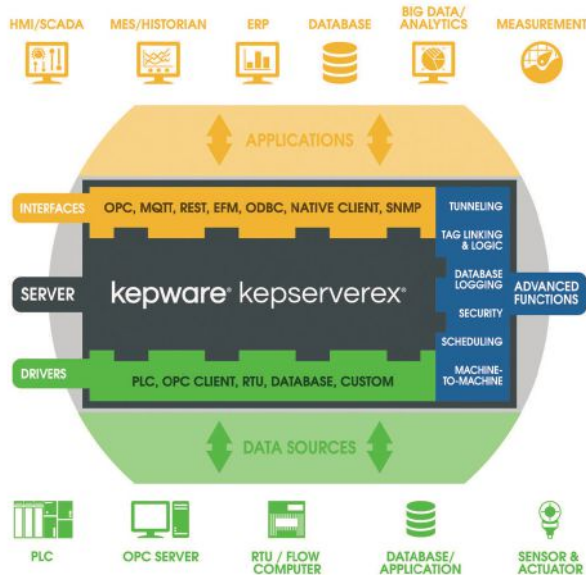
sales@ezautomation.net | 1-877-774-EASY
www.ezautomation.net

Kepware, a software development business of PTC, provides software solutions to overcome the connectivity gaps between diverse industrial automation devices and applications. Kepware's market-leading solutions are used by thousands of customers worldwide—from plant floor to wellsite to windfarm, Kepware provides a portfolio of software solutions that connect diverse automation devices and software applications and enable the industrial Internet of Things (IoT) for customers in Manufacturing, Oil & Gas, Building Automation, Power & Utilities, and more.

PTC and Kepware are at the forefront of the connected, digital transformation that is re-defining how companies create, operate, and service products. With support for both legacy and IoT-ready manufacturing technology, Kepware solutions are key components of any smart, connected factory.

KEPServerEX—Kepware's flagship connectivity platform—is the industry's leading OPC and IT-centric data connectivity platform. KEPServerEX enables users to connect, manage, monitor, and control diverse automation devices and software applications through one intuitive user interface—providing a single source of real-time industrial data to power decisions across the enterprise.

In addition to KEPServerEX, Kepware offers more than 150 drivers and advanced plug-ins. Each is designed to extend the capabilities of KEPServerEX to better suit your needs. Kepware advanced plug-ins fit the data connectivity requirements unique to your industrial control system. They extend the capabilities of KEPServerEX and increase the usefulness of raw data by transforming it into accessible and



actionable information. Kepware drivers are software components that enable KEPServerEX to meet the connectivity requirements of a specific device, system, or other data source.

Drivers handle all proprietary communications to the data source for KEPServerEX. Kepware offers the broadest range of drivers available,



PTC's Portland, Maine Office

supporting a variety of current and legacy devices and wired and wireless networks.

With IoT-ready features and seamless connectivity to legacy devices, KEPServerEX enables real-time data visibility for increased productivity, and pro-active maintenance. KEPServerEX provides the global connectivity, usability, and performance required by the enterprise—enabling improved decision-making from the shop floor to the top floor.

*KEPServerEX—
Kepware's flagship
connectivity platform—
is the industry's leading
OPC and IT-centric data
connectivity platform.*



sales@kepware.com • +1 888.KEPWARE
kepware.com

MOXA is a leading manufacturer of industrial networking, computing, and automation solutions. With over 30 years of industry experience, Moxa has connected more than 50 million devices worldwide and has a distribution and service network that reaches customers in more than 70 countries. Moxa offers a full spectrum of innovative, high-quality solutions that have been deployed in a wide variety of industries, including factory automation, smart rail, smart grid, intelligent transportation, oil and gas, marine, and mining.

Industrial Ethernet Solutions

Moxa offers a wide array of Industrial Ethernet products that feature open Ethernet infrastructure, industry-proven standards, extended temperature tolerance, environmental protection, and network redundancy to ensure network availability and reliability.

Product lines include Industrial Ethernet switches, industrial wireless devices, serial cards, serial device servers, embedded device servers, and USB and fieldbus components.



Moxa's reliability-focused solution portfolio

remote sites through Industrial Ethernet or wireless backbones. We offer computers with rugged construction, fanless operation, and an operating temperature range from -40 to 85°C, as well as a user-friendly environment that makes application development easy. Customization service is also available.

Remote Automation Solutions

Moxa has an extensive selection of intelligent and reliable RTU and remote I/O products, including modular RTU controllers, cellular RTU controllers, Ethernet RTU controllers, modular remote I/Os, and compact remote I/Os. With innovative features such as Click&Go™, a built-in control logic that simplifies programming, and Active OPC Server™ for seamless communication with SCADA systems, Moxa's RTU and remote I/O products are the ideal choice for your data acquisition, remote monitoring and alarm application.



Moxa Sales and Marketing Headquarters in Brea, California

Moxa's expertise gives industry partners the tools they need to harness the power of automation network convergence and make their operations smarter, safer, and more efficient. Moxa delivers lasting business value by empowering industry with reliable networks and sincere service for automation systems.

All products are designed to stand up to harsh environments and are ideal for deployment in mission-critical applications in fields such as maritime, oil and gas, power and utilities, rail, and factory automation.

Industrial Computing Solutions

Moxa's industrial embedded solutions are used to construct powerful front-end controllers that can execute on-site data collection and control at widely distributed

MOXA®
Reliable Networks ▲ Sincere Service

714.528.6777 • usa@moxa.com
www.moxa.com

The Internet of Things brings together people, process, data and things to make networked connections more relevant and valuable than ever before – turning information into actions that create new capabilities, richer experiences and unprecedented economic opportunity for businesses, individuals, and cities.

Industrial plants are on the forefront of this connected world. Networks with intelligent devices break open silos and connect people, processes and machines from the plant floor to the executive office.



Panduit World Headquarters in Tinley Park, IL

Industrial Ethernet has become the new standard by which systems, networks, machines, and a variety of other devices get connected. It builds the critical link between the Manufacturing Systems and Business Systems.

With a variety of new connected devices to manage in industrial environments, it can be challenging to identify and visualize where each device and system is connected. Glitches in the network, under-

performing applications, device errors or compatibility issues tend to slow down the network and eventually, generates downtime for the production process.

Each connected device can increase the level of complexity of the underlying network. Which element eats up the network? Why? Are there interoperability issues that threaten to bring the system down? Etc.

As interconnection issues become a threat to production efficiency, a larger focus will need to be placed on detection, diagnosis, and problem resolution in an increasingly complex environment. This focus leads to connected processes, correlated data and faster root causes that provide insights for making higher value business decisions.

Taking a more proactive approach to monitor, predict and fix issues before they interrupt processes can help improve both uptime and efficiency in real time. Many of our customers who are currently enhancing their manufacturing systems face challenges:

- Monitor performance across Ethernet endpoints in real-time
- Document and act on critical data
- Diagnose act and validate efficiencies from anywhere
- Troubleshoot with advanced analytic tools to maximize operational efficiencies

Steve Timian

*Vice President,
Internet of
Things Business
Development,
Panduit Corp.*



*By 2020, more than
half of major
New Business Processes
and Systems will
incorporate some
element of the
Internet of Things.*

Industrial system visualization, environmental and condition monitoring and predictive analytics address these challenges in very specific and unique industrial, retail, office and warehouse applications. These tools need to be simple to deploy and use, to enable higher value business decisions.

PANDUIT®

info@panduit.com
800.777.3300
www.panduit.com

As a world leader in drive technology and a pioneer in drive-based automation, SEW-EURODRIVE has established a reputation for quickly solving the most difficult power transmission and motion control challenges. We introduced the gearmotor in 1931. Since then, we have been bringing the best in drive technology to our customers worldwide.

Quickly solving problems so that our customers can be more productive and profitable continues to be our priority. We offer the broadest product line in the industry – from gearmotors and heavy industrial gear units to drive electronics, software and complete drive-based automation systems.

Our products are based on a unique system of modular components that can be assembled in literally millions of different configurations

Flexibility

Our products are based on a unique system of modular components that can be assembled in literally millions of different configurations so every drive solution is custom built to our customer's exact specifications. Our five regional assembly centers in the U.S. stock millions of dollars of our modular inventory for quick delivery of drive solutions and spare parts.

Reliability

At SEW-EURODRIVE our expertise doesn't stop with the sale of our products. We offer one of the most accessible customer support systems in the industry. Our trained product specialists are readily available for on-site start up assistance, application support, and maintenance services.



PT Pilot simplifies the choices and identifies a custom solution for each application

Innovation

In addition to engineering excellence, SEW-EURODRIVE is also known for innovative new products. MOVIGEAR® is an all-in-one mechatronic drive solution for horizontal material handling.

It combines the gear unit, motor, and electronics in one highly efficient and hygienically designed unit. MOVIGEAR® also eliminates excess inventory since it allows the use of a single ratio to replace several different ratios. MOVIGEAR has been proven to reduce total start-up costs and annual operating costs in your material handling system by 20-30%!



MOVIGEAR® is an all-in-one mechatronic drive solution that combines the gear unit, motor and electronics into one unit.

Support

Our PT Pilot® online drive selection tool quickly selects the perfect drive for your specific needs. PT Pilot simplifies the choices and identifies a custom solution for each application within minutes. This powerful program includes technical documentation, net pricing, CAD files, and an application calculator. *Visit ptpilot.com.*

Our customer service personnel, engineers, product specialists, and service technicians are available to answer questions and troubleshoot problems. SEW-EURODRIVE also offers on-call technical support around the clock for emergency breakdown situations.

SEW-Eurodrive...Driving the World

**SEW
EURODRIVE**

864-439-7537
www.seweurodrive.com

In 1984, the master distribution sales channel for YAMAHA robotics was launched in North America, located in Fort Wayne, Indiana, which is now known as YRG, Inc.

YRG, Inc. is comprised of a team of engineers and sales professionals. Our mission is to provide service and support for YAMAHA brand robots in North America. Many of YRG's employees have background experience in machine design and offer expertise in application design and controls integration to other peripheral devices that interface to YAMAHA controllers.



Intelligent Machinery Division of YAMAHA Motor Corporation

A Culture of Caring

YRG's culture is about taking care of our customers and end users who trust our team to help them solve their automation problems. We know how important it is for those who use our products to be able to pick up the phone and talk to someone who can provide solutions. We are passionate about doing the right thing and believe

in providing timely answers and expert solutions to everyday challenges.

Four Decades of Experience

Since 1976, YAMAHA has provided assembly robots to the industrial marketplace that are unsurpassed for payload, speed, and dependability. The current robot line-up is the culmination of over four decades' experience in YAMAHA's own plants and thousands of others around the world.

YAMAHA robots' extraordinary lifespan gives a return on investment unequalled by any other robot manufacturer. Comprised of three motor technologies, stepper-motor, AC servo and linear motors that offer economical solutions to high speed, high payload and high precision of linear motors. As a standard, reliable resolver-based feedback is included in all YAMAHA robots which are immune to dirt and vibrations.

YAMAHA offers the largest SCARA selection in the world from the

Phil Friend

General Manager, YRG, Inc.



smallest to the largest sizes handling 1 KG to 50 KG payloads, spanning 120 mm to 1200 mm in reach.

In the AC servo and linear motor family, YAMAHA offers a wide selection for all types of single and multi-axis robots.

Cartesian systems are pre-engineered, fully assembled and ready to install. These robots are superior in performance for servo dispensing, nut running, and screw driving applications where either precision velocity control is required or high rigidity is needed.

Let us know how we can help you solve your automation problems.

We know how important it is for those who use our products to be able to pick up the phone and talk to someone who can provide solutions.



Tel: 260-747-3482
sales.support@yrginc.com
www.yrginc.com

Executive VOICE CORPORATE PROFILE



ADVERTISEMENT

Balluff is one of the leading providers of high-quality sensor, identification and network solutions for your automation requirements. We live our motto “innovating automation”; we are automation pacesetters, developers and technological pioneers, and we always keep sustainability in mind.

We give our all to provide top services for innovative solutions that increase your competitive edge and lead you to a successful future through the competence of a manufacturer, production skills and high personal motivation.

Family-run for more than 90 years, the company now employs around 3,600 employees worldwide, all working towards the highest quality standards. You can always

count on our people and our products, as well as our scheduling and delivery reliability.

Founded in Neuhausen auf den Fildern in 1921, Balluff stands for progress, quality and worldwide cross-industry experience in industrial automation.

As a leading sensor and automation specialist, this 4th generation family company offers a comprehensive portfolio of innovative sensor, identification and network solutions. In 2016, the Balluff Group reported a turnover of around 378 million euros.

In addition to the company headquarters in Neuhausen auf den Fildern, Balluff has production and development facilities all around

the globe, and is represented by 68 branches and sales offices.

This global presence guarantees excellent availability for the customer, as well as high-quality advice and service on site, all around the world.

With an award winning culture, our office in Florence, Kentucky supports sales, marketing, production and warehousing for all of our North American customers.



North American headquarters in Florence, KY

Tony Canonaco
President and CEO

BALLUFF

balluff@balluff.com • 1-800-543-8390
www.balluff.us

Executive VOICE CORPORATE PROFILE



ADVERTISEMENT

Doug Stubbs has nearly 30 years of technical and commercial experience in the industrial arena. Doug has broad-based experience in multiple technologies, including adhesive and fluid management, fluid power, position sensing, networking and factory automation, covering several large-scale industries, including consumer goods, nonwovens, pulp and paper, and automotive.



Beijer Electronics' Americas operations based in Salt Lake City, UT

Since arriving at Beijer Electronics, Doug has seen the broadening of the product line and solution set. He leads the Americas sales and marketing efforts as a member of the global management team. His focus is on innovation of its flexible solutions which are designed to control, connect and present data for

business critical applications. Beijer's open software, hardware and IIoT solutions help customers optimize processes and create reliable secure communication, complete with leading-edge user experiences. Doug's goals are to make the complex simple while working with its customers to capture the opportunities of tomorrow.

Leading this offering is the X2 series of human machine interfaces (HMIs) and open PLC products for industrial OEMs, machines builders, and systems integrators. With over 50 models and configurations, there is an X2 product for most applications, from food/beverage, packaging, pharmaceutical, and traditional manufacturing to pulp & paper, water/wastewater, maritime and oil/gas.

All X2 operator panels are programmed by its iX Developer software. iX Runtime is included in all of its HMIs, as well as sold separately for PC applications. All configurations can be coupled with Beijer Electronics' WARP Engineering Studio and its remote IO modules to create integrated control and visualization solutions.

Doug Stubbs
Vice President - Americas

Beijer Electronics' global HQ is based in Malmö, Sweden and is directly present in over twenty-two countries; twice that with its distribution partners. It is listed on the NASDAQ OMX Nordic Exchange Stockholm's Small Cap list under the ticker BELE.

Beijer ELECTRONICS

Phone: 1.801.466.8770
www.beijerelectronics.com
www.beijerinc.com

Executive VOICE

CORPORATE PROFILE



ADVERTISEMENT

Digi-Key Electronics, a global Internet-based distributor of electronic components, is an authorized distributor of more than 6 million components, including over 1.3 million in stock, from more than 650 trusted suppliers. The company's reputation extends worldwide through the continuous choice of Digi-Key's customers as the provider of the widest range of electronic components in the industry, ready for immediate delivery. With this wide range of products available in both design and production quantities, Digi-Key is the best resource for designers and buyers alike.

Product availability is one of the distinguishing features of Digi-Key from other electronic

component distributors. They stock over 1 million products at its distribution center in Thief River Falls, MN. New products are added every day, in a continuous effort to offer the full range of electronic components required by the customer.



Headquarters in Thief River Falls, MN

Whether semiconductor, passive, interconnect, electromechanical, wireless or lighting components, Digi-Key will carry the parts you need when you need them.

The company offers a vast selection of online resources including a range of EDA and design tools, reference design library, on-demand multimedia library, a comprehensive article library, and community forums, among others. Digi-Key also offers numerous Supply Chain solutions such as bonded inventory and just-in-time shipping, as well as a newly updated BOM manager.

Digi-Key prides itself on the ability to provide the best possible service to customers. A customer can request electronic components or reach the talented team of technicians and application engineers 24 hours a day, seven days a week, 365 days a year, either by phone, fax, e-mail or through the website.

Dave Doherty
President and COO

From prototype to production, Digi-Key has the resources and products to take your design to the next level! Find out more at www.digikey.com.



sales@digikey.com
1-800-344-4539
www.digikey.com

DIGITAL REPORTS

HMI
IIoT: Machines, Equipment & Asset Management
Machine Vision
Motion Control
PLC

www.controleng.com/DigitalReports

**CONTROL
ENGINEERING**



Your place for new products, literature, Apps, Videos, Case Studies and White Papers.

X2 series

Strong. Stylish. Smart.



The X2 series is the next generation of HMIs from Beijer Electronics. Six product families combine great design with strong performance to power your HMI solutions.

► Learn more at beijerelectronics.com/x2

Beijer
ELECTRONICS

Input #100 at controlengineering.hotims.com

MULTI-CONTACT connectors

With Silver-Nickel Butt-Style Contacts for Maximum Performance & Durability



FEATURES AVAILABLE

7 to 37 contacts
4mA to 150A per contact
Easy-to-wire contact terminals

meltric.com
800.433.7642 **MELTRIC**

Input #101 at controlengineering.hotims.com

Handy Temperature Reference Guide



Compact 110 page, open-flat guide with sensor basics, RTD and EMF tables, measurement tips, materials and wire composition info, and more.

Get your **FREE Copy** now!

Visit miinet.com/temperatureguide

MOORE INDUSTRIES
WORLDWIDE
Demand Moore Reliability

Input #102 at controlengineering.hotims.com

Want to receive your *Control Engineering* magazine as a digital publication?



Update your subscription, and get our digital edition, on a more interactive and user-friendly platform, in your email in-box.

Update now at:
www.controleng.com

Input #103 at controlengineering.hotims.com

POWER + CONTROL In 1 Connection

Up to 5 contacts for POWER + 6 contacts for CONTROL



Provide electrical power and control motor drives, communicate alarms or monitor process parameters with only 1 connection.

Ratings up to 250A, 600V, Type 4X

meltric.com
800.433.7642 **MELTRIC**
A COMPANY OF MARECHAL ELECTRIC

Input #104 at controlengineering.hotims.com



Bring Remote Devices to Your SCADA System

Visit Moxa.com to learn more.

MOXA

Input #105 at controlengineering.hotims.com



TMPS Series
Miniaturized AC/DC power supply modules 3 to 5 Watt for PCB mount. For highest efficiency in low power operation or standby mode.

TRACO POWER
Reliable. Available. Now.
www.tracopower.com

Input #106 at controlengineering.hotims.com

NAPCON

TO ERR IS HUMAN, TO IMPROVE IS NAPCON

NAPCON continues where human capabilities end. We use artificial intelligence to help you find and utilize powers you didn't know existed.

napconsuite.com

Input #107 at controlengineering.hotims.com

stay informed

Stay current with technology and trends in electrical, mechanical, instrumentation and automation.

CONTROL ENGINEERING

To subscribe, visit
www.controleng.com/subscribe

Input #108 at controlengineering.hotims.com

PRODUCT & LITERATURE SHOWCASE

Get it Done

Go with the Leader in Performance for Signal Conditioning and Data Acquisition

www.dataforth.com
1 800-444-7644

DATAFORTH

Input #109 at controlengineering.hotims.com

eNewsletters
Subscribe today by visiting: www.controleng.com/newsletters

Want to receive your *Control Engineering* magazine as a digital publication?

Update your subscription, and get our digital edition, on a more interactive and user-friendly platform, in your email in-box.

Update now at:
www.controleng.com

Input #110 at controlengineering.hotims.com

ContentStream

Patrick Lynch,
 Director of Content Marketing Solutions
 630-571-4070 x2210
 PLynch@CFEMedia.com

AL, FL, GA, MI, TN

Aaron Maassen,
 Classified, Product Mart,
 Media Showcase
 630-571-4070 x2216
 AMaassen@CFEMedia.com

AR, IL, IN, IA, KS, KY, LA, MN, MO, MS, NE, ND, OK, OH, SD, TX, WI, Central Canada

Bailey Rice
 (630) 571-4070 x2206
 BRice@CFEMedia.com

AK, AZ, CA, CO, HI, ID, MT, NV, NM, OR, UT, WA, WY, Western Canada

Iris Seibert
 (858) 270-3753
 ISeibert@CFEMedia.com

CT, DE, MD, ME, MA, NC, NH, NY, NJ, PA, RI, SC, VA, VT, WV, DC, Eastern Canada

Julie Timbol
 (978) 929-9495
 JTimbol@CFEMedia.com

Internation (outside U.S., Candada)

Stuart Smith
 +44 208 464 5577
 stuart.smith@ssm.co.uk

Publication Services

Jim Langhenry, Co-Founder/Publisher, CFE Media
 JLanghenry@CFEMedia.com

Steve Rourke, Co-Founder, CFE Media
 SRourke@CFEMedia.com

Trudy Kelly, Executive Assistant,
 630-571-4070, x2205, TKelly@CFEMedia.com

Elena Moeller-Younger, Marketing Manager
 773-815-3795, EYounger@CFEMedia.com

Kristen Nimmo, Marketing Manager
 KNimmo@CFEMedia.com

Brian Gross, Marketing Consultant, Global SI Database
 630-571-4070, x2217, BGross@CFEMedia.com

Michael Smith, Creative Director
 630-779-8910, MSmith@CFEMedia.com

Paul Brouch, Director of Operations
 PBrouch@CFEMedia.com

Michael Rotz, Print Production Manager
 717-766-0211 x4207, Fax: 717-506-7238
 mike.rotz@frycomm.com

Maria Bartell, Account Director, Infogroup Targeting Solutions
 847-378-2275, maria.bartell@infogroup.com

Rick Ellis, Audience Management Director
 303-246-1250, REllis@CFEMedia.com

Letters to the editor: Please e-mail your opinions to
 MHoske@CFEMedia.com or fax 630-214-4504. Letters should
 include name, company, and address, and may be edited.

Information: For a Media Kit or Editorial Calendar,
 email Trudy Kelly at TKelly@CFEMedia.com.

Marketing consultants: See ad index.

Custom reprints, electronic: Brett Petillo
 Wright's Media, 281-419-5725, bpetillo@wrightsmedia.com

CONTROL ENGINEERING

ad index

Company	Page#	RSN	Web
2017 Programmable Controller Software & Hardware Study . . . . .	.21		www.controleng.com/2017ControllersReport
ABB Drives and Controls . . . . .	.43	17	www.new.abb.com/drives/us/acs580-campaign
Allied Electronics . . . . .	.7	5	www.alliedelec.com
AutomationDirect . . . . .	.C2, IFG, OFG1, 22		www.automationdirect.com
BALLUFF . . . . .	.21 . . . . .	.11	www.balluff.com
Beckhoff Automation LLC . . . . .	.45	19	www.beckhoff.com
Beijer ELECTRONICS . . . . .	.40	15	www.beijerelectronics.com/x2extreme
CONTEMPORARY CONTROLS . . . . .	.5	4	www.ccontrols.com/machine
<i>Control Engineering</i>			
Digital Reports . . . . .	.60		www.controleng.com/DigitalReports
EZAutomation	Bellyband		www.EZAutomation.net
HELUKABEL USA, Inc. . . . .	.41	16	www.helukabel.com
Kepware Technologies . . . . .	.1	2	www.kepware.com/CE
Moore Industries - Intl. Inc. . . . .	.4	3	www.miinet.com
Moxa Technologies . . . . .	.2		www.moxa.com
Panduit . . . . .	.14	9	www.panduit.com
ProComSol . . . . .	.13	8	www.procomsol.com
SEW-EURODRIVE, Inc. . . . .	.9, C4	6, 21	www.seweurodrive.com
Siemens . . . . .	.11, 15	7, 10	www.usa.siemens.com/controllers-ce
TRACO POWER . . . . .	.44	18	www.tracopower.com
Yaskawa America, Inc. . . . .	.C3	20	www.yaskawa.com
Inside Process			
Allied Moulded Products, Inc. . . . .	.P4	14	www.alliedmoulded.com
Load Controls Inc. . . . .	.P3	13	WWW.LOADCONTROLS.COM
WAGO Corp. . . . .	.P2	12	www.wago.us

REQUEST MORE INFORMATION about products and advertisers in this issue by using the <http://controleng.com/information> link and reader service number located near each. If you're reading the digital edition, the link will be live. When you contact a company directly, please let them know you read about them in *Control Engineering*.

Robbie Peoples, Cross Co.

Ten control system programming best practices

Best practices for programmers include defining their structure, knowing the system resources and tools, consistency, and keeping track of changes during a project.

Control system programming is an art and a science. The use of multiple tools, languages, and functions allows engineers to produce creative solutions. With multiple methods and tools available, the road to success can vary. Programming standards are methods of coding that have been declared acceptable and are defined and supported typically by control system vendors. Ten best practices can help provide a baseline to help ensure consistent success for programmers.

1. Define the structure: When developing a program from scratch or augmenting an existing program, programmers must step back from the details and define a structure. This provides a clear plan of how to divide up the functions, variables, and provide a logical arrangement. Segmentation of functions allows for a design that easily can be expanded and followed by other programmers. Start by developing a visual diagram of how the code will be structured.

2. Provide documentation: Supporting documentation of functional requirements and/or specifications is essential to allow developing functions. Just as important are supporting documentation of the programming standards that will be used to achieve the objectives defined in the specifications.

3. Plan for change: When developing a system, it is important to plan for future expansion, changes, and reductions.

4. Know system resources: System resources are a vital part of what makes software run efficiently. The last thing programmers want to do is overburden the system's capabilities, which could cause latency or even crash the system.

5. Reuse code: The easy part of control systems is that the same functions can be reused to achieve the logic task at hand. Programmers do not want to hard-code the same functions, which would incur additional costs and extra time to make changes to an application that is programmed not using function calls.

6. Be consistent: Consistency is a common element to success on many levels. Programming is no different. Reverse engineering a control system to follow a design concept and find inconsistent practices is frustrating. This shows immaturity in a design and can cause multiple issues over the control system life cycle.

7. Know your tools: Good programmers should have a good understanding of all accessible tools. If programmers don't stay abreast of what's currently available, they are cheating themselves and potentially losing work efficiency. Take the time to test the programming tools to ensure programming and deployment use the most efficient methods.

8. Practice good housekeeping: Good housekeeping within a program is always a good practice. In some cases, programmers have to build functions or things to help manage the data and keep the work area clean to avoid confusion. Being organized promotes efficiency and professionalism.

9. Comment on code: Commenting should be performed at each level. Meaning, each function itself should have a brief comment, but each section of code should include a header comment to explain the breakdown. Then, the application as a whole should be commented on to help the subsequent programmer to follow a consistent train of thought. Comments should be concise, consistent, and written during programming.

10. Track changes: Keeping track of changes within an application is essential to maintaining it over the lifecycle. Change logs should be incorporated into the application and preferably in the header section for overall changes. If changes are needed at the function layer, they should be reflected in the overall header and at the comment layer in the function.

Projects with solid solutions enable businesses to thrive in the manufacturing environment. **ce**

Robbie Peoples is an integration manager at Cross Co. Integrated Systems Group. This article originally appeared on Cross Company's Innovative Controls blog. Edited by Chris Vavra, production editor, Control Engineering, CFE Media, cvavra@cfemedia.com.



KEYWORD: Control system programming

Control system programming best practices should provide a baseline for a project so a new programmer easily can step in if needed.

Programmers should be consistent and knowledgeable about tools.

Following best practices in control system programming provide usability, flexibility, and maintainability for developers and end users.

GO ONLINE

For more programming advice, read this article at www.controleng.com.

CONSIDER THIS

What other best practices should programmers consider for control systems?

YASKAWA

Iconic Since 1967



Delivering the Future in America for 50 Years

Building on our 50-year reputation for delivering revolutionary innovation, Yaskawa America promises to maintain the culture that provides the products, processes and people that enable our customers to do what they do – better.



Leading Innovation • Quality Products • Industry Knowledge • Personal Service • Custom Solutions

input #20 at www.controleng.com/information

Yaskawa America, Inc. Drives & Motion Division 1-800-YASKAWA yaskawa.com



For more info: <http://go.yaskawa-america.com/yai1128>



Byte Me!

Go ahead...talk nerdy to us. We'll byte back. That's because our fieldbus cards and gateways can speak your language. We can also eliminate all of your C++ or C# programming. That's right...no special language needed! Finally, you can easily and dramatically reduce the startup time on conveyors, hoists, turntables and many other applications. So, keep your bus and leave the driving to us.



SEW
EURODRIVE

— Driving the World —

seweurodrive.com / 864-439-7537

input #21 at www.controleng.com/information